

Ricebean:

High valued fodder crop

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*Ricebean (*Vigna umbellata*) is an underutilized, neglected legume considered as a minor food and fodder crop of northern and north-east India, grown in a range of cropping systems mainly with maize during summer or alone in uplands, terraces, rice bunds, jhum field, backyard of home and in small patches. It is mainly grown for human consumption, and also used for fodder and green manure. Ricebean foliage and dry straw are nutritious livestock feed and provide higher productivity and quality fodder if sown with cereal likes maize and sorghum. Hence there is need to focus about ricebean crop to utilize as a high nutritious fodder crop inspite of used as green manure or other purpose. More emphasis has been given for popularizing a high nutritious fodder crop as a potential legume crop among the farmers.*

Keywords: Crop management, Fodder nutritive value, Intercropping, Ricebean

RICEBEAN [*Vigna umbellata* (Thunb.)] is a native of South and South East Asia. As a cultigens, ricebean occur in India, Myanmar, Malayasia, China, Korea, Indonesia and Phillipines. It is also cultivated in West Indies, USA, Australia, East Africa, Java, Fiji, Bangladesh, Srilanka and Nepal. Ricebean is believed to be of hindustan origin. It is presumed that the centre of domestication of ricebean is Indo-China. In India, it is cultivated in 20,000 ha with average green fodder productivity of 15-30 t/ha. It's distribution pattern indicates its adaptive polymorphism for diverse distribution range with climate variation ranging from humid sub-tropical to warm and cool temperate climate and it can grows up to an elevation of 1,500 m from mean sea level. The best performance is obtained with 24–28°C and 1,500-2,000 mm

annual rainfall and it can grow well on wide range of soils. It established rapidly and has the potential to produce large amount of nutritious animal fodder and high quality grain. It is mainly grown for human consumption, though it is also used for fodder and green manure. Ricebean foliage and dry straw are

valuable livestock feed and used as green manure which improve soil fertility. Thus ricebean is a vibrant potential fodder legume crop to provide balance diet to the livestock and to sustain under wide range of climatic condition.

Plant morphology

Ricebean is a short lived perennial legume usually grown as an annual self pollinated having erect, semi-erect or twining growth habit. It is usually 30-100 cm in height and as a potential to grow up to 200 cm. Ricebean is fast summer growing legume found from sea level up to attitude of 1,500 m in Assam and 2,000 m in the hills of the Himalayas. Ricebean requires short day to produce seeds. It is grown on wide range of soil including shallow, infertile or degraded soil. High soil fertility may hinder pod formation by



Ricebean (sole crop)



Maize + Ricebean (1:1) + 100% RDF + PGPR

promoting more vegetative growth which result in poor seed yield. Ricebean is photosensitive plant, it does better in area where temperature range from 18-30°C average, tolerate 10-40°C but does not withstand frost. It prefers full light and growth can be hampered if it is intercropped with tall growing crops such as maize.

Origin and distribution

Ricebean is a neglected crop, cultivated on small areas by some hill farmers in NE India. In India, its distribution is mainly confined to the tribal region of north eastern hills and hilly tracts of Western and Eastern Ghats. In the North Eastern Region of India (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura), ricebean is grown predominantly under rainfed conditions in mixed farming system, under shifting cultivation, terraces, kitchen garden and backyards.

Uses

Ricebean is a promising multipurpose crop with a good potential to be used as food, fodder, green manure and cover crop, the dried seeds are usually eaten boiled or as pulses. Young immature pods are used as vegetables. Immature pods and beans sprouts are highly recommended in the nutritional diet of the Philippines. Whole plant is used as forage for livestock. The foliage, green pods, immature seeds and flowers are readily eaten by

animals. Ricebean seeds are also good for boiler ratio.

Push Back of crop due to following features:

- Low seed yield
- Photoperiod sensitivity
- Indeterminate growth
- Sporadic and asynchronous flowering
- Dehiscent pods and small, hard seeds
- Susceptibility to pest and disease
- Shatter susceptibility.

Inclusion of fodder legume

- As fodder, legumes play an important role in inclusion with cereal fodder to enrich the soil fertility through atmospheric nitrogen fixation and biomass addition into soil.
- Provide residual nitrogen and reduce the needs for mineral nitrogen fertilizers by non legumes.
- Legume crops produces highly digestible and protein rich fodder. Legume are palatable and protein rich fodder which have important role in animal productivity and cheapest source of feed for livestock.
- Forage legume plays an important role in dairy and meat production due to rich source of protein, fibre and energy.

Ricebean as a fodder crop

- Ricebean is a multipurpose underutilized legume. The green forage can be fed fresh or processed into hay and seeds are used as

concentrate feed. Ricebean straw after seed harvested, including the stems, leafy portions, empty pods and seeds can be used as fodder.

- It can be grown on terraces, sloping hillsides and on rice bunds and in jhum fields. Ricebean can be grown for green manure, cover crop and live fences as vegetative barriers.
- Ricebean as fodder crop at vegetative phase contains high amount of protein (14-24%) which are similar with cowpea and blackgram. However, seeds contain high mineral content, vitamins including thiamine, riboflavin, niacin and ascorbic acid and also rich in Ca, P and Fe.
- Ricebean is an ideal crop for catch cropping, intercropping and multiple cropping system and also serves as a excellent cover crop and green manure crop.
- It can tolerate drought condition up to remarkable extent.
- It is having good scope to grow during lean periods and provides the good tonnage of fodder.
- Having the capacity to establish rapidly and has the potential to accumulate large amount of nutritious animal fodder and high quality grains.
- Ricebean is an N-fixing legume that improves the N status of the soil, thus providing nitrogen to the succeeding crop.

Anti-nutrient contents

Ricebean contains phytic acid, polyphenol, tannins, trypsin inhibitors other anti-nutrients and

flatus producing oligosaccharides (2.25%). However the content of all those is lower than in many comparable pulses. The effect are strongly reduced through common cooking such soaking, germination, dry roasting and cooking very low polyphenols and ranged from 0.08-0.16%. If consumed without processing, the mineral nutrients are less available. Some of such toxic elements are destroyed during cooking through different kind of heat treatment such as roasting, toasting and frying increase the availability of the nutrient.

Nutritive values

Ricebean has a comparatively higher content of proteins than other cereal crops. It contains 20% protein. Its favourable protein content ensures high digestibility and therefore makes it as fit food for little children, women and older people with weak digestion. Ricebean retains high nutritional value. It is richer than cowpea and black gram in protein, calcium and phosphorus. Dried seeds of ricebean contain 16-17% protein, 3-4% fat, 5-7% crude fibre, 3-4% ash and 61-65% carbohydrates, 11-12% aspartic acid and 17-18% glutamic acids. Along with sulphur containing amino acids, ricebean is a good source of various nutrients given in Table 1, 2 and 3.

The data recorded on quality parameters of fodder ricebean (Table 4) from the experiment conducted in Randomized Block Design (RBD) during *kharif* season in 2019 at research field of Agronomy Section, ICAR-National Dairy Research Institute, Karnal. From perusal of data green fodder yield, dry matter yield, crude protein (CP) content, ether extract (EE), ash content and acid detergent lignin (ADL) differed significantly with all treatments of

Table 1. Biochemical constituents of ricebean

Constituent	(%) Per cent
Carbohydrate	58.20 – 72.00
Crude protein	18.30 – 32.20
Ash	3.50 – 4.90
Soluble ether extract	0.10 – 0.50
Crude fibre	3.60 – 5.50

Source: Buergelt (2009).

Table 2. Comparative biochemical constituents of ricebean (seed) and other pulses

Crop	Crude protein (%)	Ash (%)	Fibre (%)	Fat (%)	CHO (%)	Soluble E E (%)	Ca (mg/ 100 g)	Fe (mg/ 100 g)	P (mg/ 100 g)
Ricebean	25.0	4.3	4.8	0.6	-	1.6	450	6.0	393
Mungbean	23.6	4.0	3.3	1.2	58.2	3	199	7.5	313
Urdbean	23.4	4.8	3.8	1.0	57.3	-	-	-	-
Frenchbean	22.1	3.6	4.0	1.6	57.8	2.1	175	6.9	328
Broadbean	23.4	3.2	7.1	1.5	48.5	-	-	-	-
Chickpea	20.1	2.7	3.9	5.3	61.2	5.3	283	10.3	43
Cowpea	23.4	3.6	3.9	1.3	56.8	2.1	243	6.9	459
Lentil	24.2	3.3	3.7	1.0	55.8	3.1	140	7.3	263
Pea	22.5	3.0	4.4	1.0	58.5	3.2	259	5.2	286
Pigeon pea	20.9	3.8	3.1	1.5	57.3	3.8	296	6.7	366

Source: Singh *et al.* 1920; FAO 1970.

nutrient management. Highest green fodder and dry matter yield was produced by Maize + Ricebean (1:1) + 100% RDF + PGPR followed by Maize + Ricebean (1:1) + 75% RDF + PGPR and Maize + Ricebean (1:1) + 75% RDF. Sole crop of ricebean with recommended dose of nutrients gave maximum protein content followed by treatment Maize + Ricebean (2:1) + 100% RDF + PGPR and at par with Maize + Ricebean + 100% ROF + PGPR. Maximum ether extract was recorded by sole maize + RDF. NDF and ADF had no effect of nutrient management. Lower the value of NDF and ADF is higher the quality of fodder. Higher value of NDF and ADF shows poor quality fodder as NDF contains hemicellulose + cellulose + lignin and ADF contains cellulose + lignin. Ricebean sole crop contains less NDF so it is better in quality fodder. While maize alone with RDF, lowest in ADF content

showed better quality. The sole maize contain lowest lignin contain and ADL was significantly influenced by nutrient treatment with maximum by Maize + Ricebean (1:1) + 50% RDF.

Nutrient management had significant influence on minerals *viz.* Zn, Mn and Cu and no significant difference was found in N, P, K and Fe content in ricebean plants on dry weight basis. N, P, and K content was estimated highest in ricebean monoculture. However K content was higher in sole ricebean and at pat. Highest Zn content was recorded in Maize + Ricebean (1:1) + RDF. Iron (Fe) was not significantly affected in ricebean by nutrient management. Minerals like Mn and Cu content was influenced by nutrient management. However Mn and Cu content was obtained highest in sole crop of ricebean.

Cultivation practices and management

Forage ricebean gives best performance when sown in mid June to mid July. The sowing should be done at optimum moisture in well pulverized soil and has sufficient organic matter planting should be done at a distance of 30 cm apart in rows. The spreading types that very viney and twine or throw long whips can be grown at 60-90 cm row spacing, the plant-to-plant distance should be kept between 15-20 cm. To sow one hectare area of land, the seed requires 25-30 kg. The germination of ricebean is epigeal in some cultivars and some are hypogeal and generally excellent germination occurs under field conditions. Thinning and spacing should be done within the

Table 3. Biochemical constituents and amino acid composition of dried seeds of ricebean (per 100 g)

Constituent	(Per 100 g)	Amino acid composition	(mg/g N)
Protein	20.9 g	Arginine	462
Fat	0.9 g	Histidine	380
Total carbohydrate	60.7 g	Leucine	606
Crude fibre	4.8 g	Isoleucine	387
Ash	4.2 g	Lysine	769
Calcium	200 mg	Methionine	769
Phosphorus	390 mg	Cystine	44
Iron	10.9 mg	Phenylalanine	325
Thiamine	0.49 mg	Tyrosine	262
Riboflavin	0.21 mg	Threonine	294
Niacin	2.4 mg	Valine	394

Source: Duke 1981.

Table 4. Effect of Nutrient Management practices on quality of fodder of ricebean and maize intercropping system under irrigated condition

Treatment	Ricebean							
	GFY (t/ha)	DMY (t/ha)	CP(%)	EE(%)	Ash(%)	NDF(%)	ADF(%)	ADL(%)
T ₁ : Maize + RDF	34.17	9.64	10.24	2.51	8.41	57.27	32.97	4.67
T ₂ : Ricebean + RDF	15.17	3.71	21.17	1.80	14.42	50.46	35.9	7.20
T ₃ : Maize + Ricebean (1:1) + RDF	11.52	2.82	17.83	1.60	14.12	52.72	38.0	7.73
T ₄ : Maize + Ricebean (1:1) + 50% RDF	8.60	2.01	15.88	1.36	13.02	56.60	39.9	8.75
T ₅ : Maize + Ricebean (1:1) + 50% RDF + PGPR*	8.55	2.03	16.58	1.42	13.15	55.23	39.5	8.70
T ₆ : Maize + Ricebean (1:1) + 75% RDF	10.50	2.52	16.76	1.45	13.21	53.43	38.7	8.47
T ₇ : Maize + Ricebean (1:1) + 75% RDF + PGPR	10.83	2.66	17.48	1.49	13.76	53.20	38.2	8.37
T ₈ : Maize + Ricebean (1:1) + 100% RDF + PGPR	11.75	2.93	18.64	1.61	13.84	52.27	37.9	7.41
T ₉ : Maize + Ricebean (2:1) + RDF	6.75	1.83	19.50	1.61	12.29	51.49	37.8	7.63
T ₁₀ : Maize + Ricebean (2:1) + 50% RDF	5.83	1.52	16.64	1.43	11.69	55.15	39.3	8.67
T ₁₁ : Maize + Ricebean (2:1) + 50% RDF + PGPR	5.67	1.49	16.70	1.44	12.29	54.69	38.8	8.62
T ₁₂ : Maize + Ricebean (2:1) + 75% RDF	6.02	1.61	17.67	1.56	12.23	52.98	38.0	8.01
T ₁₃ : Maize + Ricebean (2:1) + 75% RDF + PGPR	5.97	1.61	17.83	1.57	11.82	52.83	38.0	7.87
T ₁₄ : Maize + Ricebean (2:1) + 100% RDF + PGPR	7.08	1.99	19.69	1.73	12.75	51.24	36.9	7.33
SEm±	0.62	0.17	0.75	0.04	0.52	1.46	1.18	0.30
CD (P=0.05)	1.83	0.49	2.18	0.11	1.52	NS	NS	0.87

Source: Rundun & Singh (2019). *PGPR – Plant growth promoting *Rhizobacteria*.

first fortnight to allow the remaining plant population to establish firmly. Care is normally needed in the initial stage of growth to keep the field clean from weeds and to allow the crop to come up well. Irrigation is needed in rainless period and when it is in peak growth of biomass accumulation. Being a leguminous crop it has high microbial nodulation. The existing *Rhizobium* available in the soil is fairly effective and enrich the soil fertility by

nitrogen fixation from atmosphere. However, fertilizer dose of N&P (20:40) appear to be suitable for good yield. Ricebean posses good synchrony in pod maturity in its cultivars, almost all pods borne on a plant mature simultaneously and the whole crop can be effectively and economically harvested at one time. Maize + ricebean intercropping in the ratio of 1:1 or 1:2 in the Haryana (Karnal) is reported to be quite

promising with significant effect on yield. Maize plants are used as supporting plant to help in climbing of ricebean.

Forage varieties

Some of ricebean varieties identified for higher green fodder yield or high biomass yield and RB 11-14, RB 13-9, RB 19-1, RB 31-3, RB12-6, RB 09-4 and RB 17-9. Some important ricebean variety

Table 5. Effect of nutrient management practices on nutrient content of ricebean forage in maize + ricebean intercropping system under irrigated condition

Treatment	Ricebean						
	N(%)	P(%)	K(%)	Zn (ppm)	Fe (ppm)	Mn (ppm)	Cu (ppm)
T ₁ : Maize + RDF	1.88	0.30	0.90	41.7	429	47.8	18.7
T ₂ : Ricebean + RDF	3.11	0.48	1.65	56.3	471	85.8	27.7
T ₃ : Maize + Ricebean (1:1) + RDF	2.82	0.41	1.53	60.3	450	80.3	22.3
T ₄ : Maize + Ricebean (1:1) + 50% RDF	2.59	0.38	1.34	50.7	396	70.5	14.2
T ₅ : Maize + Ricebean (1:1) + 50% RDF + PGPR*	2.67	0.38	1.41	49.7	430	73.3	16.7
T ₆ : Maize + Ricebean (1:1) + 75% RDF	2.79	0.39	1.47	53.8	436	78.3	18.2
T ₇ : Maize + Ricebean (1:1) + 75% RDF + PGPR	2.79	0.40	1.48	52.8	435	79.3	17.0
T ₈ : Maize + Ricebean (1:1) + 100% RDF + PGPR	2.88	0.41	1.53	55.3	441	79.5	20.3
T ₉ : Maize + Ricebean (2:1) + RDF	2.93	0.42	1.58	55.7	450	83.2	20.5
T ₁₀ : Maize + Ricebean (2:1) + 50% RDF	2.73	0.39	1.41	52.3	417	63.8	14.4
T ₁₁ : Maize + Ricebean (2:1) + 50% RDF + PGPR	2.77	0.39	1.46	52.5	423	71.7	16.4
T ₁₂ : Maize + Ricebean (2:1) + 75% RDF	2.80	0.40	1.48	53.0	436	78.3	17.3
T ₁₃ : Maize + Ricebean (2:1) + 75% RDF + PGPR	2.80	0.40	1.50	54.4	437	76.3	19.2
T ₁₄ : Maize + Ricebean (2:1) + 100% RDF + PGPR	2.95	0.44	1.65	58.2	484	85.8	23.3
SEm±	0.11	1.18	0.06	1.90	15.78	2.93	0.72
CD (P=0.05)	NS	NS	NS	5.55	NS	8.55	2.10

Source: Rundun and Singh (2019). *PGPR – Plant growth promoting *Rhizobacteria*.

recommended for fodder production are:

RBL 6 (2002): Photosensitive, medium maturing variety having resistance to fungal, bacterial and especially viral diseases. Growth habit is spreading type with many lateral interwinning branches having vigorous growth. Pod formation, development and maturity are synchronous. Seeds are light green and bold. It matures in 125 days under irrigated conditions; its average grain yield is about 6 q/acre. Suitable for cultivation in Northern India.

Bidhan ricebean 1 and 2: This variety has been developed by BCKV, West Bengal. It has semi spreading type, plant are high green foliage with 4-5 branches per plant and flowering occurs in 100-110 days. The protein content is 14-15%. Yield is 225-250 q/ha. Suitable for North-east region.

Bidhan ricebean 3: It is also developed by BCKV, West Bengal. It is a semi spreading type; plants are indeterminate type with green foliage and flowering occurs in 111-120 days. It falls in medium maturity group. It has got average green fodder production of 300 q/ha. Seeds are brown with back spot mosaic. Suitable for North-east region.

JRBJ 05-2 (Jower ricebean): This variety was developed by JNKV, Jabalpur through selection and local material from adjoining area of Dindori. It is semi- erect variety with green fodder production of 300 - 350 q/ha, 57-63 q/ha DMV and 14.8% CP. The seed yield is about 5-6 q/ha. This variety has been notified in 2016 by CVRL. It is a potential crop/ variety for lean period cultivation.

JRBJ 05-4 (Jower ricebean 2): This variety of ricebean was developed by JNKV, Jabalpur from secondary selection of IC 108860. It is an early type semi-erect variety with green fodder of 240-260 q/ha, 44-47 q/ha

DMV and 14.6% crude protein. It is suitable for intercropping with maize and sorghum. It is tolerant to leaf blight, mosaic and flea beetle under field condition. This variety has been notified in 2016 by SVRC.

RBL-1: Developed from PAU, Ludhiana in 1997. This variety is suitable for Punjab, Haryana and Northern region for fodder production.

KRB 4: Developed by BCKV, West Bengal released in 2000. Suitable for North East region.

Insect-pest and disease management

Diseases: The diseases seen in ricebean are discussed below.

1. **Rust (*Uromyces appendiculatus*):** Rust pustules are white, minute and slightly raised on leaves and rarely appears on stem and pods. In later stage, pustules become reddish brown and are seen distinctly under the leaves. Control measures include (i) Follow crop rotation, (ii) Apply Indofil M-45 @ 3 g/lit. of water before or immediately at appearance of rust pustules at periodical intervals.
2. **Rhizoctonia Blight (*Rhizoctonia solani*):** It spreads at high humidity. The spread of disease is very fast and plants develop small, irregular, water soaked, pale greenish spot with damp appearance on the lower leaves and extend towards the apex and cover the leaf blade and stem these are destructive phase of the disease. The leaflet and pods shrivel, turn brown and dry up. Control measures include (i) Collect and burn the infected plants, (ii) Prefer late sowing, (iii) Wider planting, (iv) Crop rotation, (v) Proper drainage, and (vi) Seed treatment with Bavistin @ 1 g/kg seeds.
3. **Bacterial Blight (*Pseudomonas spp.*):** The pathogen is seed borne and main source of primary

inoculum. In the beginning, symptoms shows small, round or irregular, flat water soaked spots surrounded by a greenish yellow zone on leaf. The infection spreads along the veinlets and veins. Control measures include (i) Crop rotation, (ii) Alteration of sowing date, and (iii) Seed treatment with Streptomycin.

Insect-Pest: Following insect pests infest ricebean.

Pod borer: Spray systemic pesticides Dichlorovos (DDVP) or monocrotophos @ 2 lit./ha.

Aphids: Heavily infested plants develop yellow curled foliage, distorted pods, wilt and may be killed. To control this spray Dimethoate @ 0.03% is beneficial.

Harvesting

Harvest the crop for green forage at 50% of flowering. As the plants are intertwined, harvest the crop by rolling the plants in small patches. For seed, harvest the crop when about 80% of the pods turn brown during morning hours to avoid shattering.

Yield

Worldwide the seed yield of ricebean is about 2,250 kg/ha. It is 1,300-2,750 kg/ha in Zambia, Brazil and India. In India, fodder yield were reported to range from 5-7 t DM/ha in May and June and 8-9 t DM/ha in November and December. Ricebean grown with other grasses gives more yield.

SUMMARY

From the above facts, ricebean is a vibrant potential fodder legume crop which has the capacity to enhance the productivity and quality of fodder to the livestock and sustain under wide of range climatic conditions.

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