

Winged bean – A nutritionally rich underutilized vegetable crop

Winged bean [*Psophocarpus tetragonolobus* (L.) DC] is a protein rich, underexploited leguminous vegetable of the tropics. Winged bean grows abundantly in hot and humid equatorial countries. In Asia, the major producing countries are India, Burma, Sri Lanka, Indonesia, Malaysia, Thailand, Philippines, Indo-China, China and is also extending to Papua & New Guinea. It has high nitrogen fixing capacity with multiple nodules present in the root system and the leaves contains superior quality of protein. This underutilized vegetable has an ability to fight malnutrition and provide dietary supplementation. A considerable amount of diversity exists in the germplasm lines of winged bean, thus providing scope for the plant breeders to seek for improvement of the seed, vegetable, tuber yield and quality aspects. This promising vegetable offers resistance towards the adverse impact of abiotic stresses and can withstand marginal upland conditions. It can be introduced in the marginal upland areas as a source of income, especially for resource-poor households in these regions. It has been observed that proteins present in legumes have low nutritive value, which is mainly attributed to low amounts of sulphur-containing amino acids, less digestible proteins and anti-nutritional factors. Thus, winged bean is recommended for commercial cultivation to enhance diversity in field conditions and improve soil health. When it reaches the plate of hungry people, it leads to improvement in human health and consequently helps in solving the malnutrition problems.

THE winged bean is popularly known as ‘One Species Supermarket’ because of its high nutritionally rich green pods, tuberous roots, leaves, immature and mature seeds. Leaves are eaten like spinach, flowers as salad, tubers as raw or processed food and seeds are used in different forms of processed food. Owing to its vining nature and nitrogen fixation ability, it used as a cover crop and also incorporated into rotation or intercropping systems. As such, winged bean could be a good candidate for diversifying diets to improve nutritional security, based on complex and more sustainable agricultural systems. Besides nutritional qualities, winged bean is a potential climatic resilient crop for adaptation in suboptimal weather conditions, like drought, flood, heat and biotic stresses as compared to other major staple crops.

Increasing awareness about the role of agro-

biodiversity in sustainability, socio-economic resilience and human health has resulted in re-diversifying agro-biodiversity through utilization of neglected and underutilised crop species. Realizing the importance of such crops, the US National Academy of Sciences (NAS) constituted a committee in 1974 to carry out ‘an extensive survey of underexploited tropical plants’ as possible crops for the future and winged bean was identified for promotion among agricultural research communities

with exceptional merits. Despite the good qualities and international attention, winged bean cultivation could not be extended to the non-traditional areas in our country.

Recognising the importance of the crop amid changing climatic conditions and increasing health awareness among the human society, winged bean is considered as one of the future crops which is likely



Field view of winged bean in its vegetative stage



Winged bean fruits



Winged bean in fruiting stage

shape that emits an aroma which is similar to asparagus.

The diversity of this crop has been observed in Papua, New Guinea, Mauritius and India, but maximum variation occurs in Papua and New Guinea. In India, it is grown mainly in eight states, including Assam, Manipur, Mizoram, Kerala, Tamil Nadu and Karnataka by the tribals as a backyard crop. The encouraging results of trials provide a ray of hope for its successful cultivation in North Indian plains also.

Nutritional significance

to play crucial role in world food and nutritional security. Recent technologies like genomics and phenomics tools along with precision agriculture practices can play very important role in enhancing the crop productivity.

Winged bean belongs to the genus *Psophocarpus*, legume family Fabaceae and sub-family of Papilionoideae. The plants are herbaceous perennial but mainly grown as annual. It is a vine crop with climbing nature and a wiry stem, which attains a height of 4 m and above, if the stacking provided is tall enough. The stem is usually green but certain varieties have stem with a shade of purple, pink or brown. Leaves are trifoliate, alternate, subtended by a stipule oval to ovate on the entire margin. The inflorescence is axillary, raceme and bearing many flowers. The calyx tube is long, inflorescence is axillary and 4-10 flowered raceme. The height of the vines varies between 3 and 4 meters. The colour of flower varies from white to deep purple, basically, blue, bluish white etc. Maximum flower opening is between 10 AM to 12 noon. The plant bear pods of different length and shape. Based on the shape, pods are of four types namely, rectangular, semi-flat, and flat on sides, flat on suture. The pods are 4 angled, 15-22 cm long, 2-3 cm broad with each angle continued into a much crisped and papery wing. Pod wings may be undulated, dented or serrate. An individual pod contains 5-20 seeds; the seeds are smooth, shiny and globular in shape with an average weight of 250 mg. They burst out from ripe pods and the colour of seed changes to brownish at the time of ripening. Seeds are round in

Winged bean has been recognized as a crop having much promise for nutritional security in the coming decades. Winged bean tubers are notably rich sources of starch, protein, and B-complex vitamins. Winged beans provide adequate amounts of proteins, minerals and vitamins. In addition, thiamine, pyridoxine (Vitamin B-6), niacin, and riboflavin are some of the

Table 2. Nutritive value of winged bean (*Psophocarpus tetragonolobus*) per 100 g

Principle	Nutrient value	Percentage of RDA
Energy	49 Kcal	2.5%
Carbohydrates	4.31 g	3%
Protein	6.95 g	12%
Total fat	0.87 g	3%
Cholesterol	0 mg	0%
Vitamins		
Folates	66 µg	16.5%
Niacin	0.900 mg	6%
Pantothenic acid	0.059 mg	1%
Pyridoxine	0.113 mg	9%
Riboflavin	0.100 mg	8%
Thiamin	0.140 mg	12%
Vitamin A	128 IU	4%
Vitamin C	18.3 mg	30%
Electrolytes		
Sodium	4 mg	<1%
Potassium	240 mg	5%
Minerals		
Calcium	84 mg	8%
Copper	0.051 µg	5.5%
Iron	1.5 mg	19%
Magnesium	34 mg	8%
Manganese	0.218 mg	9%
Phosphorus	37 mg	5%
Selenium	1.5 µg	3%
Zinc	0.39 mg	3%

(Source: USDA National Nutrient Database)

Table 1. List of winged bean varieties

Varieties	Economic part	Seed yield (q/ha)	Specific features
AKWB-1	Green pods and Seeds	10-12	It is dual purpose variety used as vegetable and pulse.
IWB-1	Seeds	11-13	High yielding, medium duration variety and test weight is 36-38 g.
IWB-2	Green pods and Seeds	13-14	This variety is amenable for seeds, green pods and fodder.
Chhattisgarh Pankhiya Sem-2	Green pods and Seeds	10-12	It is a dual purpose variety performing well under backyard (badi situation) at tribal people of Chhattisgarh



A. Flowers of winged bean, B. Fruiting stage – in this stage it is used for vegetable purpose, C. Maturity stage, D. Seeds of winged bean

B-complex vitamins embedded in these beans. Some of the essential minerals such as iron, copper, manganese, calcium, phosphorus, magnesium is concentrated in them. Manganese is utilized in the human body as a co-factor for the powerful antioxidant enzyme, superoxide dismutase. Winged bean green leaves, are an excellent source of fibre, vitamin A, C and minerals. Hundred grams of fresh leaves provide 45 mg of vitamin C (75% of recommended daily value) and 8090 IU of Vitamin A (270% of RDA).

Fresh, young winged bean pods are one of the finest sources of folates. Hundred grams beans provide 66 µg or 16.5% of daily requirement of folates. Folate, along with vitamin B-12, is one of the essential components of DNA synthesis and cell division. Adequate folate in the diet around conception and during pregnancy may help prevent neural-tube defects in the new-born baby. Fresh winged beans contain quite a good amount of vitamin-c as 18.3 mg/100g, or 31%. Vitamin C is a powerful water-soluble antioxidant, and helps in building immunity against infections, maintaining blood vessel elasticity, and offers some protection against cancers when adequately provided in the diet. Tender, immature pods of winged beans are one of the very low-calorie vegetables as 100g beans carry just 49 calories.

Adaptation amid changing climatic conditions

Winged bean can tolerate drought, flood, extreme

temperatures, pests and diseases to a greater extent than other major staple crops. The diversification of global food systems with this vegetable can prove to be an effective instrument in addressing the extreme weather patterns or the effects of long-term climate change while tackling the problem of dietary imbalances being faced by the world in present era.

It is estimated that food supply must be doubled by 2050 to cope with the adverse impacts of climate change and population pressure on global food systems. The diversification of staple crops and the systems in which they grow is

essential to make future agriculture sustainable, resilient, and suitable for local environments and soils. A recent analysis conjures up a worrying picture of global food consumption patterns and urges people to consume a broader range of food sources to combat malnutrition and global food insecurity, which is expected to grow further. That implies humans should consume more of the world's underutilized crops, also known as 'potential' or 'minor' crops.

One notable feature of the winged bean is the potential for almost all parts of the plant to be eaten, including leaves, flowers, tuberous roots, pods and seeds, whereas stems and leaves are used as fodder. It also serves well in crop rotation, because of the nitrogen fixation capability.

As with several underutilized crops, however, there are anti-nutritional factors in winged bean (specifically trypsin inhibitors), requiring thorough soaking, rinsing, and cooking of the dried beans, which may deter more widespread acceptance of winged bean in human diet. It is also relatively high in vitamins A and C, calcium, and iron. In countries where protein deficiency is high, or access to meat protein is low, winged bean is a candidate crop, which can enable diversification of human diet and improve nutrition.

The winged bean is largely a self-pollinated crop but up to 7.6% cross pollination is reported. It is a short-day plant and maximum flower-bud opening is between 10 AM to 12 noon. The exclusion of pollinating agents by

caging winged bean plants resulted in significant yield reduction and delayed fruit maturity. This indicated that insect pollination is beneficial for fruit-setting in winged bean. The stigma remains receptive up to 34 hours after flower opening. Anther dehiscence occurs even before flower opening. Considering above facts, winged bean is considered largely as self-pollinated with a level of cross pollination ranging from 0 to 7.6%. Flowers are hermaphrodite and light blue coloured.

Cultivation

Soil and climatic requirements

The land is ploughed at a depth of 3-4 cm and a very fine tilth is maintained. The purpose of land preparation is to provide the necessary soil conditions which enhance the plant and root growth. The sandy to heavy clays soils, well-drained sandy loam, rich in organic matter having a pH of 4.3-7.5 is preferred. Hot and humid climate is ideal for the cultivation of winged bean. It can tolerate temperature range of 15.4–27.5°C and annual rainfall between 700–4100 mm. Flowering is observed from mid-September to October under short day conditions. Despite prevalence of short day conditions, temperature above 32°C or below 18°C inhibits flowering. The crop grows well up to an elevation of 2,000 m.

Method of sowing and seed rate

Winged bean is mainly propagated through seeds, but stem cuttings can also be used under specific circumstances. The recommended seed rate is 15-20 kg/ha. However, seeds have a hard seed coat and should be pre-soaked for 1 - 2 days. The seeds are sown at a depth around 3 – 4 cm, which germinate within 5-7 days after sowing. Optimum mean temperature for the growth of crop is 25°C and North-South orientation of trellis is best for proper exposure to sunlight. The optimum spacing is 90 cm × 90 cm for commercial crop and 45 cm × 45 cm for seed crop. A spacing of 30 cm × 20 cm can be followed in case of dwarf types.

Time of sowing

Normally, the winged beans are sown with the onset of monsoon in June-July. The crop grown for tubers should be sown in August- September, since early sowing results in profuse vegetative growth and may inhibit tubulisation.

Integrated nutrient management

Being a leguminous crop, winged bean holds prolific nodulation capacity. This legume crop does not need inoculation with nitrogen fixing bacteria for its vigorous growth, as it has ability to grow quickly and enriches the soil with nitrogen especially under ploughed conditions. Tropical soils are generally deficit in nitrogen but winged bean thrives well even in poor soils reflecting its ability to fix the atmospheric nitrogen. In acidic soils, winged bean reflects the symptoms of aluminium toxicity similar to other legumes. The crop requires 20 tonnes/ha FYM and application of fertilizer dose of N:P:K at 50:80:50 kg/ha. Full dose of P and K and split dose of nitrogen is applied at the time of sowing while remaining dose of

nitrogen is top dressed at 40 to 60 DAS.

Weed control

Winged bean is a fast growing crop and provides plant cover within one month of sowing. However, one hand weeding at 15-20 DAS is required to control weeds during early growth period.

Staking is a very important practice to obtain good and quality yield in winged bean due to indeterminate stem growth. Several methods of staking are in practice, depending on the uses of crop and availability of resources. For instance, plants grown for tuber yield are allowed to trail across the ground but if the legume is grown exclusively for the pods, short stalks are used for continuous picking of green tender pods. The support of the vine is also essential for higher seed production.

Plant protection

There are no major reports of insect-pest and disease incidence on winged bean in India. However, false rust (*Synchytrium psophocarp*), leaf spot (*Pseudocercospora psophocarp*) are the important fungal diseases. Similarly, *Maruca testulalis* and *Hermoeplachna signatipennis* and root knot nematodes may affect the crop. Therefore, suitable plant protection measures may be taken to minimize yield losses.

Harvesting and Post-harvest management

Harvesting the shoots and leaves is done while they are still tender. Green pods can be harvested from about 10 weeks after sowing. Fresh pod and tuberous root yield 5-10 t/ha each, whereas seed yield ranges from 1-1.5 t/ha. Winged bean can be stored in plastic bags, tightly tied at the neck to keep them fresh. The shelf life of the pods can be increased to 4 weeks under storage temperature of 10°C and 90% relative humidity.

Future thrust and Prospects

The exceptional nutritional quality along with tropical adaptation makes winged bean a potential candidate for cultivation in the tropical areas of the world. Past research efforts were hampered by a lack of genetic resources and knowledge upon which to build, critical infrastructure that can spur research efforts. More importantly, efforts must be made to collect, conserve and utilize the largely eroding genetic resources and promote awareness among the local people, particularly the young generation, of its existence thus, enhancing its utilization. The establishment of an enabling policy and financial assistance by government agencies and support of non-governmental organizations will be critical to push forward research and development efforts. Yet, the nutritional potential of this legume demands such efforts. There is no doubt that renewed research efforts will thrust winged bean forward and transform this orphan legume crop into one of worldwide impact.

For further interaction, please write to:

P K Singh (Principal Scientist), Center for Protected Cultivation Technology, ICAR-Indian Agricultural Research Institute, Pusa, New Delhi 110 012. *Corresponding author's email: pksingh128@gmail.com