Golden Jubilee Publication

IGFRI

Green Fodder Healthy Livestock

FORAGE CROPS VARIETIES

भारतीय चरागाह एवं चारा अनुसंधान संस्थान

Indian Grassland and Fodder Research Institute

Jhansi - 284 003


DINANATH
BUNDEL-2

Forage Crops Varieties

भारतीय चरागाह एवं चारा अनुसंधान संस्थान
Indian Grassland and Fodder Research Institute
Jhansi 284 003

Printed : January, 2011

Citation : Pandey KC and Roy AK 2011.Forage Crops Varieties. IGFRI Jhansi (India)

Compilation : KC Pandey
AK Roy

Assistance : GP Nigam
KP Rao

Production : VK Bharti
Ashok Shastri
DIPA, ICAR

Published by : Director
Indian Grassland and Fodder Research Institute
Jhansi 284 003 (Uttar Pradesh)

Phone : 91-510-2730666
Fax : 91-510-2730833
Web : http://igfri.ernet.in
E-mail : igfri@igfri.ernet.in

Cover Page	:	*Top Left*	:	*Zea mays* L.
		Bottom Left	:	*Trifolium alexandrinum* L.
		Top Right	:	*Pennisetum glaucum* L. R. Br. Emend. L. Stuntz
		Bottom Right	:	*Stylosanthes hamata*
Back Cover	:	*Top Left*	:	*Pennisetum purpureum* × *P. glaucum*
		Middle Left	:	*Sorghum bicolor* (L.) Moench
		Bottom Left	:	*Avena sativa* L
		Right Top	:	*Vigna unguiculata* (L.)
		Middle Right	:	*Cyamopsis tetragonoloba* L. Taub
		Bottom Right	:	*Panicum maximum* Jacq.

Laser typeset by Xpedite Computer Systems, D-20, 2nd Floor, Ranjit Nagar Commercial Complex, New Delhi 110 008 and printed at M/s Royal Offset Printers, A-89/1, Naraina Industrial Area, Phase-I, New Delhi 110 028.

Foreword

FORAGES are although not directly used for human consumption but they are the source of protein and fat *i.e.* meat, egg, milk and other dairy products that become available to human beings through intermediaries like cattle, sheep, goats, poultry etc. Since feeding alone accounts for 60-70% of the total cost of milk production, availability of adequate nutritious fodder coming from cheaper sources assumes greater importance.

Considering the huge gap between the demand and supply of green nutritious fodder and quality dry matter along with the static or decreasing land availability, efforts at various SAUs and institutes mainly IGFRI Jhansi were directed to intensify forage production per unit area per unit time, which can be achieved through improved high yielding varieties and better management practices. These efforts led to development of more than 200 varieties in different fodder crops.

Though significant developments have been made in the development of varieties, no serious effort has so far been done to compile and document these at one place. The present document is an effort in this direction to collect, compile and edit various information related to fodder variety development.

Fodder crops pose a unique problem as they are highly area, location and season specific. In different parts of the country different crops are used as fodder crops and often efforts were successful in developing varieties in crops, which are highly location specific. Compiling all this scattered information at one place is a huge task and has been accomplished to a great extent, for which authors need special appreciation.

The availability of green forages from various sources is only 40% of the required quantity. It is matter of prime concern to bridge this gap. This is also to note that the area under forage production has not increased considerably in the last few decades and our natural grazing lands and pastures are fast degrading. Hence, efforts should be directed to intensify forage production per unit area per unit time, which can be achieved through improved high yielding varieties and better management practices.

January, 2011
New Delhi

(Swapan K. Datta)
Deputy Director General (Crop Sciences)
Indian Council of Agricultural Research

Preface

CONCERTED multidisciplinary efforts in last 50 years mainly in last 3 decades have led to significant improvement in forage production. This has been accomplished despite shrinking or static cultivation area. Multidisciplinary efforts involving scientists from wide ranging disciplines such as plant improvement, plant protection, plant physiology and biochemistry, animal nutrition have led to development of more than 200 varieties in fodder crops. These varieties have made significant changes in fodder production scenario where fodder is fast becoming a component of agri-business from backyard cultivation.

With growing realization of importance of forage crops in agriculture and livestock industry, it is becoming pertinent to pay more attention on the improvement of forages. From breeding point of view, forage crops have not been exploited to the extent as in the case of other cash crops.

Information on development of forage crop variety is available scattered at many places as fodder crops are highly area, location and season specific. More than 50 species are being used as forage in different parts of the country, out of which about 30 has attracted attention of scientists for developing new cultivars. The information about these varieties are lying scattered and the present effort is a step in the direction of collecting, compiling and editing of this information for the benefit of scientists, students and policy planners.

Although every effort have been made to collect as much information as possible but still we feel that a lot of scope remains for further improvement.

We sincerely request readers and scientists to kindly provide us more information available with them regarding forage crop varieties which will help us to improve the present document.

January, 2011
Jhansi (UP)

(K.C. Pandey)

(A.K. Roy)

Contents

I. Cereal Forages

1. JOWAR (SORGHUM)

Botanical Name : ***Sorghum bicolor* (L.) Moench**
Family : **Poaceae (alt. Gramineae)**
Subfamily : **Panicoideae**
Tribe : **Andropogoneae**

Introduction

Sorghum is indigenous to Africa, and most of prevalent varieties originated on that continent. Sorghum was also grown in India before recorded history and in Assyria as early as 700 BC. Sorghum, besides being fifth most important cereal crop of the world, is also valued for its fodder and stover. Sorghum fodder is suitable for silage and hay making. In India, fodder sorghum is grown in 2.6 m ha mainly in western UP, Haryana, Punjab, Rajasthan and Delhi and fulfills over two third of the fodder demand during *Kharif* season. Forage sorghum plant grows 6 to 12 ft tall and produces more dry matter tonnage than grain sorghum.

Sorghum is fast-growing, warm weather annual that can provide plenty of feed in mid-summer during lean period. Sorghum is best suited to warm, fertile soils whereas cool, wet soils limit its growth. The crop tolerates drought relatively well, though adequate fertility and soil moisture maximize sorghum yields. The plant becomes dormant in the absence of adequate water, but it does not wilt readily. Growth resumes when moisture conditions improve.

Sorghum plants, particularly young plants, contain an alkaloid, which releases hydrocyanic, or prussic acid, when hydrolyzed. This can be toxic to livestock. When the crop is cut and field-cured, or is ensiled, the hydrocyanic acid degrades (2 to 3 weeks after ensiling), greatly reducing the toxicity. During periods of drought or other stresses, sorghum tend to accumulate nitrates, which can be toxic to livestock. If retarded crop growth is observed, forage needs to be analysed for excessive nitrates before feeding. In the case of high nitrate levels, the forage should be ensiled or combined with other feeds low in nitrate to reduce daily nitrate intake.

The buds formed at the nodes often develop into branches. Buds that form near the crown develop into grain-producing tillers. The tillers develop their own roots but remain attached to the old crown. The culms or stalks of forage sorghums are juicy. If the pith is not juicy, the midrib of the leaf becomes white because of the air spaces in the tissues; when these air spaces are filled with juice, the colour is more neutral. Because of this difference in moisture content, optimum time for silage varies for juicy and non-juicy stalked varieties.

Another variation between varieties is the sweetness of the juice within the stalk, which is not related to juiciness. Sweet forage sorghum is preferred by livestock and likely to be consumed more if used as green chop, hay or bundle feed. Stalk sweetness appears to be of no concern if the crop is to be ensiled because most of the soluble plant sugars are converted to organic acids in the fermentation process.

Under drought conditions, sorghum leaves tend to fold rather than roll. A heavy white wax (bloom) usually covers sorghum leaf blades and sheaths, protecting them against water loss under hot, dry conditions.

Botanical Description

The plants are annual or short-lived perennial without rhizomes; culms 0.3–4 m tall often robust, the nodes glabrous or pubescent. Leaf-blades variable, often large, 5–75 cm long, 5–70 mm wide. Panicle linear to broadly spreading, 10–60 cm long; primary branches compound, ultimately bearing racemes of 2–7 spikelet pairs. Sessile spikelet lanceolate to narrowly ovate, 4–9 mm long, glabrescent to white pubescent, sometimes tomentose or fulvously pubescent, awnless or more often with an awn 5–30 mm long. Pedicelled spikelet linear to lanceolate, male or barren, smaller than the sessile.

Cultivation Practices

Normally 2–3 harrowings are required before taking up planting as rainfed crop and sown with the onset of monsoon. Seed rate is 10 kg/ha for single cut and 25 kg/ha for multi cut sorghum. Optimum spacing is 45 cm between rows for multicut sorghum and 30 cm for single cut sorghum. Fertilizer application of 100 kg N and 60 kg P_2O_5/ha for multicut sorghum and 80 kg N and 40 kg P_2O_5/ha for single cut sorghum is recommended. In forage sorghum, the mixed cropping is also practiced with fodder legumes, viz., Pigeon pea, cowpea and cluster bean, in 2:1 ratio to improve fodder yield and quality.

Since HCN is present in sorghum especially in early stages up to 40–50 days, proper care has to be exercised during harvesting for avoiding HCN poisoning. Single cut varieties are harvested from 50% flowering to full bloom and in multi cut varieties, the first harvest is taken at 55 days after sowing and subsequent cuts at 40 days interval.

VARIETIES

Single cut

Pusa Chari-1: It was developed by IARI, New Delhi by selection from germplasm collected from Uttar Pradesh. It was released in 1974. It is resistant to lodging, drought and pests. The variety is highly responsive to fertilizers. Green fodder yield is 28 t/ha and dry matter yield is 8.9 t/ha..

Haryana Chari (J5-73/53): The variety was released for all sorghum growing areas in 1976. It was developed by selection from germplasm collected from Uttar Pradesh by CCS HAU, Hisar. This variety has medium tall plants and the seeds are creamy white in colour. The variety is susceptible to red leaf spot and stem borer. The green fodder yield is 30 t/ha and dry matter yield is 9 t/ha. (CVRC- Notification no. 786 dated 2nd February 1976)

SL-44: The variety was developed by PAU, Ludhiana following intervarietal hybridization (JS-263 × SSG 59-3) and released in 1976 for cultivation in NW zone of the country. (CVRC- Notification no. 440 dated 21st August 1975)

MP Chari: MP Chari was released for cultivation in the entire country in 1978. It was developed by JNKVV, Jabalpur from the germplasm collected from UP, MP, Haryana and Punjab. The variety matures in 110 days and produces 30 t/ha green fodder and 10 t/ha dry matter yield. (CVRC- Notification no. 14 dated 19th December 1978)

Pusa Chari –6: The variety was developed by IARI, New Delhi and released in 1979 for cultivation in the sorghum growing areas of the country. It produces 34 t/ha green fodder and 12.5 t/ha dry matter. (CVRC- Notification no. 1572(E) dated 19th February 1980)

HC-136: The variety is a derivative of cross between 3214 × PJ 7R from CCS HAU, Hisar. It was released in 1982 for cultivation in entire country under irrigated conditions. The variety is tall growing with long and broad leaves and matures in 140 days. It is tolerant to foliar diseases. Seeds are creamy and bold. It has low HCN and tannin contents. The variety is juicy, much better than the earlier released varieties in quality characters like crude protein and digestibility. The fodder yield is 39 t/ha green and 10.8 t/ha dry. (CVRC-Notification no. 19(E) dated 14th January 1982)

Jawahar Chari-6: The variety was developed at JNKVV, Jabalpur by selection from the samples of Coimbatore local. It was released in 1981 for cultivation in MP particularly suitable for medium and heavy soils. Seeds are pearly white, bold, plant height 310 cm and variety is resistant to leaf spot disease. It produces 70.2 t/ha green fodder and 20.4 t/ha dry fodder. (CVRC- Notification no. 19(E) dated 14th January 1982)

UP Chari-1 (IS 4776): The variety was released for UP state in 1983. It was developed from a single plant selection from *Durra caudatum* (Maje Vari-Junagarh) by GBPUA&T, Pantnagar. It is not suitable for high rainfall areas. It has very low HCN and can be fed to animals at any growth stage. The green fodder yield is 33 t/ha and dry matter yield is 8 t/ha (CVRC- Notification no. 499(E) dated 8th July 1983)

Pusa Chari-23: The variety was developed by IARI, New Delhi and released in 1984 for cultivation in the entire country. The variety produces 44.5 t/ha green fodder and 16 t/ha dry matter. (CVRC- Notification no. 295(E) dated 9th April 1985)

Haryana Chari-171 (HC-171): The variety was developed by CCS HAU, Hisar from a derivative of cross between SPV-8X × IS-4776. It was released in 1984 for irrigated conditions in all sorghum growing areas of the country. HC-171 is suitable for *kharif* and summer seasons. It matures in 110 days. It has tall plants having long and broad leaves and is resistant to foliar diseases. The green fodder yield is 35 t/ha and dry matter yield is 9.5 t/ha. (CVRC- Notification no. 165(E) dated 6th March 1987)

Rajasthan Chari- 1: The variety was developed from the cross between CSV6 × NCL3 by RAU, Udaipur and released in 1981 for whole of India. The variety is resistant to stem

borer and is non-lodging. Green fodder yield is 45 t/ha and dry matter yield is 12.3 t/ha. (CVRC- Notification no. 295(E) dated 9th April 1985)

Rajasthan Chari - 2 (SU- 45): The variety was developed from selection of local sorghum in Udaipur region by RAU, Udaipur and released in 1984 for whole of India. The variety is resistant to stem borer and have high digestibility. Green fodder yield is 33 t/ha and dry matter yield is 8.3 t/ha. (CVRC- Notification no. 832(E) dated 18th November 1985)

UP Chari-2: The variety was developed by GBPUA&T, Pantnagar by intervarietal hybridization (Vidisha-60-1 × IS 6953) followed by pedigree selection. The variety was released in 1984 for north India. It is not suitable for high rainfall areas but suitable for late sown conditions. The green fodder yield is 38 t/ha. (CVRC- Notification no. 295(E) dated 9th May 1985)

Pusa Chari – 9: The variety was developed by IARI, New Delhi and released in 1985 for cultivation in the entire country. The variety produces 42 t/ha green fodder and 10 t/ha dry matter. (CVRC- Notification no. 295(E) dated 9th April 1985)

Haryana Chari-260 (HC-260) : The variety was developed by CCS HAU, Hisar and is notified for all India cultivation in 1987. HC-260 is non-sweet, tall, juicy and suitable for *karvi* making. It is resistant to foliar diseases and have early flowering and maturity. The variety produces 32 t/ha green fodder and 9.5 t/ha dry matter. (CVRC- Notification no. 834(E) dated 18th September 1987)

MFSH-3: MFSH-3 was developed by Maharashtra Hybrid Seed Co. and notified for cultivation in the entire country in 1990. The variety is a derivative of the cross between 531 Y × SG 101. It produces 65 t/ha green fodder and 14.1/ha dry matter. (CVRC- Notification no. 386(E) dated 15th May 1990)

Pant Chari- 3: The variety was developed by GBPUA&T, Pantnagar and released in 1990. It was notified for cultivation in UP. The variety produces 37 t/ha green fodder and 20 q/ha seed.(CVRC- Notification no. 527(E) dated 16th August1991)

Proagro Chari (SSG-988): The variety was developed by Pro Agro Seed Co., Aurangabad and released in 1991 for cultivation in the entire country. (CVRC- Notification no. 527(E) dated 16th August 1991)

Pant Chari- 4: The variety was developed by GBPUA&T, Pantnagar and recommended for cultivation in Uttar Pradesh (except hills) during *Kharif* season The plants are tall (350 cm), purple pigmented with dark green leaves numbering 14 per plant which are 62 cm long with light green mid rib. Average green fodder and dry fodder yield is 45–47.5t/ha and 12–12.5 t/ha respectively with 6% protein content. (CVRC- Notification no. 360(E) dated 1st May 1997)

HC-308: The variety was developed by CCS HAU, Hisar and is notified for all India cultivation for all sorghum growing areas of the country in 1996. HC-308 have tall plants with sweet stem, the leaves are long and broad and is resistant to foliar diseases. It matures in 110 days and green fodder yield is 44 t/ha green and 14 t/ha dry. (CVRC- Notification no. 1(E) dated 1st January 1996)

Pusa Chari Hybrid-106 (HC-106): The variety was developed at IARI, New Delhi and recommended for cultivation in western Uttar Pradesh, Haryana, Delhi, Punjab, western Maharashtra and Gujarat during *Kharif* and summer seasons. Plants are tall (234 cm), tillering type and leafy (about 12 leaves per plant) with green mid rib. The leaves are green with semi-drooping flag leaf, leaf length (77.3 cm), leaf breadth (6.1 cm), the panicles are semi-loose and partially sterile. The variety is moderately resistant to foliar diseases, shoot fly and stem borer. The seeds are creamish and medium bold. It takes 95–100 from seed to seed and is ready for fodder in 50–60 days. Average green fodder yield is 6.8 t/ha and dry fodder yield is 2 t/ha. (CVRC- Notification no. 360(E) dated 1st May 1997)

Gujarat Fodder Sorghum-4: The variety was developed by GAU, Anand in 2004 for cultivation in Gujarat. The variety is a derivative of the cross GJ 37 × sudan type throough hybridization and selection. (CVRC- Notification no. 1639(E) dated 17 August 1990)

Gujarat Fodder Sorghum-5: This is an early maturing variety developed by GAU, Surat and was released for cultivation during Kharif season in arid and semi-arid areas of Gujarat state in 1999. Average plant height is 276 cm with thin stem, leaves are medium with dull white mid-rib, the ear heads are very loose and glumes are straw coloured. The grain colour is pearly white and medium round. It is resistant to most of the leaf spot diseases and grain mold. The green fodder yield is 38 t/ha and dry fodder yield is 13.5 t/ha. (CVRC- Notification no. 122(E) dated 2nd February 2005)

Haryana Jowar-513 (S-513): This variety was developed by CCS HAU, Hisar and released in 2004 for north-west zone of the country. It is a derivative of S-305 (PJ-7R × SPV-80) × HC-136. The variety is recommended for cultivation in Haryana under timely sown/ normal fertility/irrigated conditions. The plant height is 245–260 cm, leaves have white midrib, the ear heads are very long, symmetric and semi-compact. It is tolerant to major foliar diseases namely, gray leaf spot (*Cercospora sorghi*), zonate leaf spots (*Gloeocercospora sorghi*) and sooty stripe (*Ramulispora sorghi*). It provides average 47t/ha green and 11.9 t/ha dry fodder yield. (CVRC- Notification no. 1178(E) dated 20th July 2007)

Double Cut

CO-27: The variety was developed by TNAU, Coimbatore and released in 1986 for cultivation in south zone of the country. The crop is ready to harvest for first cut of fodder in 60–65 days. It has thin stem, ratoonability (2–3 ratoons) and is drought tolerant. It has loose panicle with blackish purple glumes enclosing seed. It provides 40 t/ha green fodder with 9.8% crude protein. (CVRC- Notification no. 425(E) dated 8th June 1999).

Gujarat Forage Sorghum (AS-16): The variety was developed by AAU, Anand and is released for cultivation in Gujarat state in 1989.

Gujarat Forage Sorghum Hybrid-1 (GFSH-1): This variety was developed through hybridization (3600 A × IS-4776) by GAU, Banaskantha and is recommended for cultivation in whole Gujrat state excluding its southern parts in 1992. It has plant height (237–263 cm), stem thickness (11.5 mm), leaf length (73–80 cm), leaf breadth (4.7–7.2 cm) with white seed. Its plants are succulent, moderately salt tolerant and is suitable for two cuttings providing 65 t/ha green and 25 t/ha dry fodder. (CVRC- Notification no. 814(E) dated 4th November 1992)

Multi Cut

SSG 59-3 (Meethi Sudan): The variety was developed by CCS HAU, Hisar and released in 1977 for all sorghum growing areas in the north zone of the country. It is derived from pedigree selection of non sweet sudan grass × IS-263. The variety is tall and profuse tillering with quick growth. It is tolerant to drought and water logging. The stems are sweet and thin. The variety produces 75 t/ha green fodder and 22 t/ha dry fodder.

Ruchira Maldandi: The variety was developed by MPKV, Rahuri following intervarietal hybridization (35-1 × Kalbondi) with pedigree selection. It is recommended for cultivation in Maharashtra state in 1982. It has multi-cut ability and yields 40–50 t/ha green fodder and 8.2 t/ha dry matter.

Jawahar Chari-69: The variety was developed at JNKVV, Jabalpur and released in 1981 for cultivation in MP state. It was developed by hybridization (K-38 × J-98) followed by pedigree method of selection. It is a multi cut Sudan variety, the seed is covered ¾ th by black glumes, inflorescence lax, average height 250 cm, leaf long and narrow. It becomes ready for 1st cut in 55–60 days and subsequent cuttings at an interval of 40–45 days. It gives 4–5 cuts under irrigated conditions and 2 cuttings under rainfed situation. The total green fodder and dry fodder yield is 53 and 15 t/ha respectively. (CVRC- Notification no. 19(E) dated 14th January 1982)

Proagro Chari (SSG-988): This is a hybrid (PFF1 × PFG 2) × PFM 1 developed by Proagro Seed Co. Ltd, Aurangabad in 1991. The variety is suitable for cultivation in Andhra Pradesh, Gujarat, Haryana, MP, UP and Delhi. It is high tillering, thin stem, leafy, dark green in colour producing 40–45 t/ha green fodder. The variety produces 40 t/ha green fodder and 10 t/ha dry matter. (CVRC- Notification no. 527(E) dated 16th August 1991)

PCH-106 (Hybrid): The variety was developed by PAU, Ludhiana and released in 1985. It has profuse tillering and quick regeneration capacity and provides 3–4 cuts. It yields up to 65 t/ha of green fodder and is recommended for sorghum growing areas in north zone of the country.

Punjab Sudex Chari-1: The variety was released in 1994 and developed by PAU, Ludhiana. The variety was developed by intervarietal hybridization (2077 A × SGL-87). (CVRC Notification no. 408(E) dated 4th May 1995)

Harasona 855: This variety was developed by Pro Agro Seed Co., Aurangabad and released in 1994 and has been notified for cultivation in sorghum growing areas in north India, Maharashtra, Haryana, Punjab, Rajasthan, UP and Gujarat. The variety has been derived from the cross (PFS5A × PFS5C) × PFS5R followed by pedigree method of selection. It is high tillering, thin stemmed, tall, multi-cut, high in protein content, low in HCN. The green fodder yield is 60–65 t/ha. It is widely grown SSG hybrid in India. (CVRC Notification no. 408(E) dated 4th May 1995)

Safed Moti (FSH-92079): The variety was developed through hybridization (PSA 93016 × FSR 93025) by Pro Agro Seed Co., Aurangabad and was recommended for cultivation in Haryana, Punjab, UP, Gujarat in 1999. The variety is tall with thick stem and is tolerant to leaf diseases, high protein content, high DPM and low HCN. It gives 65–70 t/ha green fodder. (CVRC Notification no. 425(E) dated 8th June 1999)

Pant Chari-5 (UPFS- 32): This variety was developed by GBPUA&T, Pantnagar and released in 1999 for cultivation in all the *kharif* sorghum growing areas of Andhra Pradesh, Gujarat, Haryana, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu and Uttar Pradesh for fodder under irrigated conditions in summer. The plants are 245 cm tall, semi-erect, tan type, highly juicy and internodes are fully enclosed. The leaves are 74 cm long and 6.2 cm broad with light green mid rib. The panicles are cylindrical, semi-compact, glumes are straw coloured. The seeds are pearly white, medium bold, soft and round. It is highly resistant to anthracnose, zonate leaf spot and other foliar diseases. The nutritional qualities are good with protein content (6.58%), digestibility (47.7%) and low HCN (100.4 ppm). Average yield is green fodder 48.2 t/ha, dry fodder 13.4 t/ha and seed 18 q/ha. (CVRC- Notification no. 1050(E) dated 26th October 1999)

COFS- 29: The variety was released in 2001 and developed by TNAU, Coimbatore by interspecific hybridization followed by pedigree method of selection (TNS 30 × *S. sudanense*). It gives 5–6 cuts in one year at 60 days intervals. The leaves and stem is highly succulent in nature. It contains high protein (8.41%) and less crude fibre (34.0%). It attains 50% flowering in 65–70 days and ready for seed harvest in 105–110 days. The variety is recommended for cultivation in Tamil Nadu under irrigated conditions. The plants are 220–250 cm tall with 2.5–3.0 cm stem girth, having 10–15 tillers per plant. Number of leaves are 80–105 and leaves are 75–90 cm long, leaf breadth is 3.5–4.6 cm, leaf stem ratio 0.20–0.25. Panicle lax, 30–35 cm long, seeds are small covered with blackish purple glumes. It is tolerant to shootfly/ stem borer. Average yield of green fodder is 170 t/ha, 34.5 t/ha dry matter and seed yield is 5 q/ha. (CVRC Notification no. 1134(E) dated 15th November 2001)

CSH-20MF (UPMCH- 1101): This variety was developed by GBPUA&T, Pantnagar by interspecific hybridization (2219 A × UPMC 503). This variety was notified for cultivation in medium irrigated summer and rainfed conditions of Uttar Pradesh, Uttranchal, Haryana, Rajasthan, Punjab, Bihar and Gujarat. It has low HCN content and is highly resistant to foliar diseases and lodging under natural conditions. It is tolerant to drought and water logging. It is tall (215 cm), tan and has medium thick juicy stem with many basal tillers and long and medium broad semi-erect, stay-green leaves. This hybrid shows fast regeneration after cutting. (CVRC- Notification no. 1172(E) dated 25th August 2005)

Pusa Chari Hybrid-109 (PCH-109): It is a multi-cut hybrid developed by IARI, New Delhi and recommended for cultivation during early summer and normal *kharif* under timely sown irrigated/ rainfed areas in Delhi. The plants are 225 cm tall, semi-erect, stay green type, leafy (13/plant) with juicy stem. Its leaves are long (83 cm), broad (6.5 cm) with dull green mid rib. The panicles are semi-loose, the grains are creamy white. It attains 50% flowering in 61 days and matures in 101 days. The variety is tolerant to major foliar diseases, shoot fly and stem borer. It produces 82 t/ha green fodder and 21 t/ha dry fodder. (CVRC Notification no. 1566(E) dated 5th November 2005)

Pusa Chari-615: This variety is a derivative of the cross between Pusa chari 40 × Pusa Chari 67 and is developed by IARI, New Delhi. It has been recommended for cultivation during early summer and *kharif* seasons of NCR Delhi. The variety mid blooms in 70 days and matures in 110 days. The plants are 300–320 cm tall, erect, stay green type with 3–6 tillers in a plant. The leaves are dark green 75–85 cm long and 5.0–6.5 cm wide. The leaf stem ratio is 0.35–0.45. The panicles are semi loose. It produces 70 t/ha green fodder, 19.5 t/ha dry fodder and 12 q/ha seed. The protein content in forage is 8.1%, IVDMD 55.3% and HCN content 152 ppm. The variety is resistant to major foliar diseases and insect-pests. (CVRC Notification no. 1572(E) dated 20th October 2006)

CSH-20-MF (UPMCH-1101): The variety is a hybrid (2219 A × UPMC 503) developed by GBPUA&T, Pantnagar. It has been recommended for cultivation in medium irrigated summer and rainfed condition of U.P., Uttaranchal, Delhi, Haryana, Rajasthan, Punjab, Bihar and Gujarat. The seed to seed maturity is 105–110 days. The plants are 200–230 cm tall, erect with 4–5 basal tillers. The leaves are broad with green mid rib, semi erect with senescence up to 3–4 lower leaves. Panicles are narrow, cylindrical, semi-compact, borne on straight peduncle. The leaf stem ratio is 0.50–0.55. This is a fast growing variety with regeneration (ratooning ability) up to 4 cuttings for fodder. It produces 87 t/ha green fodder and 24 t/ha dry fodder. Nutritional qualities are: stalk semi-sweet (TSS 7–8%), crude protein (8.5–9.0%), HCN content (0–120 ppm), IVDMD (53–58%), DDM (140–152 q/ha) and protein yield (15–20 q/ha). The variety is resistant to major foliar diseases and insect-pests. (CVRC- Notification no. 1172(E) dated 25th August 2005)

Pant Chari-6 (UPMC-503): This variety was developed from selection in Zimbabwe germplasm line EC-438401 by GBPUA&T, Pantnagar. The variety has been recommended

for cultivation in Uttranchal state under rainfed conditions during *kharif* season and under irrigated conditions in summer season. It reaches mid bloom in 65–70 days and matures in 105–110 days. The plants are tall, erect, tan pigmented and stem is sweet and juicy (TSS-6–7%). The seed is red, semi-bold and circular in shape. It is resistant to major foliar diseases namely, zonate leaf spot, downy mildew, gray leaf spot and moderately resistant to anthracnose and sooty stripe under natural field conditions. It provides 80–100 t/ha green fodder and 25–35 t/ha dry fodder and 18–20 q/ha seed yield. (CVRC- Notification no. 1572(E) dated 20th September 2006)**.**

Haryana Jowar-513 (S-513): The variety was developed at CCSHAU, Hisar and is a derivative of S-305 (PJ- 7R × SPV- 80) × HC-136. It is recommended for cultivation in Haryana under timely sown/ normal fertility/ irrigated conditions. The variety is ready for green fodder harvest in 100–110 days. The plants are 245–260 cm tall with white midrib leaves. The ear heads are very long, symmetrical and semi-compact. It is tolerant to major foliar diseases like gray spot (*Cercospora* sorghi) and zonate leaf spot (*Gloeocercospora sorghi*). The green fodder yield of the variety is 49 t/ha and dry matter yield is 12 t/ha. (CVRC- Notification no. 1178(E) dated 20th July 2007).

Dual Purpose (Grain and Fodder)

JS-20: The variety has been developed by selection from the introduced material at HAU, Hisar. The variety is recommended for cultivation in Haryana, Rajasthan and Delhi state. The plants are tall and produces 30 t/ha green fodder and 10 t/ha dry matter. (CVRC-Notification no. 361(E) dated 30th June 19737).

JS 29/1: The variety has been developed by selection from the introduced material at HAU, Hisar. The variety is recommended for cultivation in humid and sub-mountanious regions of Haryana, Punjab and Himachal Pradesh. The plants are tall with non sweet thick stems. The variety produces 32 t/ha green fodder and 10.5 t/ha dry matter. (CVRC-Notification no. 361(E) dated 30th June 19737).

SPV- 669: The variety has been developed by hybridization (SPV-97 × SPV- 29) followed by pedigree selection by PDKV, Akola. The variety has been recommended for cultivation in medium to heavy soils in better rainfall areas in Vidarbha region of Maharashtra in 1988. The plants are 200–210 cm tall with thick and juicy stem possessing broad, dark green leaves. The small glumes are straw coloured. The ear-head is oblong, compact with flat top. The variety attains 50% flowering in 72 days and takes 115–120 days for maturity. It provides 12.2 t/ha green fodder and 3–4 t/ha grain.

R Hybrid CSH 13: It is a hybrid variety developed by NRC Sorghum, Hyderabad and released in 1991. It is suitable as single cut fodder. It is resistant to leaf diseases and yields about 45–50 t/ha of green fodder. It has been notified as a dual purpose variety for cultivation in AP, Tamil Nadu, Maharashtra, MP, Gujarat, Rajasthan and UP. It has round to medium bold seed and is highly tolerant to grain mold. The crop duration is 105–110 days. (CVRC-Notification no. 527(E) dated 17th August 1991).

CSV–15: A hybrid variety developed by NRC Sorghum, Hyderabad and released in 1992 as a dual purpose variety for Maharashtra. It is a single cut variety with 12 t/ha of green fodder and 36 q seed yield. Its stems are tall, sweet and juicy. It is resistant to leaf diseases and drought. It has medium bold round seed, resistant to all leaf spot diseases, tolerant to shoot fly and stem borer. Crop duration is 107–112 days. (CVRC- Notification no. 849(E) dated 20th May 1996).

K-11: The variety has been developed by TNAU, Coimbatore and is recommended for cultivation in rainfed vertisol tracts in all seasons in Tamil Nadu. Plants are 220–260 cm tall with juicy and thin stalk. The nodes are green and glabrous, the leaf mid rib is dull white and leaf sheath colour is reddish purple at maturity. The ear heads are erect, loose and semi-open, anthers are yellow at flowering and glumes are red, partially covering the grain. It is moderately tolerant to downy mildew with low incidence of *Colletotrichum* and *Cercospora* leaf spots. Average green fodder yield is 10.36 t/ha and average grain yield is 15.60 q/ha. (CVRC- Notification no. 161(E) dated 4th February 2004).

2. BAJRA (PEARL MILLET)

Botanical Name : ***Pennisetum glaucum* L. R. Br. Emend. L. Stuntz**
Family : **Poaceae (alt. Gramineae)**
Subfamily : **Panicoideae**
Tribe : **Paniceae**

Introduction

Pearl millet (*Pennisetum glaucum*) is the most widely grown type of millet. It is grown in Africa and the Indian subcontinent since prehistoric times. It is generally accepted that pearl millet originated in tropical Africa and was subsequently introduced into India. The earliest archaeological records in India dates back to 2000 BC, so domestication in Africa must have taken place earlier.

Pearl millet is well adapted to production systems characterized by drought, low soil fertility, and high temperature. It performs well in soils with high salinity or low pH. Because of its tolerance to difficult growing conditions, it can be grown in areas where other cereal crops, such as maize or wheat, would not survive. It is an important forage crop of the arid and semi-arid regions of the country. It is fed to the cattle either as green or dry. It hybridizes very well with elephant grass (*Pennisetum purpureum* Schum.) which is believed to be of African origin. Bajra is highly drought tolerant and can grow well in the areas with a rainfall of 25–75 cm. This is grown as a *kharif* crop in northern parts and also grown as summer crop in southern part of the country.

Botanical Description

Annual, in tufted clumps, the culms slender, 15–75 cm high; leaf blades linear or linear-lanceolate, 5–30 cm long, 3–10 mm broad, glabrous or with some long white hairs toward base on upper surface; spike erect, cylindrical, golden-brown in colour, 1–15 cm long, 6–12 mm broad; spikelets broadly oblong, 3–3.5 mm long, the upper lemma rugose; spikelets subtended by 4–12 bristles in each involucre, these are 3–10 mm long, finely antrorsely scabrous.

Cultivation Practices

The recommended spacing is 45 cm between rows and 10–12 cm between plants. The seed rate is 5 kg/ha. The crop responds well to applied nutrients. Besides recommended dose of fertilizers, application of 8–10 t/ha of FYM is also helpful as it conserves moisture. An application of 20–40 kg N/ha in 2 split doses is sufficient in Rajasthan, while in Gujarat, Haryana and Maharatstra, 60–80 kg N/ha is recommended as optimum. Application of 20 kg $ZnSO_4$/ha enhances grain and fodder yield. Foliar application of $ZnSO_4$/ha at tillering and pre-flowering stage also increases grain and fodder yield.

VARIETIES

Giant Bajra: The variety was developed by MPKV, Rahuri by intervarietal hybridization between Australian and local bajra from Dhule district followed by selections. The variety has been recommended for cultivation in entire bajra growing area. Plants are leafy with profuse tillering and have 9-10% protein at boot stage. The variety is good for hay and silage making. It is moderately resistant to downy mildew and ergot diseases. The green fodder yield is 50–75 t/ha. (CVRC Notification no. 295(E) dated 9th April 1985).

Raj Bajra Chari-2: The variety was developed by RAU, Jobner after two cycles of full sib selection in a population created through random mating among 20 crosses of four inbreds (originating from west Africa). It has been notified for cultivation for entire bajra growing area. The green fodder yield is 30–45 t/ha and is resistant to foliar diseases and insect-pests. At ear emergence stage, internodes are completely covered (enclosed) in the leaf sheath and the leaves are broad and shining. (CVRC Notification no. 386(E) dated 15th May 1990).

CO-8: The variety was bred by TNAU, Coimbatore by hybridization (732 A × Sweet Giant Bajra) followed by pedigree selection. It was released for entire bajra growing areas of the country. It is ready for fodder harvest in 50–55 days and produces green fodder to the tune of 30 t/ha. It has soft stem with high leaf stem ratio and is highly palatable. The variety has pale yellow green bristles on panicles at flowering. (CVRC Notification no. 615(E) dated 17th August 1993).

TNSC-1: The variety was bred by TNAU, Coimbatore and recommended for cultivation in the entire bajra growing area of the country in 1995. The variety provides 27–40 t/ha green fodder and is resistant to foliar diseases and insect-pests.

APFB-2: The variety was developed by recurrent selection in the randomly mated population at ANGRAU, Hyderabad in 1997. It was recommended for cultivation in Andhra Pradesh. It belongs to early maturity group, non-lodging, fertilizer responsive, best suited to summer and early *Kharif* sowings. The plant height is 160–180 cm providing green fodder yield 25 t/ha and dry fodder yield 5.5 t/ha in a single cut. The variety is useful for multi-cut also in the summer season.

Proagro No. 1 (FMH-3): This variety was developed by Proagro Seed Company, Hyderabad through hybridization of PSP-21 × PP-23. The variety is recommended for cultivation throughout the pearl millet growing areas of the country. The plants require 50-55 days for flowering and matures in 90-95 days. The variety is highly resistant to downy mildew and provides 75 t/ha green fodder in multi cut system and 36 t/ha in single cut system. (CVRC-Notification no 401(E) 15th May 1998).

GFB-1: The variety has been bred by GAU, Anand and released in 2005.

PCB-164: The variety has been developed by PAU, Ludhiana from five late maturing lines. It was released and notified for cultivation in north west India. (CVRC Notification no. 1178(E) dated 20th July 2007).

FBC-16: The variety has been bred by PAU, Ludhiana and notified for cultivation in the entire north-west India. This is a multi-cut variety, resistant to major diseases. The variety has low concentration of oxalates and high voluntary dry matter intake by the animals. The green fodder yield potential is 70–80 t/ha. (CVRC Notification no. 1178(E) dated 20th July 2007).

Avika Bajra Chari (AVKB-19): The variety has been bred by IGFRI- RRS, Avikanagar by selection from material collected from Nagore, Rajasthan in 2006. The variety is recommended for cultivation in the state of western Uttar Pradesh, Rajasthan, Haryana, Punjab and Tarai region of Uttarakhand. The variety is a dual purpose with green fodder yield potential of 36.7 t/ha, dry fodder 8.8 t/ha and 10.2 q/ha seed yield.

Narendra Chara Bajra-2 (NDFB- 2): The variety has been developed by NDUA&T, Faizabad and is recommended for cultivation in pearl millet growing areas in north-east zone under salt-affected soils. (CVRC Notification no. 449(E) dated 11th February 2009).

3. MAIZE

Botanical Name : ***Zea mays* L.**
Family : **Poaceae (alt. Gramineae)**
Subfamily : **Panicoideae**
Tribe : **Andropogoneae**

Introduction

Maize is one of the most important fodder crop particularly for milch animals. The crop is grown in over 0.9 million ha in different parts of the country throughout the year. It is a C4 plant having high fodder production capacity in short duration. Maize is generally grown in the areas with rainfall of 50 cm, but higher yields are achieved in 120–150 cm rainfall areas. It is susceptible to water logging. In the early stage upto 35 days after sowing, the crop is drought tolerant.

Botanical Description

Maize has a very distinct growth form; the lower leaves being like broad flags, 50–100 cm long and 5–10 cm wide; the stems are erect, conventionally 2–3 metres in height, with many nodes, casting off flag-leaves at every node. Internodes can reach 20–30 centimetres. Under these leaves and close to the stem grow the ears. The ears are female inflorescences, tightly covered over by several layers of leaves; they do not show themselves easily until the emergence of the pale yellow silks from the leaf whorl at the end of the ear. The silks are elongated stigmas that look like tufts of hair, at first green, and later red or yellow.

Cultivation Practices

The crop prefers deep, fertile, organic matter rich, well drained soils with pH 5.5–7.5. Maize do not prefer heavy clay low land soils. The alluvial soils of Uttar Pradesh, Bihar and Punjab are suitable for raising maize crop. Normally 4–5 harrowings are required before taking up planting with the onset of monsoon. A balanced application of 60–120 kg N, 40–60 kg P and 40 kg K/ha is recommended. Early maturing varieties require less quantity than full season maturity crops. It is also advisable to apply 20 kg Zinc Sulphate/ha along with basal dose of fertilizer. One fourth of nitrogen and entire quantity of phosphorus, potassium and zinc should be applied 5–7 cm deep before sowing. The rest of the dose are applied at knee high stage and after emergence of flag leaf but before tassel emergence. About 20 kg seed/ha should be sown 5cm deep into soil for good germination, seedling growth and vigour. Transplanting should be avoided as the plant can not cope up with main crop stand. A population of 65000–70000 plants /ha at harvest is optimum for realizing higher yields. For attaining desired level of plant density, a row-to-row and plant to plant spacing of 75 x18 cm or 60x22 cm should be maintained. To ensure high and stable yield, it is desirable to give 1 or 2 irrigation at critical stages (flowering and grain filling stages).

VARIETIES

African Tall Composite: The variety was bred at MPKV, Kolhapur and is a composite of seven genotypes (H-611 C, H-611, H-611 (R)C_3, K-III × EC-573 (R12) C_3, Ukiri Comp A (F) C_5 × Ukiri Comp A, (F) C_3, Chitedge Comp A and Ilonga Comp) developed through modified mass selection technique. It has more dry matter and crude protein content, more number of leaves/plant, more leaf area, good grain and seed yield potential than other grain varieties. The variety is resistant to foliar diseases and stem borer. The average plant height is 260 cm and provide 60–70 t/ha green fodder and 30 q/ha grain. It is released for cultivation throughout the country. (CVRC Notification no. 499(E) dated 8th July 1983).

APFM-8: This variety was developed at ANGRAU, Hyderabad in 1997 and is suitable for cultivation in south zone of the country. This is a synthetic variety derived from Varun (V- 41) and Palampur local varietal cross advanced by mass selection. It is leafy, non lodging, orange grain variety, plant height 180– 200 cm, sturdy plants type with dark green leaves. The seed to seed maturity is 90–95 days during *kharif* and 105–110 days in winter. It provides 35 t/ha green and 7.5 t/ha dry fodder.

J-1006: The variety was developed at PAU, Ludhiana by crossing 'Makki safed 1-DR' × 'Turpeno PB' and released in 1992 for cultivation in Punjab. It is resistant to Maydis blight, brown striped downy mildew and stem borer. (CVRC- Notification no. 4045 dated 25th November 1992).

Pratap Makka Chari 6: The variety was developed by MPUA&T, Udaipur by compositing 11 early to medium white seeded entries. The variety was released in 2008 for north-west zone of the country covering Punjab, Haryana, western UP, Rajasthan and Uttarakhand. Average green forage yield is 35 t/ha. It is a medium tall variety with relatively low ear placement. Its stem is strong, medium thick and resists lodging. The ears are long, thick with a tight husk cover. The grains are medium, flint to semi dent and orange-yellow. It matures in 90–95 days. Its green fodder yield potential is 45–50 t/ha. It is released for cultivation in Punjab.

4. OATS

Botanical Name : ***Avena sativa* L**
Family : **Poaceae (alt. Gramineae)**
Subfamily : **Pooideae**
Tribe : **Poeae**

Introduction

Oats are a crop of Mediterranean origin, the domestication dates back to ancient times. Oat seeds are reportedly found in 4000 year old remains in Egypt. The genus *Avena* comprises of about seventy species, a few are cultivated. *A. sativa* and *A. byzantina* are the main oats grown for fodder and grain. Oats are presently grown in temperate parts of the world including USA, Canada, Europe as spring-sown cultivars. In the tropical countries and higher altitude region it is grown as a winter annual. World oat production is generally concentrated between latitudes 35–65ºN and 20–46º S.

Oat is the most important cereal fodder crop grown in winter in north western, central India and is now extending to the eastern region. Oat ranks sixth in world cereal production following wheat, maize, rice, barley and sorghum. It is important winter forage in many parts of the world and is grown as multipurpose crop for grain, pasture, forage or as a rotation crop. Oats are consumed as human food and fodder for cattle. They have a high fat, protein and mineral content. It has excellent growth habit, quick recovery after cutting and good quality herbage. It is a palatable, succulent and nutritious crop. The protein quality of oat is excellent. Oat requires a long and cool season for its growth, therefore, it is successfully grown in the plains and hilly areas of the country. In India it is grown in Punjab, Haryana, Jammu & Kashmir, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh, Rajasthan, Maharastra and West Bengal. The total area covered under oat cultivation in the country is about 500 000 ha. The crop occupies maximum area in Uttar Pradesh (34%), followed by Punjab (20%), Bihar (16%), Haryana (9%) and Madhya Pradesh (6%).

Botanical Description

Culms 40–80 cm tall; Blades linear, 8–20 cm long by 4–15 mm wide; ligule chartceous, tongue-shaped, minutely hispid on backside, 2–3 mm long. Panicle open, about 10–20 cm long. Spikelets nodding, 1–2-florets, persistent, not falling off when mature, 2–2.5 cm long; glumes subequal, chartaceous, margin hyaline, rounded on the backside, 7–11-nerved, sometimes connected with tessellate nerves; lemma stiff, hairy on the lower half, 7–9-nerved, awnless or with a long straight awn arising from the backside; palea shorter than the lemma, minutely hairy on the two keels. Caryopsis hairy; tightly enclosed between the lemma and palea, hilum linear.

Cultivation Practices

Oat grows best in loam to clay loam soil with adequate drainage. They produce satisfactory yields on heavy or light soils with proper moisture. It can be grown under moderate acidic or saline conditions also. A seed rate of 80–100 kg/ha is recommended for uniform stand in oats. Low tillering varieties should be sown with 20–25 cm row-to-row spacing while high tillering type should be sown at 30 cm apart. Sowing of seed should preferably be done in line with seed drill or *pore/kera* behind the plough. Sowing time varies from one location to other. Normally, Oat sowing should be started in early October to end of November in north-west to east zone of the country. For regular supply of fodder from December to March, scattered sowing is also advocated. In general, addition of 20–25 t/ha of FYM 10–15 days before sowing with the application of 80 kg N, 40 kg P_2O_5/ha to single cut and 120 kg N, 40 kg K_2O/ha to multicut varieties promotes good crop growth. In double and multicut varieties, top dressing of 40 kg N/ha after first cut and two equal split doses of 40 kg N/ha after first and second cut should be done, respectively. Oats require 4–5 irrigations including the pre-sowing irrigation. If soil is dry, first irrigation is given before preparing the seedbed. Subsequent irrigations are given at intervals of about one month mostly after each cut. Timely irrigation improves the tillering remarkably, which contributes to higher forage yield. The harvesting of single cut oat varieties is done at 50 per cent flowering (about 50–55 days of sowing). In double cut varieties, first cut should be taken at 60 days followed by second cut at 50% flowering. However, in multicut varieties, first cut is recommended at 60 days, second cut at 105 days and third cut at 50% flowering. For seed production, the crop should be left for seed after the first cutting, which should be taken 50–55 days after sowing. For good re-growth, first cut should be taken at 8–10 cm above the soil surface.

VARIETIES

HFO - 114 (Haryana Javi - 114): The variety was released in 1974 and developed by CCS HAU, Hisar by pure line selection method from germplasm line 37/14. It is notified for cultivation in the entire country. This is an early sown variety which provides two cuts and have good tillering, synchronous flowering. The variety is tall and resistant to lodging and diseases and has bold seeds. It produces 50–55 t/ha of green fodder in two cuts, 13 t/ha dry matter and 20 q/ha seed. (CVRC- Notification no. 786 dated 2nd February 1976).

Algerian : The variety was released in 1975 and is suitable for irrigated areas. The plant height is 100–125 cm, decumbent, 2–3 stout culms, slow early growth, leaves are slightly pubescent on sheath and are medium wide, ligule is present and light green in colour, panicles are equatorial 12–15 cm long and 10–12 cm wide, rachis straight, 5–7 nodes. Green fodder yield 40–45 t/ha. (CVRC- Notification no. 440(E) dated 21st August 1975 & 13 dated 19th December 1978).

Brunker-10: It is a quick growing type with fine, smooth leaves. The green fodder yield is 45 t/ha. (CVRC Notification no. 440(E) dated 21st August 1975).

FOS-1/29: The plants of the variety are prostrate with profuse tillering and slow early growth. The leaves are fine and narrow. The green fodder yield is 40–45 t/ha in 140 days. It is suitable for growing in Punjab, Haryana, Delhi and Uttar Pradesh. It is resistant to drought and can be raised under rainfed conditions. (CVRC- Notification no. 440(E) dated 21st August 1975)

Kent: Kent was released in 1975 and is an introduction from USA. The variety has been notified for cultivation in the entire country. It is medium late and erect type with long droopy leaves. Average plant height at 50% flowering is 75–80 cm. It is resistant to rust, blight and lodging. It yields about 50 t/ha of green fodder. (CVRC- Notification no. 440(E) dated 21st August 1975 & 13 dated 19th December 1978)

Weston 11: This is an exotic introduction and has been released in 1978 and notified for cultivation in Punjab. The variety is semi erect with a height of 155 cm. The leaves are broad with smooth panicles. The day to flowering is 110 days and maturity is 160 days. The glumes are yellowish and grains are long and amber in colour. The green fodder yield is 50 t/ha. (CVRC Notification no. 13 dated 19th December 1978)

Palampur-1: This variety was developed by selection from variety Algerian by CSK HPKV, Palampur and released in 1980. It is characterized by medium maturity, profuse tillering and resistant to lodging. The variety has been notified for cultivation in Himachal Pradesh. It produces 50 t/ha green fodder. (CVRC Notification no. 371(E) dated 29th May 1982)

UPO-94: This is a variety developed by GBPUA&T, Pantnagar and released in 1981. The variety is medium late and erect with a plant height of 75–80 cm at 50% flowering. It is resistant to rust, blight and lodging. It yields about 40–45 t/ha of green fodder. (CVRC-Notification no. 19(E) dated 14 January 1982)

OS-6: OS-6 was released in 1981 for cultivation in entire country and was developed by CCS HAU, Hisar from selection of the cross between HFO 10 × HFO 55 P2. The variety has early vigour, tall, broad leaves of light green colour, medium bold seeds. Flag leaf remains erect at emergence of panicle, tolerant to diseases. The variety performs well under temperate and sub-tropical regions giving 54 t/ha green fodder in a single cut. (CVRC-Notification no. 19(E) dated 13th August 1984)

OS-7: The variety has been released in 1981 for Haryana. The variety has been developed by CCS HAU, Hisar as a progeny of the cross between HFO 10 × HFO 55 P2. It is suitable for single cut in temperate and sub-tropical regions of the country and also suitable for two cuts under irrigated areas of Haryana. The variety has early vigour, tall, broad light green colour leaves and medium bold seeds. The green fodder yield is 69 t/ha and dry fodder is 12.5 t/ha. (CVRC- Notification no. 596(E) dated 13th August 1984)

OL-9: This variety has been released in 1987 for Punjab state by PAU, Ludhiana and is developed from N.P. Hybrid × Kent. It is also cultivated in north, north-west and south hills. Green fodder productivity is 40–50 t/ha.

Bundel Jai-822: A multi-cut variety developed at IGFRI, Jhansi from a cross between IGO-4268 × Indio-6-5-1 following intervarietal hybridization and pedigree method of selection. It was released in 1989 for cultivation in central zone of the country. The variety has erect growth habit and glabrous nodes. It takes 95–100 days for flowering and matures in 125–130 days. The fodder yield is 50 t/ha green and 12 t/ha dry. (CVRC- Notification no. 915(E) dated 6th November 1989).

UPO–212: The variety was been developed by GBPUA&T, Pantnagar by intervarietal hybridization (VS-1492 × Kent) followed by pedigree breeding and selection. The variety was released in 1990 for cultivation in the north and central India under multi-cut system. The variety has light green stem with 8–10 tillers, thin and variable awns. It flowers in 140–150 days. The average green fodder yield is 60 t/ha. (CVRC- Notification no. 386(E) dated 15th May 1990).

OL-125: The variety was developed by PAU, Ludhiana by intervarietal hybridization using Appler and IPC-163 followed by pedigree breeding and selection. The variety was released in 1995 for cultivation in north-west and central zone of the country. This is suitable for single cut/multi cut and yields 58 t/ha green fodder.

Haryana Javi-8 (HJ -8): The variety was developed by CCS HAU Haryana from OS-7 × S-3021 P_{15} and released in 1997 for Haryana. It has fast growth, better regeneration and suitable for two cuts. The flag leaf of the variety remains erect at the time of panicle emergence and panicle is straight and open. The variety provides 65 t/ha green fodder and is suitable for two cuts. (CVRC- Notification no. 401(E) dated 15th May 1998).

Sabzaar (SKO-7): The variety was released in 1997 and developed by SKUA&T, Srinagar. The variety has been notified for cultivation in temperate areas of Kashmir and high altitude regions of Jammu. The variety is profuse tillering, leafy and suitable for dual purpose. It produces 35–40 t/ha of green fodder. (CVRC- Notification no. 386(E) dated 15th May 1990).

Bundel Jai- 851: The variety was released in 1998 and notified for cultivation in entire country. The variety was developed by IGFRI, Jhansi through selection from exotic Japanese germplasm “Hiugo Karyokuro”. This is a multicut variety having fast regeneration and high protein content. It can give up to 4 cuts, takes 110 - 115 days for flowering and 140–145 days for seed setting. It has prostrate growth habit but becomes erect after tillering. It gives 47 t/ha of green and 8t/ha of dry fodder. The seed yield is 1.2 t/ha and crude protein yield 0.99 t/ha. The variety possesses desirable traits such as high regeneration potential, multicut nature (up to 4 cuts), high leafiness, high tillering, and high crude protein. (CVRC-Notification no. 401(E) dated 15th May 1998).

Bundel Jai 992 (JHO 99-2): The variety was developed at IGFRI, Jhansi using intervarietal hybridization followed by pedigree method of selection. It was released in 2004 for cultivation in north-east and north-west zone of the country for single cut system. The variety has medium plant height, flowering in 100–105 days with maturity at 140–145 days. It has high quality parameters like crude protein (10.7%), IVDMD (58%). It produces 50 t/ha green fodder and 10 t/ha dry fodder. (CVRC- Notification no. 122(E) dated 2nd February 2005).

JO-1: The variety was developed by JNKVV, Jabalpur and released in 2004. The variety is suitable for cultivation in central zone of the country.

Bundel Jai 2004 (JHO 2000-4): The variety was developed by IGFRI, Jhansi by interspecific hybridization (*A. sativa*- JHO-851 × *A. maroccana* - 16/30) followed by induced polyploidy and pedigree method of selection. This is a single cut variety released in 2002 for north-east and north-west zone (Punjab, Haryana, terai region of Uttranchal and UP, Rajasthan, eastern Uttar Pradesh, Jharkhand, West Bengal, Orissa and Assam plains). It has high green fodder (50 t/ha), dry matter (10 t/ha), CP (11%), ADF ((47.9%), NDF (62.45%) and IDVMD (57.6). It is tolerant to root rot, crown rust, leaf blight and powdery mildew. (CVRC Notification no. 1572(E) dated 20th September 2006).

Harita (RO -19): The variety was released in 2007 and notified for the Maharashtra. This is a multicut variety developed by selection from base population of Kent by MPKV, Rahuri and is suitable for winter season under irrigated condition. The average yield is 50 t/ha for green forage and 9.5 t/ha for dry matter. It has high leaf to stem ratio and is resistant to leaf blight disease. (CVRC Notification no. 122(E) dated 6th February 2007).

Bundel Jai 991 (JHO 99-1): The variety was developed by IGFRI, Jhansi by intervarietal hybridization (OS7 × IGO 320-1139-19) followed by pedigree method of selection. It was released in 2007 for cultivation for hilly zone under single cut system. It is moderate to highly resistant for grasshoppers and aphids. Seed to seed maturity period is 150–155 days while seed to flowering is 120–125 days. It is moderately to highly resistant against leaf blight, moderately resistant to nematodes and grasshoppers. The variety provides 30 t/ha green fodder and 7 t/ha dry fodder and has good quality attributes, CP (9.5–10%), ADF (47%), NDF (63%), and IVDMD (57.4%). (CVRC Notification no. 1178(E) dated 20th July 2007)**.**

Bundel Jai 2001-3 (JHO 2001-3): This is a single cut variety developed from three way inter varietal hybridization (UPO 94 × IGO 320) × Akiyutaka followed by pedigree method of selection at IGFRI, Jhansi in 2003. The variety is recommended for tropical and sub-tropical areas of North- West and Southern zones of the country. The plants are prostrate but becomes erect later. Fodder quality is better, CP (9.23%), ADF (40.5%) and IVDMD (60.4%). The variety provides 51 t/ha green fodder and 10.4 t/ha dry fodder.

5. JOB'S TEAR (COIX)

Botanical Name : ***Coix lacryma jobi* blad Linn.**
Family : **Poaceae (alt. Gramineae)**
Subfamily : **Panicoideae**
Tribe : **Maydeae**

Introduction

Job's tear is a very useful and productive grass increasingly viewed as a potential energy source. Before *Zea* became popular in South Asia, Coix was rather widely cultivated as a cereal in India. Still taken as a minor cereal, it is pounded, threshed and winnowed, as a cereal or breadstuff. Coix has been reported from the Indo china-Indonesia center of diversity and tolerate laterite, low pH, photoperiodic latitude, poor soil, slope, virus and water-logging.

Botanical Description

Robust annuals; culms 100–300 cm tall, many-branched. Sheaths loose, terete, striate, glabrous; ligule membranous, 1.5–2 mm long, margins erose and minutely fringed; blades 10–50 cm long, 20–50 cm wide, glabrous but rather coarse. Inflorescences numerous, terminal and axillary, each consisting of separate pistillate and staminate racemes, cupules borne on long stout peduncles from axis of upper leaves, white or bluish, bony, lustrous, globose-ovoid, 5–15 mm long; upper pistillate floret fertile, lemma scale-like, 3–5-nerved; palea reduced to a small scale; staminodia 3; staminate raceme 3–5 cm long, the spikelets 7–10 mm long, glumes equal to the spikelet in length, coriaceous-membranous, broadly lanceolate, glabrous, smooth, lemma membranous, lanceolate, 3-nerved, glabrous, palea similar in shape and texture to lemma, 2-nerved. Caryopsis broadly ellipsoid to subglobose, 2.5–5 mm long.

Cultivation Practices

The crop is sown either by broadcast or dribbled in a well prepared soil with a seed rate of 10–15 kg/ha. Sufficient moisture is required in early stages of growth.

VARIETIES

KCA-3: This variety was developed by BCKV, Kalyani in 2004 and is recommended for cultivation in Assam, Orissa, Jharkhand, West Bengal, Meghalaya and Bihar.

KCA-4: This variety was developed by BCKV, Kalyani in 2005 and is recommended for cultivation in Assam, Orissa, Jharkhand, West Bengal, Meghalaya and Bihar.

Bidhan Coix 1: This variety has been developed by BCKV, Kalyani, and released for cultivation in West Bengal, Orissa, Assam and north Bihar. The average green fodder, dry matter and crude protein yield is 34.6 t/ha, 6.9 t/ha and 0.5 t/ha respectively. (CVRC-Notification no. 449 (E) dated 11th February 2009).

II. Graminacious Forages

1. NAPIER GRASS (ELEPHANT GRASS)

Botanical Name : ***Pennisetum purpureum* Schumach**
Family : **Poaceae (alt. Gramineae)**
Subfamily : **Panicoideae**
Tribe : **Paniceae**

Introduction

Elephant Grass, Napier Grass or Uganda Grass is a species native to the tropical grasslands of Africa. It has a very high productivity, both as a forage grass for livestock and as a biofuel crop. The name Elephant grass derives from it being a favourite food of elephants. It is most susceptible to frost. The elephant grass grows well at sea level and upto 2000 m and grows best in high-rainfall areas (in excess of 1500 mm/year), but its deep root system allows it to survive in drought times. It provides good hay if cut at early stage. It is usually made into silage of high quality without additives.

Botanical Description

A robust perennial with a vigorous root system, sometimes stoloniferous with a creeping rhizome. Culms usually 180–360 cm high, branched upwards. Leaf-sheaths glabrous or with tubercle-based hairs; leaf-blades 20–40 mm wide, margins thickened and shiny. Inflorescence a bristly false spike up to 30 cm long, dense, usually yellow-brown in colour, more rarely purplish. The somatic chromosome number is 2n=27, 28, 56. It crosses readily with *Pennisetum americanum* (*P. typhoides*) to produce a rugged hybrid, bane grass

VARIETY

Pusa Giant Napier: This variety was developed by IARI, New Delhi. It provides high yield (250–300 t/ha/year) of green matter under irrigated condition. It contains 25% and 12% more protein and sugar respectively than common napier grass. It is less fibrous, juicy and palatable. It is susceptible to *Helminthosporium* sp.

2. NAPIER × BAJRA HYBRID (NB hybrid)

Botanical Name : ***Pennisetum purpureum* × *P. glaucum***
Family : **Poaceae (alt. Gramineae)**
Subfamily : **Panicoideae**
Tribe : **Paniceae**

Introduction

It is an inter-specific hybrid between bajra and napier grass and combines high quality and faster growth of bajra with the deep root system and multicient habit of napier grass. It is widely distributed in sub-tropical regions of Asia, Africa, Southern Europe and America. In India, it is mainly cultivated in Punjab, Haryana, UP, Bihar, Madhya Pradesh, Orissa, Gujrat, West Bengal, Assam, Andhra Pradesh, Kerala and Tamil Nadu.

The grass grows throughout the year in the tropics. The optimum temperature is about 31°C. Light showers alternated with bright sunshine are very congenial to the crop. Total water requirement of the grass is about 800–1000 mm. It can grow on a variety of soils. Light loams and sandy soils are preferred to heavy soils. The grass does not thrive well on waterlogged and flood prone lands. Phenomenal yields are obtained from very deep fertile soil rich in organic matter. It tolerates pH ranging from 5 to 8. Hybrid Napier is superior in quality to Napier grass and contains about 10.2% crude protein and 30.5% crude fibre. The leaves are large and green, the sheaths are softer and the margins less serrated and hence the herbage is palatable. It is juicer and succulent at all stages of growth. It is less fibrous and more acceptable. The oxalate content of some of the varieties may be high. It can be mitigated if harvested at longer intervals (45 to 60 days). It can withstand drought for a short spell and regenerates with rains but is susceptible to frost.

The hybrid once planted supplies fodder continuously and regularly for a period of three years. The cost of production is almost half that of single-cut crops. The production per unit area and time is approximately double than conventional fodders. Hybrid napier is a triploid grass, so does not produce any seeds. It produces high number of tillers and numerous leaves. It grows fast and produces high herbage but the stems are hard and the plants less persistent.

Cultivation Practices

It grows well on deep, retentive soils of moderate to fairly heavy texture and also grows on light textured with sandy loam to loamy soils. For better response to management, loamy soils with good drainage are preferred. One rooted slip or stem cutting is planted at a depth of 3–5 cm on one side of the ridge at 75 × 30 cm spacing at the rate of 40000 rooted slips or stem cuttings/ha in the month of mid February to July. In irrigated situation, it can be planted throughout the year. A basal dose of 5 t/ha of FYM/compost, 50 kg N /ha, 50 kg P /ha and 40 kg K /ha should be applied followed by a top dressing of 50 kg N/ha after each

cut. The basal application should be repeated once in a year for sustained higher yields. The field should be irrigated on 3rd day after planting and as and when required thereafter especially during spring and summer.

VARIETIES

CO-1: The variety is a derivative of the cross PI 2787 (Bajra × *Pennisetum purpureum* (Merkeson) and developed at TNAU, Coimbatore and recommended for cultivation in south zone of the country. It is a drought tolerant, high yielding variety. It has plant height of 232 cm, non-lodging, profuse tillering (26 tillers/culm), highly leafy (354 leaves/culm), high leaf stem ratio (0.94) and black purple ear head. The average green fodder yield is 300 t/ha. (CVRC-Notification no. 596(E) dated 13th August 1984).

Hybrid Napier-3 (Swetika): This was developed at IGFRI, Jhansi by hybridization of Napier grass and Bajra (PSB-2). The variety was notified for cultivation in north and central zone of the country. This is profuse tillering type, erect with narrow upright leaves with quick regeneration ability and have thin stem like Guinea grass. It is tolerant to frost and low temperature and is suitable for low pH, and have field resistance to *Helminthosporium* blight. It gives 70–80 t/ha green fodder and 18 t/ha dry fodder. (CVRC-Notification no. 499(E) dated 8th July 1983).

CO-2: The variety was developed at TNAU, Coimbatore through interspecific cross between Bajra-PT 8369 and Napier-FD 488 followed by clonal selection. It has been recommended for cultivation in south zone of the country. It provides 350 t/ha of green fodder.

CO-3: The variety was developed at TNAU, Coimbatore and recommended for cultivation in south zone of the country under irrigated condition. It flowers late in the season and have dark green leaves. The variety has high leaf stem ratio making it highly palatable for animals. The variety produces 35–40 t/ha green fodder yield. (CVRC-Notification no. 622(E) dated 17th September 1997).

PBN-83: The variety was developed by PAU, Ludhiana from cross between Bajra selection-1 × N-3 (Napier) and released for cultivation in Punjab. (CVRC-Notification no. 280(E) dated 13th April 1989).

Yashwant (RBN-9): This variety was developed by MPKV, Rahuri by interspecific hybridization of Giant Bajra and napier grass and recommended for cultivation in irrigated areas of Maharashtra. It has low oxalic acid content (2.46%) and high crude protein content (10.15%). It produces 150 t/ha green fodder. (CVRC-Notification no. 915(E) dated 6th November 1989).

IGFRI-5: It is suitable for cultivation in areas of sub-mountain and low hill sub-tropical zone of H.P., which are below 800 m under rainfed and irrigated conditions and fertile as

well as marginal lands. It is very vigorous and tall growing with thin tillers, erect growth habit, very leafy (14–15 leaves/tiller), glaborous nodes and soft stems upto full growth. It is ready for harvest after 60 days of transplanting. It gives fresh fodder and dry matter yield of 114 t/ha and 37 t/ha respectively. On an average, it contains 6.35% crude protein and 2.8% oxalate. 3–4 cuttings can be obtained under rainfed conditions.

NB-21: It was developed by PAU, Ludhiana and released for all India cultivation. It is a fast growing variety with high tillering capacity. Stems are thin and non-hairy with long, smooth and narrow leaves. Oxalic acid content is comparatively less than other varieties.

NB-37: It is dwarf hybrid suitable for sub-tropic pastures. It is drought tolerant and has low oxalates (2–3%) and high crude protein (9-10%). The variety was released in 1994 for cultivation in sub-tropical grasslands and wastelands in zone I & II of Himachal Pradesh. It produces 35–40 t/ha of green fodder.

PBN 233: The variety was developed by PAU, Ludhiana by hybridization of Bajra comp. 1 × N-23 (Napier) and released for cultivation in Punjab in 1999. The hybrid produces 375 t/ha green fodder in seven cuttings in a year. It regularly supplies fodder throughout the year, except during its short dormancy in December. PBN 233, unlike NB 21 and PBN 83, is photosensitive and flowers only in winter. Due to this characteristic, it remains in the vegetative stage throughout the year, except in winter, when it is dormant. The continuity of its vegetative stage provides succulent, palatable and highly digestible fodder on cutting at the right stage.

KKM-1: The variety was developed through interspecific hybridization of Bajra-IP15507 and Napier FD 429 followed by clonal selection at TNAU, Coimbatore. The variety is released for cultivation in Tamil Nadu in 1999. It is leafy, high tillering and is specially suitable for southern districts of Tamil Nadu. It produces 250 t/ha green fodder.

APBN-1: The variety was developed by ANGRAU, Hyderabad through hybridization [IPM-121 59 (Nigeria) and elephant grass like Kasate 52440]. The variety was recommended for cultivation in whole Gujarat. The plants are 70 cm tall with 50 tillers/plant and leaf stem ratio 13.62. The foliage is dark green and production is 200 t/ha.

Suguna: The variety was developed by KAU, Vellayani in 2006 and is a derivative of cross between Composite 9 × FD 431. It is a semi-perennial, multicut and yields 260 t/ha/year green fodder yield. The variety is recommended for cultivation in southern districts of Kerala state.

Supriya: The variety was developed by KAU, Vellayani in 2006 and is a developed through inter specific hybridization of TNSC 4 × FD 471 followed by clonal selection. The variety is recommended for cultivation in southern districts of Kerala state and yields 270 t/ha green fodder.

Sampoorna (DHN 6): This variety was developed by RRS, Dharwad of IGFRI, Jhansi through interspecific hybridization of IPM 14188 (Bajra line) × FD 184 (Napier line) followed by clonal selection. The variety is recommended for cultivation in Karnataka state under irrigated conditions. The variety has low oxalic acid content (1.9%) and yields 120–150 t/ha green fodder in 6–8 cuts. (CVRC- Notification no. 449 (E) 11th February 2009).

3. DINANATH GRASS

Botanical Name : ***Pennisetum pedicellatum* Trin.**
Family : **Poaceae (alt. Gramineae)**
Subfamily : **Panicoideae**
Tribe : ***Paniceae***

Introduction

It is distributed in tropical Africa, south Africa, Asia (India, Malaysia, Philippines, Thailand), Australia, Fiji, United States. Its habitat is drier sites, savannahs and woodland margins, a weed in croplands, grasslands, waste places.

Botanical Description

Pennisetum pedicellatum is an erect or geniculate annual or perennial grass up to 150 cm tall. *P. pedicellatum* belongs to a unique section of the genus with a trilobed sterile lemma, spikelets are in clusters of 1–3 in the involucre. Lower glume length is at least 50% of spikelet. The spikelet cluster is subtended by involucre of 15–25 unfused bristles; bristles antrorsely barbed and plumose, 5–30 mm long, with one conspicuously longer bristle, surrounded by outer ring of shorter smooth bristles. Spikelet cluster is of 1 sessile and usually at least 1 pedicellate spikelet. Spikelets contain 1 fertile floret and 1 basal sterile floret. Spikelets lanceolate, slightly dorsally compressed, 3.4–6 mm long, 0.6–1 mm wide. Glumes hyaline to membranous; lower glume reduced, upper glume and sterile lemma as long as spikelet; sterile lemma trilobed. Fertile floret lanceolate, 2–3 mm long, 0.6–1 mm wide; fertile lemma and palea coriaceous, glossy, translucent, fertile lemma 5-nerved. Caryopsis lanceolate, dorsally compressed, 0.5–2.5 mm long.

Cultivation Practices

After clearing the bushes, the land is prepared by two operations of ploughing. At the onset of monsoon, the sowing can be done in lines or broadcasted using 4–5 kg/ha seeds. Before sowing a mixture of soil and seed should be prepared. The sowing can also be done by raising of nursery and six weeks later transplanting seedlings at 50 cm distance row-to-row and plant-to-plant. About 33000 seedlings are required for one ha. During the field preparation 5 t/ha FYM and 30 Kg N, 30 Kg P_2O_5/ha should be applied as basal dose. After establishment of grass, top dressing with 30 kg N is done. In subsequent years 30 Kg N, 30 Kg P_2O_5 should be applied after start of rains.

VARIETIES

Jawahar Pennisetum-12: The variety was derived from selection of strain from Pusa Bihar P. No. 12 by pedigree method by JNKVV, Jabalpur. It was recommended for cultivation in Madhya Pradesh in 1974. The variety is 156 cm tall, profuse tillering (34/plant), the

leaves are long and broad, with average leaf stem ratio 1.27. It is suitable for two cutting systems, if 1st cut is taken at boot stage. The green fodder production is 55–60 t/ha with dry matter yield 14.0 t/ha.

Pusa Deenanath Grass: This variety was developed by IARI, New Delhi through mass selection from African germplasm. The maturity period is 120–130 days and average green fodder production is 30–73 t/ha. The variety was released for cultivation for the entire country. (CVRC- Notification no. 2(E) dated 3rd January 1983).

Bundel-1: The variety was developed by IGFRI, Jhansi through selection from indigenous collection from Madhya Pradesh. The variety has been notified for cultivation in entire country in 1987. It is a late maturing grass with purple stem. There are abundant long velvet hairs on ventral surface of the leaf. The spike is very large and loose. The large spikelets have long bristles. The variety yields 30–40 t/ha green fodder. The plants have high field resistance to leaf spots. (CVRC- Notification no. 834(E) dated 18th September 1987).

Bundel-2: The variety was released in 1990 and developed by IGFRI, Jhansi through pedigree selection of IGFRI 3808-4-2-1. The variety has been notified for cultivation in entire country. This is a late maturing, purple stemmed variety having abundant long velvet hairs on ventral surface of the leaf. It has very large loose spike, large spikelets with long bristles. The variety has potential yield 30–48 t/ha. It has high tolerance to leaf spot, *Helminthosporium* and other major diseases and insect-pests, is resistance to lodging, drought hardy and is high fertilizer responsive. (CVRC- Notification no. 915(E) dated 1st May 1997).

COD-1: The variety was developed by TNAU, Coimbatore through gamma radiation (30 KR) mutation of Dinanath Pusa 3 and released in 1995. This variety has been recommended for cultivation in Tamil Nadu under rainfed as well as irrigated conditions. It closely resembles Dinanath Pusa 3. The green fodder yield is 40–50 t/ha. (CVRC-Notification no. 360(E) dated 1st May 1997).

4. SUDAN GRASS

Botanical Name : ***Sorghum vulgare var. sudanense***
Family : **Poaceae (Graminae)**
Subfamily : **Panicoideae**
Tribe : **Andropogoneae**

Introduction

Sudan Grass is an annual forage grass native to areas throughout Africa and southern Asia. This is a valuable forage plant and grows up to 3 m (10 ft). The thick, erect stems usually arise in groups from a single clump. The leaves are long and narrow and are arranged at the ends of the stems on loose-bending branches. Because of its tolerance to long, hot, dry periods of weather, Sudan grass is well adapted to the drier areas of the country. Sudan grass is sometimes considered dangerous to grazing livestock because it may contain varying amounts of hydrocyanic acid, a toxic substance. Danger of hydrocyanic acid poisoning is eliminated by delaying grazing until the plants reach a height of 91 cm (36 in) or more, at which stage they are relatively free of the substance. The acid content of the grass may also be decreased by limiting planting to fertile soils with large water-holding capacity.

VARIETIES

Meethi Sudan: This variety is a derivative of the cross involving sweet jowar JS 263. It is tall plant, height 250–320 cm, vigorous, thin stemmed, sweet and profuse tillering. It is more leafy with green mid rib and has high leaf stem ratio. 50% flowering is attained in 50–55 days and maturity in 90–95 days. Panicles are very loose, open glumes awned and straw coloured. The variety is moderately resistant to red leaf spot. The average green fodder yield is 77.7 t/ha (CVRC- Notification no. 786 dated 2nd February 1976).

Sweet Sudan Grass: The variety was released in 1978. (CVRC- Notification no. 1004 dated 23rd March 1978).

Punjab Sudex Chari-1 (LY-250): This variety is a sorghum sudex hybrid derived from Sorghum (2077 A) × Sudan grass (SGL-87) hybridization followed by selection. It is a multicut variety providing 3-4 cuts. Stem is thin, palatable. The variety is higly resistant to anthracnose. It produceses 95 t/ha green fodder and 25 t/ha dry matter. (CVRC- Notification no. 408(E) dated 4th April 1995).

5. TEOSINTE (MAK CHARI)

Botanical Name	:	***Zea diploperennis,***
		Z. perennis,
		Z. luxurians,
		Z. nicaraguensis
Family	:	**Poaceae (alt. Gramineae)**
Subfamily	:	**Panicoideae**
Tribe	:	**Andropogon**eae

Introduction

There are both annual and perennial teosinte species. *Zea diploperennis* and *Z. perennis* are perennial, while all other taxa are annual. All species are diploid (n=10) with the exception of *Z. perennis*, which is tetraploid (n=20). The different species and subspecies of teosinte can be readily distinguished based on morphological, cytogenetic, protein and DNA differences and on geographic origin, although the two perennials are sympatric and very similar. Most distinctive, as well as the most threatened, teosinte is *Z. nicaraguensis*. This teosinte thrives in flooded conditions along 200 meters of a coastal estuarine river in northwest Nicaragua.

Teosinte strongly resembles maize in many ways, notably their tassel (male inflorescence) morphology. Teosintes are distinguished from maize most obviously by their numerous branches each bearing bunches of distinctive, small female inflorescences. These spikes mature to form a two-ranked 'ear' of five to ten triangular or trapezoidal, black or brown disarticulating segments, each with one seed. Each seed is enclosed by a very hard fruitcase, consisting of a cupule or depression in the rachis and a tough lower glume. This protects them from the digestive processes of ruminants that forage on teosinte and aid in seed distribution through their droppings. Teosinte seed exhibits some resistance to germination but will quickly germinate if treated with a dilute solution of hydrogen peroxide.

VARIETIES

Improved Teosinte: The variety has been evolved at CCS HAU, Hisar in 1987 and is suitable for cultivation in north, north western and central zone of the country. The green fodder yield is 35–45 t/ha.

TL- 1: This variety has been developed from selection of indigenous material grown in irrigated areas of Punjab and released in 1995. It is comparatively taller and has more tillers, leaves and is comparatively 10 days late in maturity than the improved teosinte. It has less incidence of leaf spot disease and green fodder production is 56.4 t/ha and seed yield is 10.5 q/ha. (CVRC- Notification no. 1(E) 1st January 1996).

6. GUINEA GRASS

Botanical Name : ***Panicum maximum* Jacq.**
Family : **Poaceae (alt. Graminae)**
Subfamily : **Panicoideae**
Tribe : **Paniceae**

Introduction

Many species of the genus *Panicum* are known for their wide adaptability. However, *P. maximum* (Guinea grass) is an important multicut forage grass, because of its ease of propagation, fast growth and high quality forage during the rainy season. The crop yields 40–60 t/ha dry matter, contains crude protein up to 14% and 41–72% dry matter digestibility. The tolerance of the crop to saline sodic conditions is also reported. *P. maximum* is also used as silage at Tanzania, Brazil, Nigeria and Australia. The dry matter contains 7–10% crude protein, 30% crude fibre, 40% N_2 free extract, 2.33% ether extract and 8.36% ash.

The crop has been adopted well by the farmers in India because of its multicut nature and high yield of green fodder. It is cultivated in Haryana, Punjab, Himachal Pradesh. It has also wide adaptability in humid tracts of eastern and southern India. It has excellent growing habit, quick recovery after cutting and good quality herbage. The green fodder productivity ranges from 80 to 100 t/ha and dry matter productivity from 25–35 t/ha. Guinea grass is tolerant to the light stress and can perform very well under shaded condition. Another significant feature is quantum jump in quality (crude protein) content under shade condition. The crop is grown both as annual and perennial. First cut is taken 75 days after sowing and subsequent cuttings at 45 days interval. Thus, it can give 7–8 cuttings annually.

Guinea grass as understorey grass in agroforestry system has high potential for tropical regions. It is also suitable for rangelands receiving 900 to 1500 mm rainfall, although can survive under less than 400 mm rainfall. Additionally, availability of annual as well as perennial types makes the crop suitable for cultivated as well as rainfed conditions.

Botanical Description

The guinea grass is of tillering nature. The tillers arise from the base and the stem is having 6–10 nodes. The plant height ranges from 100 to 230 cm and leaf length from 15 to 75 cm and panicle length from 20 to 55 cm. At each node there is leaf sheath encircling the stem up to nearly half the internode distance. The end of leaf sheath is attached to leaf blade. The tillers bear panicle at the time of flowering. The species possess typical graminaceous flowers represented in tribe Panicoideae. The flowers are arranged on a panicle, which is 30 to 60 cm long and 15 to 25 cm wide. Small branches originate from the main branch of the panicle and on these branch axis, the spikelets are arranged. Spikelets are 3 to 30 mm long and 1 mm wide. The flowers possess small lower glume (green/ purple), upper glume (green/ purple), upper lemma (green/ purple). There are 3+3 anthers and single bifid

hairy stigma. Most widely used cultivars are having 70–80 cm long hairy leaf, erect stem of 2m long without hair and leaves are 15–18 mm wide with hairy leaf surface. Panicle is 15–40 cm long and 12–30 cm wide, green, spikelet and glumes are hairless.

Cultivation Practices

It requires well prepared land (2–3 ploughings followed by 3–4 harrowings). It can be established by planting of rooted from slips in lines keeping a distance of 1 m from line to line and 50 cm slip to slip. It can be established by seed also. 3–6 kg seed/ha is required but percent germination should be tested before sowing. Being highly responsive to manuring 10–20 t/ha of FYM and 30 kg/ha P_2O_5 as basal dose should be applied to the crop. After each cut 50–60 kg N/ha are applied. After a period of 4–5 years, replanting of the crop is required.

VARIETIES

Macueni: This is an introduction, suitable for rainfed conditions of Kerala. The green fodder yield is 6–8 t/ha. The hairiness character distinguishes it from other grasses. It is erect tufted with drooping leaf canopy smaller than other cultivars like Hamil, Colonio and coarse guinea. Hairy seed coat of makueni seed can be identified from the seed of green panic.

Riversdale: This was a introduced material to Kerala in 1963 under the Indo-Swiss project, Mattupathy and is recommended for cultivation in uplands, homesteads and plains of Kerala, Tamil Nadu and Andhra Pradesh. It provides 74 t/ha green fodder.

Hamil: This variety is suitable for Kerala, Tamil Nadu, A.P., West Bengal, Bihar and North- Eastern States providing 9-13 t/ha of green fodder.

Punjab Guinea Grass 1: This is a variety developed by PAU, Ludhiana and released for cultivation in N-W and hill zone. It is an introduction from Australia (CPI 59985). It matures in 210 days. (CVRC- Notification no. 371(E) dated 29th May 1982).

PGG 9: This variety was developed by PAU, Ludhiana and released for N-W and hill zone. It is an obligate apomictic variety developed from a cross between a sexual clone 82059 and obligate apomictic clone 80013. It has long, broad, light green leaves and thick stem. Panicle is compact, have low seed shedding and good synchrony in seed maturity. It provides 2–3 cuttings with an average yield of 45–50 t/ha. Its herbage contains 8–10% CP (DM basis) and is very nutritive. Dry matter digestibility is 55–70%. It is adapted between 300–400 m above sea level and is recommended as perennial grass on marginal and wastelands in zone-1 and for arable land for zone-I and II. (CVRC- Notification no. 1(E) dated 6th March 1987).

PGG 19: The variety was developed by PAU, Ludhiana through hybridization of CPI 63450 (sexual line) × CPI 60013 (apomictic line) and selection of the obligate apomictic

plants. This is recommended for cultivation in Punjab state. The variety provides 98.5 t/ha green fodder in 4 cuts with dry matter yield of 17.6 t/ha. (CVRC- Notification no. 113 (E) 1st December 1988).

PGG 14: This variety was developed by PAU, Ludhiana and recommended for cultivation in central zone of the country. It is an obligate apomictic variety developed from a cross between a sexual clone 82059 and obligate apomictic clone 80013. It is profusely tillering variety with leaf sheath more hairy than Hamil and produces more than 90 t/ha green fodder. (CVRC- Notification no. 280(E) dated 13th April 1989).

Haritha: This variety has been developed by KAU, Vellayani through mutation of F.R. 600 and released in 1990 for Kerala. The plants are 176 cm tall in six months of growth. It produces 49 t/ha green fodder and crude protein content is 7.6%.

Marathakam: The variety was developed by KAU, Vellayani through mutation of F.R. 600 and released in 1990 for southern districts of Kerala. The plants are 180 cm tall in six months of growth. It produces 55 t/ha green fodder and crude protein content is 8.2%.

Co-1: It is a clonal selection from Coimbatore local and released for Tamil Nadu state in 1993 by TNAU, Coimbatore. The ventral surface of lamina is serrated. It produces 200 t/ha green fodder.

PGG 101: This is a state variety developed by PAU, Ludhiana and released for Punjab. It is an obligate apomictic variety developed from a cross between a sexual clone 82059 and obligate apomictic clone 80013. The variety is late in flowering with bolder seeds and husked seeds are light yellowish as compared to whitish grey of PGG 19. (CVRC-Notification no. 1(E) dated 1st January 1996).

PGG 518: This is an apomictic variety developed by PAU, Ludhiana from a cross between a sexual clone P-5 and PGG-9 (male). This is recommended for irrigated conditions of Punjab. The first cutting for fodder is available after 55 days and subsequent cuttings in 30–35 days interval. The flowering is very late and provides green fodder yield of 121.7 t/ha. The plants are erect; leaves are dark green, broad and long. Its panicle is compact in shape, white in colour in early stage and turns light yellow with maturity. The seeds are bold. (CVRC- Notification no. 425(E) dated 8th June 1999).

CO 2: This variety was developed by TNAU, Coimbatore. It is a cross between CO-1 and Centenario. Fodder is highly suited for multiple cuts in a year. This is recommended under irrigated condition of Tamil Nadu as perennial fodder crop with an average green fodder yield of 270 t/h. It is resistant to lodging, shade tolerant, profuse tillering having 80 to 100 tillers per clump and grows to a height of 250–270 cm, have high dry matter and crude protein content, quick regeneration capacity and high leaf-stem ratio. It is free from any pests. (CVRC- Notification no. 821(E dated 13th September 2000).

PGG 616: This is a variety developed by PAU, Ludhiana and released in 2001. It is an obligate apomictic variety developed from a cross between a sexual clone P-5 and PGG-101 (male). This is recommended for irrigated conditions of Punjab. The first cutting for fodder is available after 55 days and subsequent cuttings in 30–35 days interval. The flowering is very late and provides green fodder yield of 47.4 t/ha and dry fodder 10.9 t/ha. This variety has 11 percent crude protein and 60.3% IVDMD.

Bundel Guinea-1 (JHGG-96-5): This is a variety developed by IGFRI, Jhansi through selection from germplasm TGPM 19 (IG 01-80). It is recommended for cultivation under rainfed conditions of Punjab, Himachal Pradesh, central Uttar Pradesh, Maharastra and Tamil Nadu. The variety has glabrous leaf and leaf sheath surface with thick stem and remains green through out the year under irrigated condition. It has no pathological or major pest problem. It possesses 13.3% crude protein. (CVRC- Notification no. 122(E) dated 2nd February 2005).

Harthasree: The variety was developed by KAU, Vellayani by selection from JHGG 96-4. The variety is adapted for cultivation in uplands and homesteads in Kerala.

Bundel Guinea-2 (JHGG 04 –01): The variety was developed by IGFRI, Jhansi. It was released and notified for all India cultivation in 2008. It is a high yielding variety under rainfed situation. Green fodder yield is 50–60 t/ha, dry matter yield (15–18t/ha) and crude protein yield (1.3–1.5 t/ha). The variety is adaptable to rainfed condition and resistant to drought under semi-arid condition.

7. ANJAN GHAS (BUFFEL GRASS)

Botanical Name : ***Cenchrus ciliaris* L. Syn. *Pennisetum cenchroides* Rich,. *P. ciliari* (L.)**
Family : **Poaceae (alt. Graminae)**
Subfamily : **Panicoideae**
Tribe : **Paniceae**

Introduction

Cenchrus is a genus of Panicoid grasses with tereta and solid culms and fibrous roots comprising of both the annuals and perennial plants. Among the twenty species, *C. ciliaris* and *C. setigerus* are most commonly used for forage production. It is commonly known as buffel grass (Australia), African foxtail (U.S., Kenya) Dhaman grass and Anjan grass (India).

Based on a number of morphological characters for evolutionary conditions, the different species of *Cenchrus* fall into two basic groups. The first presumably more specialized group and homogenous assemblage of species of *Cenchrus pilosus, brownii, echinatus, longispinuis, tribules, insurtus, platycanthus, palmerii, gracillinu*s and *mitis* having basic chromosome number x=17. These are native to the western hemisphere. The second basic group represents heterogenous assemblage to the species, consisting of *C. ciliaris, setigerus, nultifflorus, prieurii, biflorus, mjosuroiles and caliculatus* having basic chromosme number x=9. These are restricted to Africa, India, Pakistan and southern east Asia.

C. ciliaris and *C. setigerus* in their natural stands are generally tetraploid (2n = 36 representing various cytotypes ranging from 2n = 35 to 42. Hexploid (2n = 56) are also reported occasionally.

The species are markedly protogynous. Emergence of stigma proceeds in basipetal succession. Self fertilization is common but cross fertilization also occurs frequently. Formation of unreduced egg cell both in *C. ciliaris* and *C. setigerus* is most prevalent which leads to apomictic reproduction of seeds. However, pollination has been found to be essential for the formation of endosperm (Pseudogamy).

C. ciliaris is a native of tropical and subtropical Africa, India and Indonesia. It is widely distributed in hotter and drier parts of India and is found in open bush and grassland in its natural habitat. It is widely distributed in the plains of Rajasthan, Gujarat, Punjab and western UP extending upto foot hills of Jammu upto an altitude of 400 m. It is one of the prominent grass species of *Dichanthium – Cenchrus- Lasiurus* grass cover of India. It is polymorphic, perennial and warm season bunch grass with extensive native range in the form of various ecotypes and cytotypes. It is highly drought tolerant and well adapted to arid and semi-arid areas and thrives well in light textured soils.

Botanical Description

Perennial, sometimes short-rhizomatous and forming mats or tussocks. Its culms are

ascending, 10–150 cm tall, 1–2 mm in diameter, wiry or sometimes almost woody at base, sometimes many-branched from lower or basal nodes. The sheaths are keeled, glabrous or sparsely pilose; ligule a densely ciliate membrane 0.5–2.5 mm long; blades 3–25 cm long, 2–13 mm wide, glabrous or sparsely pilose, apex caudate. The inflorescences are paniculate, gray, purple, or yellowish, densely cylindrical to ovoid, 2–14 cm long, 1–2.6 cm wide, rachis angular and puberulent; burs 6-16 m long, bristles connate only at base to form a disk 0.5–1.5 mm in diameter, inner bristles much exceeding spikelets, one of them longer and stouter than the rest, at least the longest somewhat flattened at base, sparsely or densely ciliate above, flexuous, often wavy, antrorsely scaberulous, outer bristles filiform; spikelets 1–4 per bur, 2–5.5 mm long, dorsally compressed, lanceoloid; glumes distinct, first glume membranous, 1-nerved, 1–3 mm long, second glume 1–3-nerved, 1.3–3.5 mm long; palea 2.5–5 mm long, enclosing a staminate flower; second lemma thin, 5–nerved, 2.2–5.4 mm long. Caryopsis turgid, ovoid, 1.4–1.9 mm long, ca. 1 mm in diameter.

Cultivation Practices

After clearing the area from all bushes, and two ploughing followed by two harrowings, the seeding is done @ 5 kg/ha after first shower in monsoon season for nursery raising. Fresh seeds are often dormant so seeds should be 6-18 months old. Six weeks old seedlings can also be transplanted at drizzling rain time. These seedlings are transplanted at 50 cm row spacing with 30 cm plant to plant distance. About 30,000 seedlings are required for one ha with two seedlings at each spot. In the year of establishment, 40 kg N, 20 kg P_2O_5/ha is to be mixed in the soil as basal dose. 20 kg N/ha is to be applied in one month crop and in subsequent years 40 kg N, 20 kg P_2O_5/ha needs to be top dressed at the start of rains.

VARIETIES

Marwar Anjan (CAZRI-75): This variety was developed by CAZRI, Jodhpur using clonal selection method from exotic line EC 14369 from Australia. The variety is apomictic and can be propagated by seeds or rooted slips. It is recommended for growing in arid and semi-arid areas of the country. The variety remains green for longer period. Average yield under total rainfed condition is approx. 9–10 t/ha and DMY 4–5 t/ha. The variety is erect with indeterminate growth habit, yellowish node pigmentation, green broad leaves with droopy attitude, long panicle and dull whitish spike, conical brown grains. 1000 seed weight is 2.18g (CVRC- Notification no. 832 (E) dated 18th November 1985).

Bundel Anjan-1: The variety was developed by intra-population selection of IGFRI-S-3108, at IGFRI, Jhansi. The plants have semi-erect growth habit, thick stem, medium late maturing, high tillering, large compact spike, purple pigmented nodes and droopy, long and broad leaves. The variety is drought and frost hardy, have moderate resistance to lodging and is highly fertilizer responsive. It has high regeneration ability, perennial, palatable and is highly nutritious at flowering stage. The potential yield for green fodder is 35–40 t/ha. (CVRC- Notification no. 915(E) dated 6th November 1989).

CO-1 (Neela Kolukattai): The variety was developed at TNAU, Coimbatore from clonal selection of FS-391. It is highly suitable for rainfed conditions yielding 55 t/ha green fodder. It has been recommended for cultivation in Tamil Nadu. (CVRC- Notification no. 832 (E) dated 793(E) dated /22nd November 1991).

Bundel Anjan-3 (IGFRI- 727): The variety was developed by IGFRI, Jhansi it and released in 2006. It is suitable for cultivation in arid and semi-arid tract of the country particularly in Rajasthan, Western UP, Haryana, Punjab, Maharashtra and Andhra Pradesh under rainfed condition. The variety is significantly superior to other varieties for green fodder and dry matter yield. (CVRC- Notification no. 533(E) dated 793(E) dated 25th April 2006).

8. MOTHA DHAMAN (BIRDWOOD GRASS)

Botanical Name : ***Cenchrus setigerus* Vahl**
***C. barbatus* Schumach.**
***C. ciliaris* var. setigerus (Vahl) Maire & Weiler**
C. Nees ex Steud.
Family : **Poaceae (alt. Graminae)**
Subfamily : **Panicoideae**
Tribe : **Paniceae**

Introduction

It is commonly known as, cow sandbur, (English); anjan, mode dhaman grass, kata-dhaman, kala-dhaman in India. It is native to Africa (Kenya, Tanzania, Eritrea, Ethiopia, Somalia, Sudan, Egypt), Asia (southern Iran, Yemen, India, Pakistan) occurring in open dry bush and grassland, usually on alkaline soils, sometimes on heavy black clays with impeded drainage. It is naturalized elsewhere in dry tropics and subtropics.

C. setigerus yoht. (syn. C. setiger vohl) is commonly known as bird wood grass in Australia and *motha dhaman* grass in India. It is a native of Africa from the Nile valley to red sea and eastward through Arabia to India. It is more adapted to arid and semi arid condition than *C. ciliaris*. In its natural habitat it is found in open bush and grasslands and thrives well on alkaline soils. It is a highly palatable and nutritious perennial grass suitable for both grazing as well as stocking purposes. It is extremely tolerant to heat and drought conditions. Because of its hardy nature and ability to grow in low rainfall areas, it serves as a valuable stand – over feed in these areas.

It prefers light-textured, sandy soils; adapted to a wider range of soils than is *C. ciliaris*. Often found on gravelly areas and alluvial flats, and sometimes on heavy black clays with impeded drainage. Adapted to arid and semi-arid climates (annual rainfall as low as 200 mm) with a long dry season. More drought tolerant than *C. ciliaris*. Responds well even to light rain when temperature is adequate for growth. Optimum growth occurs at 30–35ºC. It is extremely tolerant of heat and drought but also survives frost. Grows from sea level to 500–800 m asl between about 30ºN and S.

An early flowering short day plant, flowers in November to May in the southern hemisphere subtropics. It can be cut every 30 days at about 10 cm. Once established, can stand heavy grazing, even by sheep. Has high feed value during the pre-flowering stage, but much lower during the dry season. 9-10% CP and 65% IVDMD at early-bloom stage and IVDMD 40–50% during the dry season. Moderately palatable and readily accepted by stock.

Botanical description

Tufted, non-rhizomatous (or shortly rhizomatous), erect or ascending perennial to 60 cm (rarely to >1 m) tall, similar to smaller types of *C. ciliaris*. Leaf blades linear, 15–30 cm long and 4–6 mm wide. Panicle a green, maturing to light straw-coloured (mostly African origin) or dark purple (mostly Indian origin), false spike, 1.5–9 cm long and 1 cm wide. Seed units or fascicles are inserted along a zig-zag axis, each bur-like fascicle comprising a single spikelet or cluster of 2 or 3 spikelets, 3–4.5 mm long, surrounded by an involucre of short, stiff teeth 3.5–5 mm long. 180,000–350,000 seed units/kg.

VARIETIES

Black Kolukattai: Developed at Tamil Nadu, a high yielding variety with dark seed head.

CAZRI-76: This variety was developed by CAZRI, Jodhpur using clonal selection method from exotic line EC 17655 from Australia. The variety is apomictic and can be propagated by seeds or rooted slips. It is recommended for growing in arid and semi-arid areas of the country. Average yield under total rainfed condition is approx. 5–6 t/ha and DMY 3–4 t/ha. It is a semi-erect variety attaining a height of usually 50–60 cm. The variety possess thin stem with high tillering and brown nodal pigmentation, long and narrow leaves with semi-erect attitude. Leaf colour is yellowish green giving plant a yellowish green appearence. Spike is laxed compact, with tapering shape, medium long (8–10 cm), become white at maturity. Grain colour is brown (CVRC- Notification no. 832(E) dated 18th November 1985).

Marwar Dhaman (CAZRI-175): An Institutional collection. Well adapted in arid (Thar Desert) and semi-arid regions of India. Excellent for grazing due to thin stem and leafy foliage.

9. SAEN GRASS (*SEHIMA NERVOSUM*)

Botanical Name : ***Sehima* nervosum Forssk.**
Family : **Poaceae (alt. Graminae)**
Subfamily : **Poeae**

Introduction

Saen grass is predominant in whole of peninsular India in rainfall zones from 300 to 2000 mm. The optimum growth occurs in rainfall zone of 500–900 mm. The suitable soil type is brown, dark gray gravelly with good drainage.

Botanical Description

It is an herbaceous annual, or perennial, caespitose, culms and 30–100 cm high. The culm nodes are hairy, or glabrous, and culm internode are solid. The leaves are basally aggregated, non-auriculate and leaf blades are narrowed end linear. The ligule is a fringed membrane, or a fringe of hairs. The plants are bisexual, it has spikelets of sexually distinct forms on the same plant.

Inflorescence is a single raceme. Spikelet-bearing axes spike like (laterally compressed, curved); solitary; with substantial rachides; disarticulating at the joints. Spikelets paired; secund; sessile and pedicellate; consistently in 'long-and-short' combinations; in pedicellate/sessile combinations. The 'shorter' spikelets hermaphrodite. The 'longer' spikelets male-only, or sterile.

Female-sterile spikelets. Pedicelled spikelets male or neuter, strongly dorsally compressed, flat, the lemmas awnless.

Female-fertile spikelets. Spikelets slightly compressed dorsiventrally, or laterally; Rachilla terminated by a female-fertile floret. Hairy callus present. Glumes two; more or less equal; long relative to the adjacent lemmas; without; awned Lower glume two-keeled (scarcely winged).

Female-fertile florets 1. Lemmas less firm than the glumes (hyaline); incised; 2 lobed; awned. Awns 1; median; geniculate; hairless to hairy; much longer than the body of the lemma. Lemmas hairy (above), or hairless; Palea present; relatively long; hyaline; 2-nerved. Lodicules present; 2; free; fleshy; glabrous. Stamens 3. Anthers not penicillate. Ovary glabrous. Styles free to their bases. Stigmas 2.

Cultivation Practices

The grass can be raised by both direct sowing or by transplanting. For direct sowing, seed pellets should be prepared. It is better to transplant the grass. It is preferable to raise seedlings in perforated polythene bags in June. The light soil should be well mixed with FYM before filling in the polythene bags. Irrigation should be provided as per need. About 30,000 seedling bags are required for one hactare.

The area should be cleared of bushes and other vegetation. With the advent of monsoon, the land should be prepared by ploughing. At first a basal application of 10 cartload of FYM is required. This is followed by basal application of 20 kg N/ha and 20 kg P_2O_5/ha. After one month of establishment, a top dressing with 20 kg N/ha is given. In subsequent years 20 kg N/ha and 20 kg P_2O_5/ ha are broadcast in grassland with first shower of rain. The top dressing of N after one month growth may be done only between the grass rows.

Six week old seedlings from nursery bed are transplanted generally in July after first heavy shower of rains. Spacing should be maintained at between rows – 50 cm, between plants 30 cm. This would mean that 33000 seedlings of grass will be required /ha with 2 seedlings planted at each spot.

In the year of establishment, only one cutting is done in mid-October. In the subsequent years, two cuttings can be taken first after 60 days growth and next at 30 to 45 days interval depending upon the pattern of rainfall distribution. One more cutting is possible during growing season in March or April. The cutting height may be taken at 10 cm from ground level. For effective seed collection, last cut should be sacrificed. Seeds generally mature in November in peninsular India and 15–20 days later in southern India depending on rainfall distribution.

VARIETY

Bundel sain Ghas-1 (IGS 9901): The variety was developed by IGFRI, Jhansi and is released for central MP, southern part of UP, north Karnataka, Rajasthan, Rayalseema region of AP and south of Maharashtra. This is the first variety in this range grass in the country and is a selection from germplasm IG-2045. It gives average production of 183 q/ha green fodder and 47 q/ha dry matter. It is erect, perennial, highly tillering and is resistant to insect-pests and diseases. (CVRC notification no. 1178 (E) dated 20th July, 2007).

10. BLACK SPEAR GRASS (*HETEROPOGON CONTORTUS*)

Botanical Name : ***Heteropogon contortus***
Family : **Poaceae (alt. Graminae)**
Subfamily : **Panicoideae**
Tribe : **Andropogoneae**

Introduction

Heteropogon contortus is predominant in whole of peninsular India in rainfall zones from 300 to 2000 mm. The optimum growth occurs in rainfall zone of 500–900 mm. The suitable soil type is brown, dark gray gravelly with well-drained soil.

Botanical Description

It is an erect perennial reaching height of 0.5 to 1.5 m. The stems are flattened, rather tough, smooth, and pale bluish-green. Leaves are produced throughout the length of the stem and are flat or folded, 2–6 cm inches long, about 1 cm wide and rough to the touch. The flowering heads have narrow, crowded flower spikes up to 2 cm long. The spikelets overlap and each fertile one bears a conspicuous red-brown awn about 1.5 cm long, made crooked with two bends. The long-awned seeds are sharp pointed forming tangled masses as they mature. When the seeds come in contact with moisture, the hygroscopic awns and sharp barbed tips arch and twist planting them into the soil. The species is mostly apomictic, but sexual reproduction has also been known to occur.

Cultivation practice

The grass can be raised by both direct sowing or by transplanting. For direct sowing seed pellets should be prepared. It is better to transplant the grass. It is preferable to raise seedlings in perforated polythene bags in June. The light soil should be well mixed with FYM before filling in the polythene bags. Irrigation should be provided as per need. About 30,000 seedling bags are required for one hactare.

The area should be cleared of bushes and other vegetation. With the advent of monsoon, the land should be prepared by ploughing. At first a basal application of 10 cartload of FYM is required. This is followed by basal application of 20 kg N/ha and 20 kg P_2O_5/ha. After one month of establishment a top dressing with another 20 kg N/ha is given. In subsequent years, 20 kg N/ha and 20 kg P_2O_5/ ha are broadcast in grassland with first shower of rain. The top dressing of N after one month growth may be done only between the grass rows.

Six week old seedlings from nursery bed are transplanted generally in July after first heavy shower of rains. Spacing should be maintained at between rows – 50 cm, between plants 30 cm. This would mean that 33000 seedlings of grass will be required /ha with 2 seedlings planted at each spot.

In the year of establishment only one cutting is done in mid-October. In the subsequent years, two cuttings can be taken first after 60 days growth and next at 30 to 45 days interval depending upon the pattern of rainfall distribution. One more cutting is possible during growing season in March or April. The cutting height may be taken at 10 cm from ground level. For effective seed collection, last cut should be sacrificed. Seeds generally mature in November in peninsular India and 15–20 days later in southern India depending on rainfall distribution.

VARIETY

Bundel Lampa Ghas -1 (IGHC 03–4): The variety was developed by IGFRI, Jhansi. Average green fodder production is 25–30 t/ha, dry matter yield (8–10 t/ha) and crude protein yield (0.6-0.8t/ha). The variety is highly suitable for rangeland and community grazing land in drought prone areas of semi arid, tropical and sub tropical areas during Kharif season as a perennial crop. It is recommended for notification and release in All India. The variety was developed from selection from germplasm IG 95-284 collected from district Datia, M.P. It is resistant to lodging, disease and pests and highly responsive to agronomic practices. It possesses good quality parameters.

11. DHARAF GRASS (GOLDEN BEARD GRASS)/ DHAWALU GHAS

Botanical Name : ***Chrysopogon fulvus* (Spreng.) Chioiv.**
***C. montanus* Trin**
***C. monticola* (Roem. Et Schult) Hains**
***Andropogon montanus* Koen. Ex Trin**
***A. monticola* Roem. Et Schult**
Family : **Poaceae (alt. Gramineae)**
Subfamily : **Panicoideae**
Tribe : **Andropogoneae**

Introduction

It is a tufted perennial pasture grass growing up to 180 cm height and grows well under an annual rainfall of 300–1200 mm. It is well distributed in India, Indo-China and Malaysia. The grass is palatable and high yielding. *Chrysopogon fulvus* is native of southern India to Thailand, where it is considered a good forage grass.

Chrysopogon fulvus is predominant in whole of peninsular India in rainfall zones from 250 to 800 mm. The suitable soil type is well-drained soil with medium texture.

Botanical Description

Culms are geniculately ascending, 20–50 in number snd 100 cm long. The leaves are mostly basal and ligule is a cililate membrane. The leaf-blade is 2–15 cm long; 2–3 mm wide with apex abruptly acute and surface is glabrous. Inflorescence is a panicle with branches tipped by a raceme, which bears a triad of spikelets. Out of these three spikelets, one is sessile, bisexual, awned and other two are awnless and pedicelled.

Cultivation Practices

The grass habitat is stony or gravelly with shallow soils so any sort of field preparation is not advisable. Spot sowing /planting on sloppy lands and broadcasting of seeds in plain area or transplanting of rooted slips during rainy days should be done. A fertilizer dose of 60 kg N/ha along with 40 kg P_2O_5 is recommended.

VARIETIES

GAU-D-1: The variety was developed by GAU, Banaskantha by clonal selection. It is suitable for medium black soil. The sessile spikelets are in group and seeds are oval shaped yellowish in colour. The variety has been notified for Gujrat state. It provides 15–20 t/ha of green fodder. (CVRC- Notification no. 540(E) dated 24th July 1985).

Bundel Dhawalu Ghas-1 (IGC 9903): The variety was developed at IGFRI, Jhansi and is a selection from germplasm IG 2014 B and has been notified for cultivation in central MP, southern UP, north Karnatka, Rajasthan, Rayalseema region of AP and south Maharashtra. The variety provides green fodder 25–30 and dry fodder 6-7 t/ha. (CVRC-Notification no. 1178(E) dated 20th July 2007).

12. TALL FESCUE

Botanical Name : ***Festuca arundinacea***
Family : **Poaceae (alt. Gramineae)**
Subfamily : **Pooideae**
Tribe : **Poeae**

Introduction

These are cool season grasses that are adapted to the lower areas of Himalayas where the season is too hot for other grasses and in the area that is too cold in the winter for the warm season grasses. Unlike the majority of cold season grasses. Fescues are shade tolerant. Tall fescue (*Festuca arundinacea*) is a deep-rooted, cool season perennial grass. The plant produces vigorous growth in the spring and fall and its extensive root system helps it withstand drought conditions. Tall fescue is adapted to a wide range of soil and climatic conditions, but performs best on well-drained clay soils and remains green year-round under irrigated conditions.

Botanical Description

Tall fescue does produce short rhizomes but has a bunch-type growth habit. It spreads primarily by erect tillers. Individual tillers, or stems, terminate in an inflorescence, reach 100–120 cm in height, and have broad, dark green basal leaves. Leaf blades are glossy on the underside and serrated on the margins. The leaf sheath is smooth and the ligule is a short membrane. The inflorescence is a compact panicle, 8–10 cm long with lanceolate spikelets one-half inch or more long. The grass flowers in the spring and seed mature in early summer.

VARIETIES

HIM-1: The variety was developed through recurrent phenotypic selection method by CSK HPKV, Palampur and released in 1998 for cultivation in temperate grasslands of Himachal Pradesh upto 2000–2600 m altitude. The green and dry fodder yield is 30–40 and 5.0–5.2 t/ha respectively. **(CVRC- Notification no. 401(E) dated 15th May 1998).**

HIMA-4: The variety was developed by CSK HPKV, Palampur and released in 2005 for cultivation in Himachal Pradesh. **(CVRC- Notification no. 122(E) dated 2nd February 2005).**

13. GOLDEN TIMOTHY (SETARIA)

Botanical Name : ***Setaria sphacelata* Stapf. Eex Hubb.**
***S. anceps* Stapf var. *sericea* Stapf**
Family : **Poaceae (alt. Gramineae)**
Subfamily : **Panicoideae**
Tribe : **Paniceae**

Introduction

Usually the grass grows well in areas having an annual rainfall ranging from 1000 to 1500 mm. It can also survive long, hot and dry seasons. The grass grows well at 20 to 25ºC. It is more cold tolerant than most of tropical and subtropical grasses. It can come up in a variety of soil types. Setaria is usually too coarse to be of much value as preferred feed, but it has a place as low-quality roughage, as a supplement to urea-molasses feeding. It is used for this purpose in Kenya and Uganda. The setarias contain oxalates, which can poison cattle. The amount of oxalate varies with the cultivar and stage of growth. It is very palatable at young but becomes less palatable at maturity.

Botanical Description

This is a tufted perennial, 45–180 cm tall with the lower culm nodes compressed. Basal leaf-sheaths often nearly flabellate in arrangement. False spike dense with orange bristles and subacute spikelets, 2.5–3 mm long. The leaf blades are glabrous flat, 30–40 cm long, 6-10 mm wide, linear and lanceolate. Infloresecence is terminal, compressed panicle about 15 cm long, appearing as a dense cylindrical spike and orange to purple in colour.

Cultivation Practices

It can be established by planting seedlings/rooted slips in furrows 50 cm apart with a plant to plant distance of 30 cm. The planting should be done in February- March in north India and in any month in south India. It can be established by seeds also @ 2–5 kg/ha. At the time of sowing 120 kg N, 60 kg P_2O_5/ha should be applied to the soil. After each cutting 20 kg N/ha should be applied.

VARIETIES

Nandi: The variety was developed by CSKHPKV, Palampur and released for cultivation in sub-tropical hill region of the country. It is fast growing grass suitable for low hills with very good regeneration capacity with dark green leaves and thin stem. The vegetative growth starts during March and remains green till December. It provides fodder during the lean period i.e. May-June and October-November when no other green grass is available. The forage is nutritious and contains 7–8% protein on dry matter basis at 50% flowering. During its growth period, 3–4 cuttings can be obtained with an average yield of 75 t/ha. It is suitable

for planting in grasslands, wastelands and bunds of field upto 2000 m altitude. (CVRC-Notification no. 2(E) dated 3rd January 1983).

PSS 1 (Golden timothy): The variety was developed by CSKHPKV, Palampur by selection from Kenyan introduction Narok-5 and released for cultivation for sub-tropical regions of Himachal Pradesh between 1100–2100 m altitude. It is a fast growing perennial grass recommended for cool, frost prone sub-tropical grasslands. It has dark green leaves, medium thick stems and brown rusty head. It remains green for 9-10 months in a year and provides 3–4 cuttings. Green herbage is available during lean periods *viz*, April- June and October-December. It is drought and cold tolerant. It has yield potential of 57 t/ha of green fodder. Its herbage contains low oxalates (2–3%) and high protein (10%). (CVRC-Notification no. 386(E) dated 15th May 1990).

Setaria 92*:* The variety was developed by CSKHPKV, Palampur and released for cultivation in Himachal Pradesh and Uttaranchal. It has shown significant superiority in fodder yield and quality. The average green fodder yield and dry matter yield is 30.0 t/ha and 7.5 t/ha respectively. It is suitable for cultivation in subtropical grasslands and pastures between 300 and 1400 m above sea level in Himachal Pradesh. It is a late maturing variety with very thin tillers, tolerant to drought, cold and frost. (CVRC- Notification no. 122(E) dated 2nd February 2005).

14. MARVEL GRASS

Botanical Name : ***Dichanthium annulatum* (Forsk.) Stapf**
***Andropogon annulatus* Forssk.**
***A. papillosus* Hochst. Ex A. Rich**
***D. nodosum* Willemet**
***D. papillosum* (Hoechst. Ex A. Rich.) Stapf.**

Family : **Poaceae (alt. Graminae)**

Subfamily : **Panicoideae**

Tribe : **Andropogoneae**

Introduction

It is distributed from tropical Africa to south-east Asia, New Guinea and northern Australia. It is widely used for hay in India. The grass is a highly preferred forage grass in India. Being indigenous to the Indian and African gene centres, it shows maximum genetic diversity in India and South Africa. Out of the 20 species of the genus *Dichanthium* reported from the tropics and subtropics, India has 8 species distributed in various agro-ecological zones, but only two species, *viz*. *D. annulatum* and *D. caricosum* are widely used for large scale forage production. This grass commonly occurs throughout the plains and hills of India up to 1500 m altitude and has a wide range of adaptations from low rainfall areas in Rajasthan and Gujarat states to heavy rainfall areas of western and southern India. It tolerates a wide range of soils but prefers black cotton soils in India and will not thrive in acidic soils. It grows during the wet season from June to November in India and after harvest in November for hay. It provides spring growth from February to March, but this growth is stemmy.

Botanical Description

It is an erect tufted, 100–120 cm tall, fine stemmed perennial grass. Culms are purplish red or bluish in colour with distinct white hair rings at each node. Leaves are green to bluish green, 23–45 cm long, 2–7 mm wide and margins are sparsely pubescent. Inflorescence is a compound raceme with 2–8 purplish false spikes. The spikes are 3–7 cm long, geniculate, twisted awn 8–25 mm, arising nearly from the terminal tip of the culm. Each false spike is a raceme of paired spikelet, one sessile and the other pedicillate. The distinguishing character is the absence of pits on the glumes of its spikelet.

Cultivation Practices

In a well prepared land, the seeds @ 4–6 kg/ha are sown after the first shower in monsoon. Establishment is best when 5 week old seedlings/rooted slips are transplanted in lines 50 cm apart and at 30 cm plant to plant distance. At the time of sowing, a basal dose on 20 kg N and 20 kg P_2O_5/ha is applied. At one month old stage, a top dressing of 20 kg N/ha should be applied.

VARIETIES

Marvel 7: This variety was developed through clonal selection from indigenous material of Gujrat state by MPKV, Rahuri and recommended for cultivation in Maharashtra in 1973. It provides 30-35 t/ha green fodder.

Marvel 8: This variety was developed through clonal selection from weedy flora of Chharodi farm in Gujrat state by MPKV, Rahuri in 1962. It is recommended for arid and semi-arid regions of Gujrat state. The variety provides 14 t/ha green fodder and 3.9 t/ha dry fodder.

GMG-1 (Gujarat Marvel Grass-1): This variety was developed by clonal selection from the material collected from weedy flora of Charodi in Gujrat by AAU, Banaskantha. It is recommended for cultivation in arid and semi-arid regions of Rajasthan and Gujrat. Plants are sturdy, profuse tillering having 32–48 per cent leafiness. The variety is suitable for producing high quality of hay as well as green forage in short time. The average dry forage yield is 60–70 t/ha under rainfed and 100–120 t/ha under irrigated conditions in Gujarat, central and western India. (CVRC- Notification no. 2103 dated 12th December 1980).

Marvel 93: The variety was developed through clonal selection from indigenous material of Gujrat state by MPKV, Rahuri in 1973 for shallow to medium sloppy lands in high rainfall areas. The plants are spreading type with profuse growth and provides 20t/ha green fodder

15. SEWAN GRASS

Botanical Name : ***Lasiurus sindicus* Henr.**
Family : **Poaceae (alt. Graminae)**
Subfamily : **Panicoideae**
Tribe : **Andropogoneae**

Introduction

It is a native grass of India and found predominantly in arid zones of Rajasthan, extending to the parts of Haryana and Punjab. It is also distributed in Arabia, Africa, Nigeria, Ethiopia, Egypt and Pakistan.

Botanical Description

It is an erect, tufted and branched perennial grass which attains a height of 1.20 m. The stem is stout, smooth, sub-woody at base. Leaves are linear 20–45 cm long with setaceous tip. Inflorescence is 10 mm long, white, densely villous and have 3 spikelets at each node. Two spikelets are sessile, 6-9 mm long and one is pedicelled.

Cultivation Practice

Sowing is done by broadcast method at the rate of 6 kg/ha or by planting of rooted slips in the month of July at the onset of rainy season. It is better to sow by pelleting seeds. Planting by rooted slips should be done at row to row distance of 75 cm and plant to plant distance of 50 cm. Basal dose of 40 kg N and 20 kg P_2O_5/ha is recommended with addition of 30 kg N after each cutting.

Two cuttings can be taken each year with average yield of 10–20 t/ha green fodder, 5–6 t/ha dry fodder and 0.2 t/ha seed.

VARIETY

CAZRI-30-5: Developed by CAZRI, Jodhpur.

III. Leguminous Forages

1. BERSEEM (EGYPTIAN CLOVER)

Botanical Name : ***Trifolium alexandrinum* L.**
Family : **Fabaceae (alt. Leguminosae)**
Subfamily : **Faboideae**
Tribe : **Trifolieae**

Introduction

Berseem or Egyptian clover is one of the most important winter forage legumes in India, Pakistan, Turkey, Egypt and Mediterranean region. A few of the 237 species of this large genus have actually been cultivated to date. Out of 3 subgenus, Falcatula is represented in Europe, Lotoidea in Europe, Mediterranean region, USSR, Greece, Spain, Romania, Central and Portugal and subgenus *Trifolium* in Europe, Portugal, Balkan Peninsula, Greece and Mediterranean region. The genus has wide range of variability for habit (*i.e.*, annual, biennial and perennial), habitat (tropical, subtropical and temperate) and tolerance to biotic and abiotic stresses. The important perennial pasture clovers, *T. repens* (white clover), *T. hybridum* (alsike clover), *T. pratense* (red clover) and *T. ambiguum* (caucasian clover) are widely distributed in the temperate and sub-temperate regions of the world while the annual types such as *T. resupinatum* (Persian clover), *T. subterraneum* (sub-terranean clover) and *T. alexandrinum* (Egyptian clover or berseem) are commonly cultivated as winter annuals in the tropical and subtropical regions.

In India *berseem* is the most important winter season legume cultivated in an area of around 2 million hectares. It appeared to behave as a most potent milk multiplier in the lactating buffaloes, Sahiwal cows and cross breed cattles as compared to other forage crops alone on in combination. Most of the present day cultivars are derivative of ecotype Mescavi. These cultivars are multicut (4–8 cuts) in nature, providing fodder for a long duration (November to April), very high quantum of green fodder (85 t/ha) and better quality of fodder (20% crude protein), high digestibility (up to 65%) and palatability. The phenomenal success of *Berseem* in India is also due to its high nitrogen fixing ability resulting in substantial improvement in soil fertility.

Botanical Description

It is an erect-growing, non-reseeding annual legume with oblong, slightly hairy leaflets lacking a watermark. It has hollow stems and a short taproot. Berseem roots are mainly restricted to the 60 cm. Flowers are white and clustered in dense elliptical heads about 1 in long. Each floret produces one roughly-spherical yellow seed. Berseem flowers are usually pollinated by honeybees. Seed is small about 2 mm and yellow in colour. On the average there are about 440 seeds/gram.

Cultivation Practices

Berseem can be grown on all types of soils except very light sandy soils. Well-drained clay loam soils rich in calcium and phosphorous are ideally suited for its cultivation. The crop can be grown successfully on alkaline soils having good water retention capacity. The crop can tolerate mild acidity also. For field preparation, one deep ploughing with soil turning plough and 2 harrowing are essential. The field may be laid out in to smaller beds of convenient size according to topography and source of irrigation water. The sowing of *berseem* can be done from last week of September to first week of December. The ideal time of sowing is at mean day temperature of 25^0 C, which is recorded mostly in the first to third week of October in north India. The optimum seed rate is 25 kg/ha, which may be increased up to 35 kg in early or late sown conditions. For elimination of chicory weed (*kasani*), the seed should be poured in 1 per cent common salt. Floating chicory seed should be taken out and remaining seed of *berseem* should be sown. Before sowing seed should be treated with *Rhizobium*. For treating the seed, it should be first soaked into fresh water for about 8–12 hrs. For better sticking of culture with seed, the culture is prepared with jaggery. About 1.5 lit of water is mixed with 150 g of jaggery and boiled. After cooling, 2.5 packet of *berseem* culture is mixed with it and then seed is well mixed and dried in a cool shady place. There are two methods for sowing of berseem *i.e.*, dry and wet bed. For satisfactory germination and good plant stand, wet method is better. Seed should be sown in beds of convenient size by broadcast method after flooding the beds with 5–6 cm deep water. Before sowing seeds, the water in the beds should be stirred thoroughly with the help of puddler or rake so as to break the clods and capillary to avoid leaching during successive irrigations. The crop should be re-irrigated after 5–6 days of sowing when germination is complete. For obtaining good yield, 20 kg N and 80 kg P_2O_5/ha should be applied as basal dose. In saline or light textured soil, addition of 20 tonnes of well-decomposed FYM is beneficial. The depth and frequency of irrigation is decided by soil type, number of cuttings. First two very light irrigations (4–6 cm depth) should be given at 5–6 days interval. Subsequent irrigations may be given at an interval of 10 days in October, 12–15 days in November to January, 10–12 days in February-March and 8–10 days in April-May. Normally the crop should be irrigated after each cutting.

VARIETIES

Berseem (for Delhi as a kind): (CVRC-Notification no. 5505 dated 20th October 1971)

Berseem: (CVRC- Notification no. 361(E) dated 30th June 1973)

Pusa Giant: It is an auto-tetraploid variety developed by IARI, New Delhi from the diploid variety C-10. It has dark green broader and thicker leaves than those of diploids. Tetra and penta foliate leaves are also quite frequent in this variety. It has bigger flowers and inflorescences as compared to diploids. It has nearly twice as many inflorescences per plant as in diploids. It yields about 10–15% more than Mescavi. It has got greater winter hardiness and frost resistance. (CVRC- Notification no. 440 dated 21st August 1975).

Mescavi: The variety is an introduction from Egypt followed by selection at HAU, Hisar. It is recommended for cultivation in all *berseem* growing regions of India especially Punjab, Haryana and Himachal Pradesh. Plants are shrubby and erect growing up to a height of 45–75 cm, with profuse tillers. Stem is succulent which gives off branches terminating in 2 or 3 leaves. Leaves are rounded at the tip, bright green, slightly hairy on the upper surface. Flower heads are round and white. Seeds are small (2.67 g/1000 seeds), oval and yellow to brown in colour. It yields about 65 t/ha green fodder in 4–6 cuttings. (CVRC- Notification no. 440 dated 21st August 1975).

Berseem Ludhiana-1 (BL-1): The variety has been bred through selection by PAU, Ludhiana from Mescavi. It is adapted to Punjab situation and released in 1978. it is quick growing diploid variety that produces more tillers than Mescavi. Its first cutting is ready about a week earlier than that of Mescavi. It continues to supply green fodder up to the end of May about 2 weeks late than Mescavi. It yields 80–110 t/ha green fodder. (CVRC-Notification no. 13 dated 19th December 1978).

Jawahar Berseem-1 (JB-1): The variety has been developed from single plant selection from Chindwara followed by pedigree method of selection at JNKVV, Jabalpur. It is recommended for cultivation in all berseem growing areas of the country especially central and north western zones. The average plant height is 47 cm; average number of branches is 5.2 and leaf: stem ratio is 1.61. Fully developed inflorescence is cylindrical and elongated in shape. Its productivity is 70–75 t/ha green fodder and 12–15 t/ha dry fodder. (CVRC-Notification no. 41 dated 12th November 1981).

Wardan: The variety has been evolved through selection by IGFRI, Jhansi from the large genetically diverse polyploid material and released in 1981. The plant habit is erect, flower colour is white, days to 50% flowering is 150–165 days, days to maturity in 175–190 days, head colour is brown which possess 80–90 pale yellow coloured seeds. It provides green fodder yield 70–75 t/ha and dry fodder 12–15 t/ha. This is a diploid variety of Berseem. Its growth is slow in cold temperatures and fast in rising temperatures at the end of winter season. (CVRC- Notification no. 19(E) dated 14th January 1982).

BL-10: The variety has been bred through selection from irradiated material of Mescavi by PAU, Ludhiana and released in 1983. (CVRC- Notification no. 832(E) dated 18th November 1985).

BL-22: The variety has been developed by PAU, Ludhiana from irradiated material of variety Mescavi followed by pedigree selection. This variety has been released for temperate and north west zone. The green fodder production is 70 t/ha and it supplies green fodder for longer duration (up to the end of June). (CVRC- Notification no. 10(E) dated 1st January 1988).

BL-2: The variety has been released in 1989 and developed by PAU, Ludhiana by multi-line selection method. (CVRC- Notification no. 599(E) dated 31st July 1989).

UPB-10: The variety has been developed by developing composite of 5 lines followed by selection at GBPUA&T, Pantnagar. It has prolific crown branching with succulent thick stem. The basal shoots and side branches develop freely after cutting. It matures in

200–210 days. The seed size is medium bold and colour is bright yellow and green fodder yield is 70–75 t/ha. (CVRC- Notification no. 615(E) dated 17th August 1993).

Bundel Berseem-2 (JHB-146): The variety has been bred through mass selection by IGFRI, Jhansi from indigenous material no. 25776 followed by pedigree selection. This variety flowers in 150–160 days and matures in 180–190 day. The plant height ranges from 55–65 cm under optimal cutting regime. It has dark green leaves. The crop is fairly tolerant to acidic conditions and is fertilizer responsive. The green fodder yield is 90–100 t/ha. It is released for cultivation in central zone. (CVRC- Notification no. 647(E) dated 9th September 1997).

Bundel Berseem-3: The variety has been bred through colchiploidy followed by recurrent single plant selection followed with mass selection of the parent material JHB-83-3, 1-90-P3-g-bl-hs-sb. The plants are erect with white flowers achieving 50% flowering in 155–170 days and maturity in 175–185 days. The variety is resistant to moderately resistant to stem rot and root rot diseases and have mean green fodder yield of 50–55 t/ha and dry fodder 8–10 t/ha. It in released for north east zone, Bihar Orissa, WB and eastern UP. (CVRC- Notification no. 92(E) dated 2nd February 2001).

JB-5: The variety has been developed through recurrent selection from the colchicine treated seed material by JNKVV, Jabalpur. The variety has been recommended for cultivation in irrigated areas of MP, part of UP, Maharashtra, Gujrat and Chattisgarh. The variety matures in 185-195 days and the average green fodder yield is 4.8 t/ha. (CVRC- Notification no. 1566 (E) 5th November 2005).

Hisar Berseem-1 (HFB-600): The variety has been developed through selection from germplasm lines no. 6 (307011, 11-OP) by CCSHAU, Hisar. It is different from Mescavi in form of head shape and has medium maturity of 205–210 days. It yields 75 t/ha green fodder and suitable for late sowing in hill areas of the country. (CVRC- Notification no. 599(E) dated 25th April 2006).

BL-180: The variety has been developed by PAU, Ludhiana by irradiation of variety BL 10 followed by selection and released in 2006. The variety has been released for cultivation in Punjab, Haryana, Uttranchal, J&K and Himachal Pradesh under irrigated conditions. The variety matures in 260–265 days and the average yield under normal conditions is 60–65 t/ha. It is capable of supplying green fodder late in the season. (CVRC-Notification no. 599(E) dated 25th April 2006).

BL-180: The variety was developed by PAU, Ludhiana in 2005 by selection from irradiated material of BL 10. This variety is suitable under irrigated condition and matures in 260–265 days in north western zone and north hill zone. Average yield is 60–65 t/ha of green fodder and 3–4 t/ha of seed yield in north western zone. (CVRC- Notification no. 1178(E) dated 20th July 2007).

2. LUCERNE (ALFALFA)

Botanical Name : ***Medicago sativa* L.**
Family : **Fabaceae (alt. Leguminosae)**
Subfamily : **Faboideae**
Tribe : **Trifolieae**

Introduction

Lucerne or alfalfa is one of the oldest cultivated fodder crops. Roman writers described its value as feeds for horses and other animals as early as 490 BC. Alfalfa (*Medicago sativa* L.) is derived primarily from *M. coerulea*, a diploid 2n=16 that grows wild in grasslands of south west Iran, caucasan region and eastern Anatolia. Tetraploids are usually more vigorous than diploids.

Lucerne is a native to south west Asia as indicated by occurrence of wild types in the Cancasus and in mountainous region of Afghanistan, Iran. The cultivated forms probably arose in western Persia and then spread to become widely cultivated throughout Asia, Europe and America and widely distributed in temperate regions. The genus contains large number of species. In India other than *M. sativa*, the entire groups of Medics are treated as wild types. The existing *M. sativa* is largely a tetraploid species (2n=4x=32). However, diploids and hexaploids are also found in nature.

Lucerne is commonly called as *rijka* in northern India. It is a perennial plant and can supply green fodder continuously for 3–4 years from the same crop stand. The root system is deep and so can be easily grown in the areas where water is in short supply. Lucerne has high palatability for all kinds of livestock as it provides nutritious fodder and possesses about 16-25% crude protein and 20–30% fiber. Due to its high protein and vitamin A content, it is included as a feed component for poultry and piggery. Lucerne provides green fodder for a longer period (November-June) in northern parts and throughout the year in other parts of the country where winters are not severe. In India, Lucerne occupies one million hectare area and provides 60 to 130 tonnes of green forage/ha. It is grown as a farm crop in Punjab (13,554 acres), western districts of UP, Maharashtra (18400 acres), Gujarat (19,900 acres), Tamil Nadu and WB. After sorghum and berseem, Lucerne is 3rd important forage crop in India. Alfalfa is a perennial species with indeterminate growth habit, profuse basally branched and erect type.

Botanical Description

Mostly erect to sub-erect perennial herbs, 30–60 cm, pubescent to subglabrous. Leaflets 5–20 mm long, 3–10 mm broad, obovate to sublinear, dentate at apex, appressed pubescent; entire or dentate at base. Inflorescence a peduncled raceme, peduncle much longer than

petiole. Calyx teeth as long as the tube. Corolla 6-12 mm long, violet to pale lavender. Fruit falcate or in a loose spiral of 1–4 turns, glabrous to appressed pilose, 10–20 seeded.

Cultivation Practices

Lucerne needs sandy loam to clayey soil while heavy soils need an efficient drainage system, as the crop does not tolerate water logging. It cannot thrive on alkaline soils but can be grown on acid soils with liberal application of lime. Lucerne prefers a fertile soil, which is rich in organic matter, calcium, phosphorous and potash. Lucerne requires well prepared field as the seeds are very small. One deep ploughing with 2–3 harrowings followed by planking is sufficient. The best sowing time of the crop is mid October to early November. However, sowing date may spread from early October in the north to late December in the east and south zone. In the temperate zone, spring sowing is done in March. The seed rate depends upon method of sowing and type of the crop, *i.e.*, pure or mixed stands. In broadcast method, a seed rate of 20–25 kg/ha should be used while line sowing needs only 12–15 kg/ha but in case of intercropping, it requires only 6-12 kg/ha. Line sowing is preferred over broadcasting,10 to 20 m long beds should be made along with slope with irrigation channels 4–5 m apart. Water soaked seed is sown in shallow furrows at row distance of 30 cm by seed -drill or *kaira* at sufficient soil moisture. It is beneficial to add well decomposed FYM @20–25 t/ha before sowing in the first year. Normally, 20 kg N and 100 kg P_2O_5/ha should be applied as basal dose for good harvest. Application of Molybdenum and Boron may be done based on soil test. In subsequent years, annual supplementation of 80 kg P_2O_5 and 40 kg K_2O/ha should be done. To obtain good germination, pre-sowing irrigation is essential. The crop needs very frequent irrigations during its early growth period at an interval of about one week but once the plants are established, subsequent irrigations are provided at an interval of 15–20 days during winter and 10–12 days during spring and summer seasons. Proper drainage should be ensured to avoid water logging in rainy season. The first cutting should be taken at 55–65 days after sowing and the subsequent cuts may be taken 30–35 days interval. In general, annual lucerne gives 4–5 cuts while in the perennial crop, 7–8 cuts can be taken.

VARIETIES

Chetak (S-244): This is a variety developed by IGFRI, Jhansi through single plant selection from local material of Mathura and released in 1975. The variety is suitable for cultivation in Punjab, Haryana, Uttar Pradesh and Gujarat. The plant height is 70–90 cm with dark green foliage and light purple flowers. It has quick regeneration capacity with resistance to aphids. It yields 140–150 t/ha green fodder. (CVRC-Notification no. 441(E) dated 21st August 1975).

Lucerne (As a kind): This is a state variety notified by CVRC. (CVRC-Notification no. 441(E) dated 21st August 1975).

Sirsa Type 9: This variety is released in 1975 by Fodder Research Station, Sirsa. It is a quick growing variety with deep green foliage. Its yield potential is about 80–85 t/ha of

green fodder and 0.25 to 0.45 t/ha seed. It is most suitable for growing in north India particularly Punjab, Haryana, Delhi and Uttar Pradesh where cold temperature prevails. (CVRC-Notification no. 440(E) dated 21st August 1975).

Sirsa-8: This is a variety developed by Fodder Research Station, Sirsa and released in 1975. The variety is suitable for northern India where cold temperature prevails. (CVRC-Notification no. 13 dated 19th December 1978).

Type-9: The variety was developed by Fodder Research Station, Sirsa by mass selection and released in 1978. The plants are vigorous, quick growing, slender stalks, foliage dark green, leaflets long with toothed margins, flowers bluish purple, seeds kidney shaped and yellow coloured. This is suitable for northern India where cold temperature prevails. (CVRC-Notification no. 13 dated 19th December 1978).

Co-1: The variety was developed by TNAU, Coimbatore through mass selection from Coimbatore local collections. The variety is recommended for cultivation in Tamil Nadu. It has high (20%) protein and the green forage yield is 80–90 t/ha. This is a perennial cultivar which can be maintained successfully for three years. (CVRC-Notification no. 19(E) dated 14th January December 1982).

GAUL-1 (Anand-2): The variety was developed by Gujrat Agricultural University, Banaskantha, through selection from perennial type Lucerne grown in Bhuj area of Kutch region of Gujrat. The green forage yield is 80–100 t/ha. It is suitable for cultivation in Gujarat, Rajasthan and Madhya Pradesh. Yield is 70–80 t/ha green fodder in 10–12 cuts/years and 0.2–0.3 t/ha seed. (CVRC-Notification no. 596(E) dated 13th August 1984).

GAUL-2 (SS-627): This is a selection from Sirsa material by GAU, Banaskantha. It has been recommended for cultivation in whole Gujarat but has been found more suitable for northern Gujarat. The plants are tall and provide 10 to 12 cuttings in a year with 80–100 t/ha green fodder.

LL Composite 5: The variety was developed by PAU, Ludhiana by selection from 125 downy mildew resistant clones from Kutch and released in 1981 for cultivation in Punjab. It gives 8 cutting up to first week of July and has a yield potential about 70–75 t/ha fodder and 0.3–0.5 t/ha seed. (CVRC-Notification no. 596(E) dated 13th August 1984).

LL Composite 3: The variety was developed at PAU, Ludhiana from twenty clones selected from fast growing, high yielding and downy mildew resistant germplasm collected from Gujrat state. It was released in 1985 for cultivation. It is resistant to lodging and frost and provides 38–40 t/ha green fodder and 0.30–0.35 t/ha seed. (CVRC-Notification no. 540(E) dated 24th July 1985).

Lucerne no. 9-L: This variety was developed at Punjab Agricultural University, Ludhiana. It is a quick growing variety with deep green foliage, slender stalks and purple flowers. It grows well for a period of 5–7 years. Its yield potential is about 75 t/ha of green fodder/year. It yields 55–60 t/ha of green fodder up to July during the first year.

NDRI Selection No.1: It has thick roots which penetrate deep into soil. It is a selection from material from Saurashtra and Kutch by NDRI, Karnal. It has turgid stems. The leaves are smaller in size as compared to other Lucerne varieties. This variety has the capacity of maintaining itself in its pure stands over 5–6 years without getting degenerated due to the infestation of weeds. The crop is ready for first cut after 60–70 days of sowing. Its green fodder yield potential is about 100 t/ha.

Anand-3: The variety has been developed by AAU, Anand. It is an annual type, suitable for cold dry zone of Kinnaur and Lahaul & Spiti districts of Himachal Pradesh. It provides 40 t/ha green fodder. (CVRC-Notification no. 408(E) dated 4th May 1995).

RL-88: The variety was developed by MPKV, Rahuri through selection from local collections from Ahmednagar, Maharashtra. The variety has been recommended for cultivation for year round irrigated situation in all zones of the country. This first cut of the crop can be taken in 50–60 days of sowing and thereafter cut can be taken at 25–30 days. The variety is resistant to major diseases and pests and yields 75–100 t/ha green fodder in 11 cuts. (CVRC-Notification no. 1(E) dated 1st January 1996).

Anand Lucerne-3 (AL-3): The variety was developed at AAU, Anand through pure line selection and population improvement of the material collected from Kutch area of Gujrat. The plants have profuse tillers (47/plant). It is perennial type with dark green foliage and oblong leaves. The green fodder yield is 97 t/ha and seed yield 3.0 q/ha. (CVRC- Notification no. 454 (E) 11th February 2009).

3. COWPEA

Botanical Name : ***Vigna unguiculata* (L.)**
Family : **Fabaceae (alt. Leguminosae)**
Subfamily : **Faboideae**
Tribe : **Phaseoleae**

Introduction

Africa and China were considered as main centre of origin. Evidences suggest that cowpea originated and possibly domesticated in western or central Africa very likely in Nigeria, where a profusion of wild and weedy species abound in both Savannah and forested zones. The cowpea was cultivated in prehistoric times in tropical Africa and must have reached, Egypt, Arabia and India very early.

Cowpea is grown throughout the lowland tropics of Africa, India, south eastern Asia, Australia and coastal areas of South and Central America. Cowpea includes four cultigroups (1) *unguiculata*- major group, (2) *biflora orcatiang* with small erect pods grown in south-east Asia, (3) *sesquipedalis*-yard long bean grown in Asia, (4) *textiles*-grown in west Africa, for textile fibres obtained from peduncles. The wild and weedy types include, *V. pubescense*, *V. dekindtiana* and *V. cylindrical*. Cowpea is diploid and has 2n = 2x = 22 chromosomes.

In India, cowpea is grown only in some parts of Rajasthan, Gujarat, Maharashtra, Karnataka and Tamil Nadu. It has a great potential for sustainable agriculture in marginal lands and semi arid regions of the country. It is estimated that about 6.5 lakh hectare is under different forms of cowpea and the share of fodder cowpea is 3 lakh ha.

Botanical Description

The inflorescence is axially raceme with flowers congested at the top of the peduncle often in alternate pairs. Flowers are snowy white, yellow or pink, bracteate, bracteolate, bracteoles two, shortly pedicellate, bisexual, hypogynous, zygomorphic and complete. Cowpea is day neutral, highly self-pollinated crop, although significant out crossing can also occur due to large bees like bumble bees.

Cultivation Practices

It is adopted to variety of soil types *viz*., red loam, black clay loam, coarse gravel, sandy loam, light sandy soils. It is also grown in sloppy land in hilly tracts and heavy loam soils. It is more tolerant to heavy rainfall than any other pulse crop. It suffers from water stagnation and heavy drought. It thrives well between 21 to 35°C. The crop is usually grown as dryland *kharif* crop and can also be grown as pre monsoon and late monsoon crop. It is also grown as second crop during rabi after rice in southern parts of country. The

field should be prepared well for sowing. The crop is sown in the first week of July in the hills and in the second fortnight of March in lower hills and in October in plains. One hand weeding or hoeing 30-35 days after sowing or application of weedicide pendimethalin @ 1.0-1.5 kg a.i/ha immediately after sowing helps in control of weeds. The crop requires adequate moisture. In plains 3-4 irrigations are required. About 120 kg N and 80 kg P/ha are recommended. Half the nitrogen is applied as basal dose and half for top dressing. The crop matures in 120-125 days. The row to row spacing is 30-45 cm. The recommended seed rate is 20-25 kg/ha. Grain yield up to 10 q/ha is obtained.

VARIETIES

Cowpea-74: The variety was developed by PAU, Ludhiana by hybridization (FS 68 × strain No. 102) followed by selection. It has been released for cultivation in Punjab in 1975. (CVRC- Notification no. 13 dated 19th December 1978).

Kohinoor: This variety was developed by IGFRI, Jhansi through single plant selection from material from Itan (IL-68-786) and released for parts of Haryana, Punjab, Gujarat and UP. The plant height is 55-70 cm, stem green in colour, pods are green with a smooth surface and horizontally dispositioned with tendency to droop. The seeds are bold and red. Average green fodder yield is 40-45 t /ha and average dry fodder yield 50-60 t/ha. The variety has excellent growth in summer. (CVRC- Notification no. 441(E) dated 21st August 1975).

HFC-42-1 (Hara Lobia): This is an erect variety with dark green foliage and is suitable for mixed cropping. The variety has been developed by CCS HAU, Hisar and is suitable for cultivation in Haryana and Punjab. It gives green fodder yield of 26.2 t/ha. (CVRC-Notification no. 786 dated 2nd February 1976).

Cowpea-74: This is a variety from PAU, Ludhiana developed from irradiation of F1 of cowpea-74 × H2 for Punjab State. (CVRC- Notification no. 13 dated 19th December 1978).

EC 4216: The variety was developed by IARI, New Delhi through selection from exotic material. The plants are erect to semi-erect, 140-150 cm long and climbing type. The green fodder yield is 30 t/ha and dry matter yield is 5.5 t/ha. (CVRC- Notification no. 13 (E) 19th December 1978).

Type-21: The variety was developed by IGFRI, Jhansi through single plant selection from the local material and is recommended for cultivation all over the country. The plants have dark green leaves and provides 33 t/ha green fodder and 5 t/ha dry fodder. (CVRC-Notification no. 13 (E) 19th December 1978).

GFC-1 (Gujarat Forage Cowpea-1): The variety was developed by selection from local collection from Chharodi area of Gujrat by GAU Banaskantha. The plant has a trailing habit with a height of 125 cm. It takes 65–70 days for 50% flowering and has dark green

pods. It is recommended for *kharif* sowing in Gujrat and provides 25–30 t/ha green fodder. (CVRC- Notification no. 2103 dated 21st August 1980).

GFC-2 (Gujarat Forage Cowpea-2): This is a variety developed by GAU, Banaskantha through selection of local material collected from Chharodi area of Gujrat. It performs well during summer season with trailing type plants with dark green pods. The variety gives 20 t/ha green fodder and 3–4 t/ha dry fodder. The protein content is 14–19%. (CVRC- Notification no. 2103 dated 21st August 1980).

GFC-3 (Gujarat Forage Cowpea-3): The variety is developed by GAU, Banaskantha, Gujrat through selection of local material collected from Chharodi area of Gujrat followed by pure line selection. The variety has been recommended for cultivation in Gujrat state. The plants are trailing type and are 196 cm long. It provides 20 t/ha green fodder and 3–4 t/ha dry fodder. The protein content is 17.5–19.5%. (CVRC- Notification no. 2103 dated 21st August 1980).

GFC-4 (Gujarat Forage Cowpea-4): This is a variety developed by GAU, Banaskantha through selection from Chharodi area of Gujrat and it performs well during summer season. The variety gives 20 t/ha green fodder and 3.0–3.5 t/ha dry fodder. (CVRC- Notification no. 2103 dated 21st August 1980).

UPC-5286: The variety was developed by GBPUA&T, Pantnagar through single plant selection. The variety matures in 140–150 days with green fodder yield of 35 t/ha. (CVRC- Notification no. 19(E) dated 14th April 1982).

CO-5: This variety was developed by TNAU, Coimbatore and is a gamma irradiated mutant of CO- 1. It has been recommended for cultivation in south zone of the country. It produces 30 t/ha of green fodder. (CVRC- Notification no. 867 dated 26th November 1986).

UPC-5287: The variety has been developed by GBPUA&T, Pantnagar from single plant selection from CK-74-5287 followed by selection on single pod basis and bulking on plant basis. The variety matures in 155–170 days with green fodder yield of 26 t/ha. (CVRC- Notification no. 258(E) dated 14th May 1986).

UPC – 287: The variety has been developed by GBPUA&T, Pantnagar using single plant selection from germplasm line CK-72-287. The variety has been notified for cultivation in the entire country. It provides green fodder yield of 17 t/ha. The variety takes 135–140 days for 50% flowering and 135–145 days for maturity. The green fodder yield is 30–35 t/ha. (CVRC- Notification no. 471(E) dated 5th May 1988).

Sweta (No. 998): This is a variety developed by MPKV, Rahuri. (CVRC- Notification no. 915(E) dated 5th May 1988).

Charodi: This variety has been developed at GAU, Anand and has been notified for cultivation in Gujrat state. (CVRC- Notification no. 471(E) dated 5th May 1988).

Cowpea-88: This variety was developed by PAU, Ludhiana from irradiation of F_1 of intervarietal cross (cowpea-74 × H2) and has been notified for cultivation in Punjab state. (CVRC- Notification no. 860(E) dated 25th November 1992).

UPC-4200: This variety was developed by GBPUA&T, Pantnagar by pure line selection from CK-76-4200. The variety has been recommended for cultivation in north east zone of the country. The plant is erect during early stages of growth and later on becomes trailing/ climbing with profuse branching; foliage is dark green with broad globose leaflets. The flower colour is light violet. The pod colour is straw brown. The seeds are kidney shaped, medium sized and testa colour is black mottled. It is suitable for humid/wet regions. The variety yields 30.0–32.5 t/ha green forage and is resistant to collar rot, wilt and pod borer. (CVRC- Notification no. 793(E) dated 22nd November 1991).

Bundel Lobia-1 (IFC - 8401): The variety was developed by IGFRI, Jhansi through single plant selection from IL-515. It is recommended for all India cultivation. It grows up to 120–130 cm with 5–7 branches, which are basal and sub-basal. The plant growth habit is decumbent, semi-tendrillar at late stage of growth. It possess medium to broad leaves with light green colour, Seed shape is rectangular to round, tapering towards the distal end. Seed colour has yellowish back ground with gray dotting covering the entire seed coat surface. It is suited to drier areas of the country with moderate rainfall. It is ready for green fodder harvest in 60–65 days. The green fodder yield, dry-matter yield and crude protein are 30–35, 4–5 and 0.60 t/ha respectively. (CVRC- Notification no. 814(E) dated 4th November 1992).

Bundel Lobia-2 (IFC - 8503): The variety was developed by IGFRI, Jhansi through single plant selection from IL-978. It is recommended for cultivation in north-west zone mainly Punjab and Rajasthan. The plant height is 140–150 cm with 4–5 branches. The growth habit is erect to semi-erect with tendrils. The leaves are medium to broad and light green in colour, peduncle length is 15–20 cm. The number of pods per peduncle is 2–4, pod disposition drooping with tough and leathery surface at maturity. Seed colour is fawn white with variable pinkish shade. The variety is suited to drier areas of the country with moderate rainfall. The fodder yield (t/ha) is 30–35 green and 3.5–4.0 dry with 63.8% IVDMD and 17% crude protein. (CVRC- Notification no. 636(E) dated 2nd September 1994).

UPC- 8705: The variety was developed by GBPUA&T, Pantnagar and is a derivative of the cross (N-425 × H-288). It provides green fodder yield of 35–40 t/ha and dry fodder yield of 5.3 t/ha. The variety takes 80–90 days for 50% flowering and 140–145 days for seed maturity. (CVRC- Notification no. 349(E) dated 20th May 1996).

CS – 88 (Haryana Lobia - 88): The variety has been developed by CCSHAU, Hisar by hybridization of C-28 and HFC- 42-1 followed by pedigree selection. This is suited for cultivation in summer and rainy season providing 31 t/ha green fodder with erect growth nature, good early vigour, having long and broad leaves, it is suitable for mixed cropping.

Konkan Fodder Cowpea-1: (DFC-1): The variety has been developed by KKV, Dapoli through selection from local germplasm material of Ratnagiri district. It comes to 50% flowering in 60–65 days. It takes 100 days for seed to seed maturity. It provides 23–25 t/ha green fodder during *kharif* and 20–22 t/ha during *rabi*. The dry matter yield is 5 t/ha. The seed yield is 7–8 q/ha. (CVRC- Notification no. 360(E) dated 1st May 1997).

UPC- 9202: The variety has been developed by GBPUA&T, Pantnagar by pedigree selection from intervarietal cross (V-260 × UPC 9805-7-2-4). The variety has been notified for cultivation in sub-tropical to tropical regions of central zone of the country comprising of MP, Gujrat and Maharashtra. It is a medium late variety which matures in 80–85 days. It provides 35–40 t/ha green fodder. (CVRC- Notification no. 5425(E) dated 9th June 1999).

UPC 607: The variety has been developed by GBPUA&T, Pantnagar by selection from intervarietal cross (L-212 × Singapore) - 48-2-9. The variety matures in 140–150 days. The variety has been notified for cultivation in subtropical to tropical plains of north-west zone comprising Uttaranchal, northern Uttar Pradesh, tarai belt, Punjab, Haryana and Rajasthan. It provides 35–40 t/ha green fodder and 4.5–5.0 t/ha dry matter.

Fodder Cowpea-CO (FC)-8: This variety is developed by TNAU, Coimbatore. It is resistant to yellow mosaic virus, root rot and moderately resistant to leaf hoppers, beetles and bacterial leaf blight. It is suitable for intercropping with sorghum and maize. Green fodder has high protein (20.67 per cent), fat (2.72 per cent), calcium (1.49 per cent) and phosphorus (1.37 per cent), and high palatability. It is a hybrid derivative of the cross (CO-5 × N- 331). It is semi-spreading, erect in early stages of growth and later on becomes creeping. It can be grown all over Tamil Nadu except Villupuram, Cuddalore, Tiruvarur and Kancheepuram districts as irrigated crop, it can be raised throughout the year, and the rainfed crop is cultivated in *kharif* and *rabi* seasons. The plant grows to a height of 100 to 120 cm, and green fodder can be harvested in 60 to 70 days when fifty per cent flowering is recorded. When allowed to set seeds, the crop matures in 100 to 105 days.

CL-367: The variety has been developed by PAU, Ludhiana (Cowpea 74 × Strain No. 90) and bulked in F_6 generation. It has been recommended for irrigated areas of Punjab. This is an early short duration variety which provides 27 t/ha green fodder and 12.3 q/ha seed yield. (CVRC- Notification no. 599(E) dated 25th April 2006).

UPC – 618: The variety has been developed by GBPUA&T, Pantnagar from cross (UPC-8703 × IT-84 E-124 -2-5-1). The variety has been notified for cultivation in Uttranchal,

UP, Punjab, Haryana, Rajasthan, Jharkhand, West Bengal, Orissa, Assam, MP, Gujrat and Maharashtra. It is medium late variety which matures in 140–150 days. It provides 30 t/ha green fodder and 4.5–5.0 t/ha dry matter. (CVRC- Notification no. 599(E) dated 25th April 2006).

UPC-622: The variety has been developed by GBPUA&T, Pantnagar through single plant selection. The variety is recommended for cultivation in north-west, north–east and hill zone of the country. (CVRC- Notification no. 1178(E) dated 20th July 2007).

UPC- 621: The variety is developed by GBPUA&T, Pantnagar. This variety is released for cultivation in the lower hills and plains of Uttrakhand. The green fodder yield is 32.5–35.0 t/ha and dry fodder yield is 50–55 q/ha at 50% flowering stage in 85–90 days. The seed yield is 6-8 q/ha in uncut crop. DM digestibility is 60–65% with 16-17% CP besides lower ADF and NDF. Slight twining tendency character is suitable for mixed/intercropping with sorghum, maize, bajra and other cereal forages during summer and *kharif* season.

UPC- 625: The variety was developed by GBPUA&T, Pantnagar. It is a white seeded variety released for all India cultivation and can be used as dual purpose crop due to its stay green biomass at pod maturity and creamy white seeds with rough wrinkled testa which is most preferred for human consumption. It provides 35–40 t green and 4.5–5.0 t dry fodder per hectare at 50% flowering stage in 80–85 days. Seed yield is 6-8 q/ha in uncut crop. Dry matter digestibility is 65–70% with 15–17% crude protein and has higher leaf stem ratio besides lower ADF and NDF. Slight twining tendency character is suitable for mixed/intercropping with sorghum, maize, bajra. (CVRC- Notification no. 449(E) dated 11th February 2009).

4. GUAR (CLUSTER BEAN)

Botanical Name : ***Cyamopsis tetragonoloba* L. Taub**
Family : **Fabaceae (Leguminosae)**
Subfamily : **Faboideae**

Introduction

Cluster bean commonly known as guar, is an indigenous, annual and self-pollinated *Kharif* legume grown for feed, green fodder, vegetable, green manuring and gum extraction from seed. Being drought hardy, it is grown mainly under rainfed conditions in India. It provides nutritious fodder, fibreless green pods for vegetable, guar gum (having several diversified uses) and guar meal (concentrate) to the livestock, adds fertility to soil by fixing a considerable amount of atmospheric nitrogen and adding organic matter. It has assumed a great industrial importance in recent years in Indian arid zone mainly due to the presence of gum (Galactomannan) in its endosperm, which constitutes about 30–32% of the whole seed. Guar gum has several diversified uses in textile & paper industry, food processing, cosmetics, mining, pharmaceutical, explosives, petroleum, well drilling, oil industries, photography, refining etc. Guar gum and its derivatives are in great demand in the world market.

Guar is commercially grown mainly in India, Pakistan and United States. In India, guar is being grown in arid and semi-arid areas of north-western states mainly in Rajasthan, Gujarat, Haryana, Punjab, some parts of UP and MP covering about 2.56 million ha with a production of 0.72 million t of guar seed.

Botanical Description

Guar plant is an erect, robust annual with a height of 90–180 cm. It has well developed tap root system. The leaves are trifoliate and toothed. The flowers are purple in colour and borne on short axillary racemes. The pods are flattened, fleshy, beaked, 2.5–13 cm long containing 5–12 seeds and are borne in clusters. The seeds are square in shape and compressed.

Cultivation Practices

The crop grows well in sandy loams and alluvial soils. It is susceptible to water logging and prefers soils with pH 7.0–8.5. The field preparation requires two ploughings or two cross harrowing and planking. At the time of sowing ,15–20 kg N/ha should be applied. Seed inoculation with *Rhizobium* is promising for better performance of fodder crop. The crop grows well with application of 10 t /ha FYM or compost at time of sowing. The crop should be fertilized with 50 kg P_2O_5/ha. All the fertilizers should be applied at the time of sowing in furrows 4–5 cm below the seed.

VARIETIES

Durgajay: The variety was developed ARS, Durgapura from single plant selection of the material collected from Nagaur, Rajasthan. The variety is dual type for fodder and seed and is recommended for cultivation in Rajasthan. The variety provides 27 t/ha green fodder and seed yield is 12.6 q/ha. (CVRC- Notification no 470(E) 19th January 1980).

Durgapura Safed: This variety was developed by ARS, Durgapura by single plant selection from local material of Rajasthan. It is a dual type variety suitable for late sown conditions. It is recommended for cultivation in Rajasthan state. The green fodder yield is 25 t/ha. (CVRC- Notification no. 470(E) 19th February 1980).

Agaita Guara-111: The variety was developed by PAU, Ludhiana from inter varietal cross of G 325 and FS 277 followed by pedigree method of selection. The variety is recommended for cultivation in all guar growing areas of Punjab state. It provides 23 t/ha of green fodder and 4.4 t/ha dry fodder. (CVRC- Notification no. 499(E) 8th July 1983).

Agaita Guara-112: The variety was developed by PAU, Ludhiana through hybridization of (326 × FS 277) × 315 followed by pedigree method of selection. The variety is an early maturing type and is recommended for cultivation in all guar growing areas of Punjab state. The plants are hairy unbranched and bears higher number of pods. It provides 30 t/ha of green fodder and 6.4 t/ha dry fodder. (CVRC- Notification no. 499(E) 8th July 1983).

FS-277: The variety was developed by CCSHAU, Hisar through selection from local material and is recommended for cultivation in entire guar growing tract. (CVRC-Notification no. 13 dated 19th December 1978).

HFG-119: The variety was developed by CCSHAU, Hisar by selection and is notified for cultivation in the entire guar growing area of the country. The crop is harvested in 130–135 days providing 25–30 green and 5–6 t/ha of dry fodder. It is highly drought tolerant, non-shattering and resistant to Alternaria leaf spot. (CVRC- Notification no. 19(E) dated 14th January 1982).

HG-75: The variety was developed by CCSHAU, Hisar through selection and is recommended for cultivation in all guar growing areas of the country. The variety yields 25 t/ha green fodder and 20 q/ha seed. It is more preferred for seed. (CVRC- Notification no. 19(E) dated 14th January 1982).

Guara-80: The variety was developed by PAU, Ludhiana from intervarietal cross (FS 277 × Strain No. 119) followed by pedigree selection. It is recommended for cultivation in north western zone of the country. It produces 26.8 t/ha green fodder and 15 q/ha seed. (CVRC- Notification no. 499(E) dated 8th July 1973).

HG-182: The variety was developed by CCSHAU, Hisar from a single plant selection from the genetic stock (accession HFC-182). It is ready for harvest in 110–125 days. (CVRC-Notification no. 596(E) dated 13th August 1984).

Maru Guar (2470/12): The variety was developed at CAZRI, Jodhpur from the germplasm material supplied by NBPGR, New Delhi. The variety is a dual type suitable for western Rajasthan. It yields 22.5 t/ha green fodder and seed yield is 9.5 q/ha. (CVRC-Notification no. 867E) 26th November 1986).

HFG-156: The variety was developed by CCSHAU, Hisar for cultivation in Haryana. It is a tall, branched variety yielding 35 t/ha green fodder. (CVRC- Notification no. 10(E) dated 1st January 1988).

Bundel Guar- 1: It was developed through single plant selection at IGFRI, Jhansi. It provides 35.0 t/h green fodder and 6.5 t/ha of dry fodder with a protein yield of 1.15 t/ha. It provides nutritive fodder in 50–55 days. This variety is moderately resistant to leaf blight under epiphytotic field conditions. It is lodging resistant, responsive to fertilizers, drought tolerant and has a non-shattering character. (CVRC- Notification no. 615(E) dated 17th August 1993).

Bundel Guar- 2 (IGFRI-2395-2): The variety was developed by IGFRI, Jhansi by selection. Its green fodder, dry fodder and crude protein yield ranges between 25.0–30.0, 5.0–6.0 and 0.12–0.15 t/ha respectively. The variety has good palatability to the cattle with about 74% digestibility on dry matter basis. It is also superior for grain/gum production. The variety is highly responsive to fertilizers and moderately resistant to bacterial blight and has shown tolerance to lodging, drought and shattering. It has been released and notified as dual type of guar variety (forage-cum-grain) for general cultivation in entire guar growing areas of the country. (CVRC- Notification no. 408(E) dated 4th May 1995).

Bundel Guar- 3 (IGFRI 1019-1): This variety was developed by IGFRI, Jhansi through selection from indigenous material collected from Durgapura, Rajasthan (RGC-19-1). The variety is moderately resistant to bacterial blight and powdery mildew, responsive to fertilizers, highly tolerant to shattering and reasonably resistant to drought situations. The variety has been released and notified for general cultivation in entire guar growing area of India as forage-cum-grain type. The maturity is 50–55 days producing 35–40 t/ha green fodder. (CVRC- Notification no. 1050(E) dated 26th October 1999).

Guar Kranti (RGC-1031): This variety was developed at ARS, Durgapura and is a derivative of the intervarietal cross between RGC-936 × RGC- 986/P-10. It is recommended for cultivation in Rajasthan state. The variety yields 34 t/ha green fodder and 14.6 q/ha seed. (CVRC- Notification no. 1566 (E) 5th November 2005).

5. SEM (LABLAB BEAN)

Botanical Name : ***Lablab purpureus* L.**
Family : **Fabaceae (alt. Leguminosae)**
Subfamily : **Faboideae**
Tribe : **Phaseoleae**

Introduction

Lablab is a dual-purpose legume native to Africa and is traditionally grown as a pulse crop for human consumption in south and south-east Asia and eastern Africa. Flowers and immature pods are also used as a vegetable. It is also used as a fodder legume and is sown for grazing and conservation in broad-acre agricultural systems in tropical environments with a summer rainfall. It is used as green manure, cover crop and as fodder in cut-and-carry system and as a concentrate feed. It can be incorporated into cereal cropping systems as a legume ley to address soil fertility decline and is used as an intercrop species with maize to provide better legume/stover feed quality. As a dual purpose (human food and animal feed) legume, it is sown as a monoculture or in intercrop systems. Three harvests are possible from annual types, but can not stand heavy grazing of stems. For green manure, the crop should be cut before flower initiation. As a forage, the crop should be utilised before flowering. The plant has a peculiar buggy smell (fragrance). It is quite hardy and drought resistant, although cold weather depresses pollination and seed setting. It cannot thrive in waterlogged conditions. Lablab is remarkably adaptable to wide areas under diverse climatic conditions such as arid, semi-arid, sub-tropical and humid regions where temperature vary between 22°C–35°C, low lands and uplands and many types of soils and the pH varying from 4.4 to 7.8. Being a legume, it can fix atmospheric nitrogen to the extent of 170 kg/ha besides leaving enough crop residues to enrich the soil with organic matter.

Botanical Description

It is an annual or biennial legume and attains a height of 0.9-1.8 m. The stems are robust and well branched. Leaves are trifoliate and large. Leaflets are oval, 10–15 cm long, smooth on the upper side and slightly hairy on underneath. Inflorescence is loose and multi flowered. Flower of varied colours, white, purple or reddish are borne on axillary racemes. Pods are 3–12 cm long, smooth, curved with 2–4 large seeds. Seeds are globose, ovate or flattened, brown to black in colour with conspicuous white line at the hilum or point of attachment to the pod.

Cultivation Practices

After two ploughings at the onset of monsoon, the seeds are sown in line (40–45 kg/ha). The seeds are sown in rows 1 m apart with a seed to seed distance of 35 cm at a depth of 3–5 cm. At the time of sowing 10–15 kg N, 40–60 kg P_2O_5 and 20–25 kg K_2O/ha should be applied to the soil.

VARIETIES

GAUD-1: This is a variety developed by GAU, Banaskantha and released for central and western India in 1979.

Bundel Sem-1 (JLP-4): This variety was developed at IGFRI, Jhansi through hybridization of T-16 × T-14-1 followed by pedigree method of selection and notified for cultivation in the entire country. The plants are semi-erect, 135–170 cm in length and grow as annual in semi-arid or rainfed areas, and as perennial in humid or coastal region or irrigated areas. The flowers are pinkish and seeds are black in colour. The variety is highly sensitive to thermo-photoperiod, flowering strictly during short days. The average green fodder yield is 22–25 t/ha with dry matter of 4.5 to 5.0 t/ha and seed yield 12–15 q/ha (if grown as grain crop). (CVRC- Notification no. 6159(E) dated 17th August 1993).

6. RICE BEAN (RED BEAN)

Botanical Name : ***Vigna umbellate* (Thumb.) Ohwi and Ohashi, Syn. *Phaseolus calcaratus* Roxb.)**
Family : **Fabaceae (alt. Leguminosae)**
Subfamily : **Faboideae**
Tribe : **Phaseoleae**

Rice bean is a legume grown in western, northern and eastern India. A number of landraces are cultivated in these areas. It is grown as an intercrop, particularly with maize and also on residual moisture after rice. It has rapid establishment, pest resistance and potential for good yield of nutritious fodder and high quality grain.

VARIETIES

RBL-1: This variety was developed by PAU, Ludhiana and released for cultivation in 1987. (CVRC- Notification no. 165(E) dated 6th March 1987).

Bidhan-1 (BC 15/K 1): This variety was developed by BCKV, Kalyani after selection from a local landrace. This has been notified for cultivation in 2000 as pulse and fodder in West Bengal, Orissa, Manipur and Nagaland. The plant height is 130–140 cm, erect in early stage becomes viny in late stages, have profuse branching, light green stem, leaf stem ratio (0.75–0.8), yellow flower, pod length (7–9 cm), seeds/pod (6-7) and bold seeds. The variety is drought, cold and water logging tolerant. The variety produces 35–40 t/ha green fodder and 20 q/ha seed. (CVRC- Notification no. 92(E) dated 2nd February 2001).

RBL-6: This variety was developed by PAU, Ludhiana by selection from germplasm collected from district Nagaur of Rajasthan. It has been notified for cultivation in all plain zones of UP, Tamilnadu, Orissa, Karnataka, Bihar, Delhi and Punjab. It resembles RBL- 1, and takes 106-122 days from seed to seed. The plants are annual, spreading and inter vining, height 62–115 cm, light green foliage colour, lanceolate leaf shape, leaflet shape usually 3 lobed, fine delaxed hair. It is resistant to yellow mosaic virus and green fodder yield is 15–20 t/ha. (CVRC- Notification no. 92(E) 2nd February 2001).

Bidhan Rice Bean 2 (KRB 4): The variety was developed by local landrace selection by BCKV, Kalyani. The variety has been notified by CVRC for cultivation as pulse and fodder in West Bengal, Orissa, Assam, Manipur and Nagaland in 2004. It is resistant to yellow mosaic virus and most of the other foliar diseases of mung bean and urd bean under field conditions. It flowers in 110–120 days and matures in 160–180 days. The plant height is 130–140 cm. The plant growth habit is erect in early stage and later on viny with profuse branching. Green fodder yield is 35–40 t/ha and seed yield 20 q/ha. (CVRC-Notification no. 122(E) dated 2nd February 2005).

7. STYLOSANTHES

Botanical Name : ***Stylosanthes* sp.**
Family : **Fabaceae (alt. Leguminosae)**
Subfamily : **Faboideae**
Tribe : **Aeschynomeneae**

Introduction

Stylosanthes is a genus of summer growing perennial pasture fodder legumes. Most of its species are native of south and central America and the Caribbean islands. This is a fodder cum leguminous cover crop, which is suited for cultivation as sole or as intercrop. The genus *Stylosanthes* consists entirely of herbs and small shrubs. The crop is suitable for grazing as they usually have a crown of growing points near the soil surface so can tolerate excessive grazing by animals. The crop is suited for growing in warm, humid tropical climate. It is fairly drought and shade tolerant. It can be cultivated in areas receiving less than 1000 mm of rainfall and in less fertile soil, acid soils, gravelly sandy soils and also in ill-drained soils.

Botanical Description

The different types of stylosanthes, ideally suited for Indian conditions are:

Brazilian lucerne (*Stylosanthes guianensis*): This is used as a pasture legume. The plants are erect to semi-erect and are not profusely branched at the base and can attain a height up to 1.5 m. The stem is coarse and hairy. The trifoliate leaves are long, narrow and pointed which can be sticky also. Flowers are small, terminal and yellow, borne in cluster on capitate spike. Pods are flattened, single seeded with small and coiled peak. Seeds are kidney shaped, yellowish brown and 1.7 mm long. It does not tolerate shade and can grow very well in areas receiving 900 to 4000 mm of rainfall.

Townsville stylo (*S. humilis*): This is an annual type and attains an average height of 0.7 m. The stem is much branched and fibrous with short white hairs along one side of the stem. Leaves are trifoliate. The leaflets are narrow, pointed, lanceolate and without hairs. These are 15 mm long and 3.5 mm wide. The flowers are small and yellow borne in cluster of 5–15. Pod is hairy. Seed is small, yellowish to brown.

Caribbean stylo (*S. hamata* cv. Verano): This is a short-lived perennial legume similar to Townsville stylo. It is slow growing and develops a flat crown under grazing. Erect stem may grow up to 80 cm. The stems are smooth with a line of very fine, short white hairs on one side only.

Shrubby stylo (*S. scabra*): This is an erect and woody perennial. It is dark green in colour and slightly sticky. It attains a height of 1.0–1.5 m. Stems are hairy and rough. Leaves are trifoliate and leaflets are small and broad. It flowers late and flowers are small and yellow. The pod is 4.4 cm long and one seeded.

Caatinga stylo (*S. seabrana*): It is an erect perennial of 0.9-1.0 m height, with triplicate leaves varying in shape. Presence of rudimentary axis at the nose of the pod is the identifying character.

Cultivation Practices

The field should be prepared thoroughly by discing and ploughing the field 2–3 times. The seeds are sown in line or broadcasted @ 5–6 kg/ha for pure pasture or 3–4 kg/ha in mixed or natural grasslands. In pure pasture, one weeding is required. The crop is highly responsive to application of super phosphate and extract phosphorous and calcium from soil. A heavy dose 120 kg P_2O_5/ha should be added in the establishment year and in later years 40 kg/ha of N should be applied every year.

VARIETIES

Stylosanthes scabra: This is an introduction from Australia by MPKV, Rahuri. It is a perennial herb providing 45 t/ha green fodder. It was released in 1991 for cultivation in Maharashtra.

Stylosanthes Phule Kranti (RSS-2000-95): The variety was developed by MPKV, Rahuri and released in 2007. It is a selection from germplasm of *Stylosanthes seabrana* and is suitable for cultivation in western Maharashtra as a perennial crop. It is ready for green forage harvest in 65–70 days and 90–100 days for seed. It provides 25–30 t/ha green forage, 10–12 t/ha dry fodder and 4–5 q/ha seed. (CVRC- Notification no. 122 (E) dated 6th February 2007).

8. HEDGE LUCERNE

Botanical Name : ***Desmanthes virgatus* (L.) Willd.**
Family : **Fabaceae (alt. Leguminosae)**
Subfamily : **Mimosoideae**
Tribe : **Mimoseae**

Introduction

Hedge Lucerne is a native of tropics and subtropics of the new world. It is found throughout the country. It has 22% protein in leaves and 10–15% in stems. It is highly productive, yielding about 40–70 t/ha of green fodder per year. No poisonous principal is observed in the foliage. Because of its pithy stem, the harvesting is easier. It is an ideal plant for wasteland development.

Botanical Description

It is a small shrub, 2–3 m tall, erect, herbaceous, perennial, glabrous with virgate branches. Leaves are bipinnate, 2.4–8 cm long with 6-8 pinnae 2–9 mm long persistent stipules. Flowers are white, solitary, globose, peduncled. Pods reddish to golden brown containing 20–30 seeds and 5–8 cm long.

Cultivation Practices

The field should be prepared with 1–2 ploughings at the onset of monsoon. In a well-prepared field the seeds are sown @ 2–3 kg/ha at a depth of 1–2 cm. The sowing is done preferably in lines 30–50 cm apart. At the time of sowing ten cartloads of FYM along with 15 kg N, 50 kg P_2O_5 and 20 kg K_2O/ha are mixed with soil.

VARIETY

Desmenthus virgatus

Introduction from Thailand by TNAU, Coimbatore in 1983. It is perennial, drought tolerant with high yield giving 35 t/ha green fodder.

9. SHAFTAL (PERSIAN CLOVER)

Botanical Name : ***Trifolium resupinatum* L.**
Family : **Fabaceae (Leguminosae)**
Subfamily : **Faboideae**
Tribe : **Trifolieae**

Introduction

It is native to central and southern Europe, all the Mediterranean countries and south west Asia. It has three sub-species. *T. resupinatum* L. var. *majus* Boss (syn. *T. suaveolens* willd.) is traditionally cultivated in Iran, Afghanistan and northern Pakistan; the other *T. resupinatum* L. var. *resupinatum* Gib & Belli and *T. resupinatum* L. var. *microcephalum* Zoh are smaller types but locally important in natural grazing. It thrives on wet; heavy soils in low areas and can be found on roadsides, in fields, waste places, humid grassy plains and lower mountains at elevations up to 1500 m. It is a very important hay crop in Iran, Afghanistan and similar Asian areas of cold winters. Formerly it was common in Punjab as a winter fodder, but has been replaced by Egyptian clover (*T. alexandrinum*) in frost –free areas. It is grown as a fodder often under irrigation, for hay in its traditional areas. It is very important in areas with cold winters, and on saline or waterlogged soil. It withstands hard frost but generally is very slow growing at low temperatures. In the higher parts of the western Himalaya and in Afghanistan, however, it is grown both as an overwintering annual and as a summer catch-crop. The young shoots are used as spinach in Pakistan and Afghanistan. It is usually cultivated as a winter annual, sown in autumn but produces little before spring; it can be grown as a summer forage. The nutritive value of fresh aerial part as percentage of dry matter is crude protein-21.5, crude fibre-16.9, ash-17.7, ether extract-1.9, NFE-42, calcium-1.99, phosphorus-0.23%.

Botanical Description

Shaftal or Persian clover is an erect decumbent or prostrate, coarse, herbaceous legume branching from the base and reaching up to 15–30 cm in height, with prostrate stems attaining a length of 50–100 cm. It has pink mauve, sweet-smelling flowers, ovoid pods and pale brown seeds.

VARIETIES

SH-48: This variety was developed by PAU, Ludhiana, released in 1987 for cultivation in Himachal Pradesh.

Shaftal-48: This variety was developed from selection in local material collected from north India by CSK HPKV, Palampur. It is recommended for cultivation in cool temperate

climate of Kullu, Mandi, Shimla, Lahul & Spiti areas of Himachal Pradesh state. It possesses hollow stem and broad dark green trifoliate leaves. The green fodder yield is 55 t/ha.

SH-69: This variety was developed by PAU, Ludhiana, and released in 1995. The variety has been developed from irradiation of local shaftal material. The variety is recommended for cultivation in the irrigated areas of Punjab. Its plants are leafy having long stalk. Leaves are roundish in shape and flowers are light pinkish in colour. The variety is highly resistant to stem rot disease. The green forage yield is 105 t/ha and seed yield of 5.5 q/ha. (CVRC-Notification no. 1(E) dated 1st January 1996).

10. RED CLOVER

Botanical Name : ***Trifolium pratense* L.**
Family : **Fabaceae (alt. *Leguminosae*)**
Subfamily : ***Faboideae***
Tribe : ***Trifolieae***

Red clover is a fast starting, highly productive, but short lived perennial clover. It is widely adapted throughout the humid, temperate regions of the world. Flowers are rose, purple, or magenta in colour. The basal buds produce upright, pubescent, hollow stems, 60–80 cm in length, oblong to wedge-shaped leaflets (palmately trifoliate) typically variegated with a white "water mark". It requires well drained soil and performs best under irrigation. Most useful in short term pastures (1 to 4 years) or for increased legume production in permanent pastures that use a slower starting clover, such as white clover. The upright growth habit restricts its use to cutting and/or rotational grazing.

VARIETY

PRC-3: It was developed by CSK HPKV Palampur and recommeneded for cultivation in hill zone of the country in 2003. It provides 40–60 t/ha green fodder.

11. WHITE CLOVER

Botanical Name : ***Trifolium repens* L.**
Family : **Fabaceae (alt. Leguminosae)**
Subfamily : **Faboideae**
Tribe : **Trifolieae**

Introduction

White clover is one of the most nutritious and palatable legume. It grows best in humid areas of the temperate zone during cool, moist seasons. It is not tolerant to drought or extremes in soil pH. White clover plays an important role in soil conservation, soil improvement and crop rotations. It is most often grown in association with cool-season grasses (orchard grass, Kentucky bluegrass, perennial ryegrass, tall fescue, broom grass) and also to a small extent with perennial warm season grasses. The crop is best suited for grazing, it can be used for haylage, hay, soil improvement and land reclamation. However, the green forage yield is less as compared to red clover and Lucerne. It is a common component in cool season perennial grass pastures in HP and J&K.

Botanical Description

The white clover plant is a slow growing short lived perennial, which can live for 3 to 5 years. It is a leafy plant that often grows 20–30 cm tall and spreads by stolons (above-ground runners) and forms shallow roots at nodes. Leaves are non-hairy and usually marked with a white "V". The flowers are white coloured, clustered into heads. Seeds are extremely small.

VARIETY

Palampur Composite 1

This variety has been developed by CSKHPKV, Palampur by compositing S-100, Lodigimo, Merit, Oregon and local material and released in 1986. It is recommended for cultivation in sub-temperate and temperate rangelands of Himachal Pradesh. It has broad leaves, long petioles, vigorous growth habit, good regeneration capacity and high protein content (about 23% CP). It gives 3–4 cuttings in a year, if harvested for green fodder or hay. But generally, it is used for grazing purpose. It has very high nitrogen fixing capacity as well (200–400 kg/ha). It gives yield of 47 q/ha of green fodder. (CVRC-Notification no. 165(E) dated 6th March 1987).

12. SENJI (INDIAN CLOVER)

Botanical Name	:	***Melilotus alba* Desrousseaux** ***Melilotus officinalis* L. Lamarck**
Family	:	**Fabaceae (alt. Leguminosae)**
Subfamily	:	**Faboideae**
Tribe	:	**Trifolieae**

Introduction

White sweet clover is native to Europe and western and central Asia, south to India and has been assigned to the Eurosiberian and Mediterranean centers of diversity and is native to the Boreal moist to west through subtropical dry to moist forest life zones, and persists up to an altitude of 2,000 m.

Botanical Description

Melilotus spp. is not true clovers. Two common species are *Melilotus alba* (white sweet clover) and *Melilotus officinalis* (L.) Pall., (yellow sweet clover). Pods of yellow sweet clover are one or two seeded and seeds are smooth, ovoid-elliptical, 1.5-3 mm long, and 1.5 mm broad, yellow or greenish yellow, sometimes with purple spots. For yellow sweet clover, the seed cotyledons are very small, twice as long as broad, and pale green. At seedling stage, the first true leaf is heart shaped or roundish, and wavy around the edges. The second and subsequent leaves are trifoliate. The plant is an annual or biennial, erect or decumbent herb, stem 1 m or more tall, stipules entire; leaves trifoliate, leaflets lanceolate to narrowly oblong, rarely ovate, 1-2.5 cm long; rachis of larger leaves, excluding terminal petiolule, often prolonged more than 4 mm beyond lateral leaflets; racemes numerous, 5-20 cm long, on peduncles up to 4 cm long; pedicels 1–2 mm long; calyx about 2 mm long; corolla white, 4-6 mm long; style 1.7-2.3 mm long; pod with weak irregular network of veins.

VARIETIES

FOS-1: CCS HAU, Hisar developed the variety through selection from local material. (CVRC-Notification no. 786 dated 2nd February 2005).

Senji Safed-76: The variety was developed through hybridization between strain no. 341 × strain no. 174 by PAU, Ludhiana. (CVRC-Notification no. 13 dated 19th December 1978).

YSL-106: The variety is a derivative of FOS-1 × strain no. 8-7 by PAU, Ludhiana. The variety has been recommended for cultivation under irrigated timely sown conditions of *rabi* season in Punjab. (CVRC-Notification no. 832(E) dated 18th November 1985).

PC-5: The variety has been developed through hybridization between S 67 × Karak by PAU, Ludhiana. The variety has been recommended under irrigated timely sown condition of *rabi* in Punjab. The variety is of long duration and matures in 172 days. It provides green fodder yield of 23 t/ha. (CVRC-Notification no. 1(E) dated 1st January 1985).

HFWS-55: This variety is developed through selection from local material by CCSHAU, Hisar. The variety is released for all Senji growing areas of Haryana. It is medium to late in maturity, leafy, palatable and white flowered. It provides 45-50 t/ha green fodder and 8-10 dry fodder and seed yield is 12.0-15.0 q/ha.

13. METHA (FENUGREEK)

Botanical Name : ***Trigonella foenum-graecum* L.**
Family : **Fabaceae (alt. Leguminosae)**
Subfamily : **Faboideae**
Tribe : **Trifolieae**

Fenugreek is a fodder of very ancient cultivation in Mediterranean countries. Turkey is considered to be the primary center of origin. It is cultivated both under irrigation and as a rainfed crop and grows on a wide range of well-drained soils. Fenugreek is grown as a cool season crop in India and the Mediterranean region both irrigated and as a rainfed crop; it will grow on a wide range of well-drained soils. In cooler areas it may be grown in summer. The seed crop requires warm dry weather for ripening and harvest. It has long been used as hay or green feed and is reputed to be highly nutritious. It is not suited to grazing. As hay crop it is best mixed with a white straw cereal. Fenugreek is highly palatable to livestock. A highly aromatic plant which is used as a pot-herb, spice and fodder. It is widely grown in India and neighbouring countries as a flavouring and fodder, and in north Africa and western Asia as a fodder and spice. It is indigenous to southern Europe and western Asia. An erect, smooth, herbaceous plant growing up to 40–80 cm tall. The plant and seeds have a characteristic strong odour. The plant has compound leaves, 7–12 cm long. The flowers are white or purplish blue. The fruits occur as pods of 2–10 cm, long, thin and pointed and contain 10–20 seeds. In India, plants are grown for forage. It is an annual and ripens 90–150 days after planting. In India, where grown for forage, October plantings are harvested in February –March, while January plantings are harvested in April. Green forage yield is about 9-10 t/ha and seed yield is 0.5–3.8 t/ha.

VARIETIES

T-8: This variety was developed by AAU, Anand in 1989 and is recommended for cultivation in Gujarat.

ML-150: This variety has been developed by PAU, Ludhiana through intervarietal hybridization of Type 8 × Type 36. it is a medium to late variety with red leaf margins and yellow seeds.

14. SUBABUL

Botanical Name : ***Leucaena leucocephala* (Lam.) De Wit**
Family : **Fabaceae (alt. Leguminosae)**
Subfamily : **Mimosoideae**
Tribe : **Mimoseae**

Introduction

Subabul is widely distributed throughout the tropics and has been introduced into the Philippines in the 16th century as a feed for ruminant livestock; subsequently it spread throughout Asia-Pacific region. The plant is highly valued as ruminant forage and as a fuel wood by subsistence and semi-commercial farmers throughout south-east Asia and parts of central Asia and Africa. It is planted in hedgerow systems with grass for cattle production in northern Australia, and as a hedgerow species in parts of south-east Asia and Africa. It requires well-drained soils with pH above 5.0. It prefers sub-humid and humid climates of 650–1,500 mm and up to 3,000 mm annual rainfall and tolerates up to 7 months of dry season.

The tree is extremely tolerant to cutting or grazing once and its foliage have high nutritive value for ruminant production. The nutritional parameters for the edible fraction are 55–70% digestibility, 3–4.5% N, 6% ether extract, 6-10% ash, 30–50% N-free extract, 0.8-1.9% Ca and 0.23–0.27% P. The foliage is highly palatable to most grazing animals, especially compared to other forage tree. It contains mimosine, a non-protein amino acid that has antimitotic and depilatory effects on animals. Concentrations in young leaf can be as high as 12% and the edible fraction commonly contains 4–6% mimosine.

L. leucocephala is a highly self-compatible tetraploid (2n=4x=104) and has a relatively narrow genetic base. It is thought to have evolved as an amphidiploid between *L. pulverulenta* and *L. lanceolata. L. leucocephala* hybridizes readily with the other tetraploid species *L. pallida, L. diversifolia* and *L. confertilflora* and with the diploid species *L. esculenta, L. retusa, L. salvadorensis* and *L. shannonii.* Hybridisation with other diploid species of *Leucaena* is more difficult to achieve.

There are four types of subabul

Hawaiian type: The plants are short bushy and remarkably drought tolerant. It is suited to hilly terrains in drought prone areas. It is a prolific seed producer and is good for fodder purpose. K-341 is a Hawaiian variety.

Salvador type: Tall, tree like and fast growing having maximum annual biomass production. Possesses large leaves, pods and seeds than Hawaiian types. Responds to high fertilization. Variety K-8 is useful for fodder.

which have variable length up to 35 cm, with a large gland (up to 5 mm) at the base of the petiole. The tree bears numerous flowers in globose heads. The pods are 14–26 cm × 1.5–2 cm and brown at maturity. Each pod bears 18-22 seeds.

VARIETY

Subabul CO-1 (P): This is a selection of variety Giant lpil K-28 of Subabul (*Leucaena leucocephala*) by TNAU, Coimbatore and released in 1984 for Tamil Nadu state. The selection is high yielding (green leaf fodder 85 t/ha) with high protein and drought tolerance.

FD 1423: This is an introduction of Subabul (*Leucaena diversifolia*) by TNAU, Coimbatore and released for the state of Tamil Nadu in 1999. The introduction is highly psyllid tolerant and is suitable for rainfed conditions. The green leaf yield is 55 t/ha.

Acronyms

AAU	Anand Agricultural University
ANGRAU	Acharya NG Ranga Agricultural University
ARS	Agricultural Research Station
BCKV	Bidhan Chandra Krishi Viswa Vidyalaya
CAZRI	Central Arid Zone Research Institute
CCS HAU	Chaudhary Charan Singh Haryana Agricultural University
CSK HPKV	Chaudhary Shravan Kumar Himachal Pradesh Krishi Viswavidayalaya
GAU	Gujrat Agricultural University
GBPUA&T	Govind Ballabh Pant University of Agriculture and Technology
IARI	Indian Agricultural Research Institute
IGFRI	Indian Grassland and Fodder Research Institute
JNKVV	Jawahar Lal Nehru Krishi Viswa Vidyalaya
KAU	Kerala Agricultural University
KKV	Konkan Krishi Viswa Vidyalaya
MPKV	Mahatama Phule Krishi Viswa Vidyalaya
MPUAT	Maharana Pratap University of Agriculture and Technology
NBPGR	National Bureau of Plant Genetic Resources
NDUA&T	Narendra Deo University of Agriculture and Technology
NRC	National Research Centre
PAU	Punjab Agricultural University
PDKV	Panjabrao Deshmukh Krishi Vidyapeeth
RAU	Rajasthan Agricultural University
RRS	Regional Research Station
SKUA&T	Sher-e-Kashmir University of Agriculture and Technology
TNAU	Tamil Nadu Agricultural University