TECHNOLOGIES FOR INCREASING MUNGBEAN AND URDBEAN PRODUCTION IN ANDAMAN & NICOBAR ISLANDS

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2016 INTERNATIONAL YEAR OF PULSES

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ICAR - Central Island Agricultural Research Institute
Post Box No.181, Port Blair – 744 101
(Andaman & Nicobar Islands)

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Dr. Sibnarayan Dam Roy
Director

FOREWORD

Pulse crops have been one of the major components of sustainable agriculture mainly because of their soil ameliorating properties and nutritional values. Andaman and Nicobar islands is endowed with rich and vast diversity of natural resources particularly soil, water, climate and agrobiodiversity. In order to utilize the optimum potential of the agricultural production in these islands on a sustained basis, efficient management of these resources is of paramount importance. Out of approximately 12000 hectares of cultivable land under field crops in these islands about 2900 ha is under different pulse crops namely, mungbean, urdbean and pigeonpea. The climate of this region in general is characterized by high, erratic and unpredictable rainfall, tropical and humid, high wind speed and high evapotranspiration. Soils are generally coarse textured and highly degraded with low water retention capacities and multiple nutrient deficiencies.

Tropical rainfed agro-ecosystem plays an important role to feed the burgeoning population of the islands and production per unit area per unit time of pulse crops especially mungbean and urdbean has to be increased without causing any adverse effect on the natural resources. Improving production and productivity of mungbean and urdbean in these areas is essential for food and nutritional security as the pulse production fluctuates with crop performance in these islands. The potential of pulse crops in these islands is unexploited by the low levels of productivity. Under the challenging scenario, management of natural resources with intervention of high yielding mungbean and urdbean varieties with production technology, the first step towards systematic research on genetic improvement of pulse crops for these islands was initiated by the Central Island Agricultural Research Institute, Port Blair for better livelihood of the farmers of both traditional and non-traditional tribal farming community.

These efforts has resulted in the generation of a pool of basic knowledge and improved technologies, which have made an impact in the area of adoption and turned in augmenting mungbean and urdbean cultivation. For achieving further success to improve agricultural production, access to knowledge and technologies has to go hand in hand with the researcher, extension personnels and farmers that enable to adopt these innovations. Therefore, it is appropriate and timely to bring together major implications for increasing mungbean and urdbean production in these islands in the form of a technical bulletin entitled *"Technologies for increasing Mungbean and Urdbean Production in Andaman & Nicobar Islands*" which provides the information on mungbean and urdbean cultivation technologies.

I understand, this technical bulletin has been prepared at an appropriate time when pulse crops production in this agro-ecosystem is seriously concerned with a challenge posed by demands of the growing population. The last few years witnessed a steep decline in area and production of pulse crops namely, mungbean, urdbean and pigeonpea in these islands due to deteriorating production environments and growing menace. I would like to compliment Dr. Awnindra K Singh and his team for their sincere efforts in bringing out this publication timely. I hope that the technical bulletin will serve as an important resource material for those engaged in the task of improving and stabilizing pulse crops production and will stimulate further research on these crops besides presenting an example to emulate them in other areas.

04.03.2016

Date : 04.03.2016

(Sibnarayan Dam Roy)
Director

Acknowledgemcnts

Pulse crops especially mungbean and urdbean have been an integral part of the Island agriculture occupying approximately 6 per cent of the total land available for field crops. By virtue of their ability to fix atmospheric nitrogen and being rich in vegetable protein it offer one of the viable options for diversification of contemporary agriculture for ecological sustainability of these islands and management of natural resources.

Keeping in view the urgency and challenges for further improvement in mungbean and urdbean production in these islands from the present level and opportunities available for making awareness among the farmers of these islands on the scientific cultivation of these crops for increasing production and productivity the technical bulletin entitled "Technologies for increasing mungbean and urdbean production in Andaman & Nicobar Islands" may serve as treasure of information based on scientific research carried out at ICAR-Central Island Agricultural Research Institute, Port Blair.

The authors of this technical bulletin are extremely indebted to Dr. Sibnarayan Dam Roy, Director, ICAR-Central Island Agricultural Research Institute, Port Blair for his encouragement, necessary guidance, motivation and supports. We are also expressing our gratitude to the Indian Council of Agricultural Research, New Delhi and acknowledge the funding under Tribal Sub Plan, which helped to bring out this publication. We are also thankful to our colleagues and staff who helped us for providing necessary inputs during preparation of this technical bulletin.

Authors

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Introduction

Global agriculture has witnessed dramatic changes during the last century, and expansion of urban areas and shifting of agricultural land in forest areas has become major factor behind global climatic change. Pulses can be grown very well on marginal and sub-marginal soils, hence were pushed from high productivity and long growing cool environment to short, low yielding and relatively warm environments. Due to this shift in pulses area (from North to central and South), the potential of high yielding varieties could not be realized to the level of satisfaction. Being an inseparable ingredient in the diet of the vast majority of population, more specifically the major source of protein to vegetarian diet and integral part of sustainable crop production, pulses continue to be an important component of the rainfed agriculture since time immemorial. Besides improving soil health by fixing atmospheric nitrogen through bacteria present in their roots and extensive tap root system, cultivation of pulses helps in opening up of the soil to deeper strata, thus ensure better aeration in soil which leads to effective establishment of soil micro-flora. This group of crops can be grown successfully in varying environmental conditions covering well irrigated to rainfed conditions. The role of pulses in sustaining agricultural production and cropping system is well recognized. India grows such a variety of pulse crops which none of the countries in the world grows. In India, more than a dozen pulse crops, namely chickpea, pigeonpea, mungbean, urdbean, lentil, field pea, lathyrus, cowpea, common bean, moth bean, horse gram, fababean and rice bean are cultivated under varying agro-ecological conditions.

India is the largest producer of pulses, accounting for about 25 per cent of the global share (Chaturvedi 2009). India is a largest producer of pulses in the world, with 25 per cent of total production, 30 per cent of total consumption and 32 percent of global acreage. During 2013-14, 19.27 million tonnes of pulses were produced on 24.97 million ha area in India. The productivity of pulses in the country has been very low (638 kg / ha average grain yield). Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra, Gujarat, Andhra Pradesh and Karnataka are major states occupying approximately 95% of the total pulses area. Pulses are grown throughout year in one or other part of the country during three distinct seasons viz., rainy or kharif season (June to October), winter or rabi season (November to April) and spring/summer or zaid season (March to June). They specially play an important role in food and nutritional security and sustainable agricultural production systems in the rainfed which cover over 60% of the national cultivated area and are home to approximately 60 per cent of the population. Some of the pulse crops are also grown in temporal niches overlapping two seasons partly or completely. Pulses, or '*dal*,' are an integral part of the average Indian population meal as constituting a major source of vegetable protein. This makes pulses one of the cheapest sources of protein for human consumption. With an ever-growing health conscious vegetarian population, the demand for pulses is increasing and so is the opportunity.

Due to increasing population in developing countries at a fast rate and health concerns and changing dietary patterns in developed countries, demand of pulses is rising worldwide. India is the major producer as well as consumer of pulses. The gap exists between demand and supply and thus country has to import 2-3 million tonnes of pulses from several countries causing huge

pressure on foreign exchange. With recent surge in the prices and commitment of the policy makers and researchers to make the country self reliant on pulses production, the main focus is placed on bridging the yield gaps by expanding area under the improved technologies already generated and to break the yield plateau through application of recent technological breakthroughs. To meet the projected requirement of 17.02 million tonnes of pulses by 2012, and 29.43 million tonnes by 2025, growth rate need to be accelerated to the level of 3.5 per cent (IIPR Perspective Plan, 2007).

Table 1: Area, Production and productivity of pulse crops in India

Production year	Area (mha)	Production (mt)	Productivity (kg/ha)
2010-11	26.28	18.24	694
2011-12	24.78	17.09	690
2012-13	23.47	18.45	785
2013-14	25.23	19.27	764
2014-15	24.40	17.43	714

(*Source:* *Agricultural Statistics at a Glance, Directorate of Economics & Statistics, Department of Agriculture & Cooperation, Ministry of Agriculture & Farmer Welfare*, *Government of India*)

As a result of the Green Revolution, the rice-wheat cropping system now dominates the important food production areas of the Indo-Gangetic Plains and the Peninsular Region. About 60% of the total cropping area is under rice and wheat; these two staple grains have replaced more than 25 different crops in both the Kharif (rainy) and Kharif & summer (summer) growing seasons. This system provides good returns to farmers and strengthens food security, but sustainability is declining due to the lack of any adjustment in crop rotation although options for such adjustment exist. This phenomenon relegates pulses to marginal lands. Due to continuous cultivation of cereals in intensively cropped areas leading to a rapid decline in the organic matter content of soils. After the harvest of rice in southern part of the country and wheat in central and northern part and before transplanting of rice, the land remains fallow for 65-70 days; this period could be used to raise a catch crop of summer mungbean and urdbean as a substantial crop. A low input, short duration, high value crop, mungbean and urdbean fits very well into rice fallow and/ or rice-wheat cropping systems and other crop rotations. Mungbean and urdbean fixes nitrogen in the soil requires less irrigation than many field crops to produce a good yield, and helps maintain soil fertility and texture. By adding mungbean and urdbean to the cereal based cropping systems, it has the potential to increase farm income, improve human health and soil productivity, save irrigation water and promote long-term sustainability of agriculture. Traditional mungbean and urdbean varieties were long duration (70-80 days to maturity) and non-synchronizing. In the Islands agro-ecosystem, peninsular region, and southern part of the country, mungbean and urdbean are cultivated in rice fallows during winter season (November onwards) should be medium duration maturity (70-80 days), tall, vigorous growing (to smother weeds) and resistant to powdery mildew and late sown mungbean in rice fallows (January-March) should be early maturing (60-65 days) with resistance to Mungbean yellow mosaic virus (MYMV).

In general, the new mungbean and urdbean varieties are resistant to MYMV, more compact, having a high harvest index, reduced photoperiod sensitivity, early (60-70 days) and synchronous maturity, bear pods at the top in bunches, have long pods with bold, shiny seeds, and determinate growth habits. Drooping pods with thick pod coats are desirable, as they are less damaged by rains and less prone to shattering at maturity. Genotypes with these plant characteristics are more suited to rice fallows cultivation. For maximum productivity, vegetative growth should terminate with flowering and assimilates should be channelled into production of more number of pods.

Pulse: Good for the Planet, Good for the People

The water scarcity posing a significant risk to sustainable development of agriculture, pulses may offer a part of the solution as pulse crops are efficient users of water and nutrients, offering more crops per drop in terms of protein and micro-nutrients. With prevailing child malnutrition as much as 37% in India, the high-protein, micronutrient-rich caloric values of pulses offer the opportunity for eradicating malnutrition in challenging soil and climatic environments. According to UNCCD, today 52% of the land used for agriculture is moderately or severely affected by degradation of soil, a non-renewable resource. The worsening land degradation scenario is challenging sustainable food production, particularly in rainfed areas where natural resources are scarce. Pulses have the ability to replenish soil nutrients through nitrogen fixation, making them valuable to improve production systems through crop rotation.

Importance of Pulse Crops in Andaman & Nicobar Islands

Agriculture land available in Andaman and Nicobar Islands is very limited and restricted within 6 percent of the total area of this place. Due to the need to increase the fertility of this land, intense measures have been taken to bring scientific revolution to increase the productivity of major field crops like rice and pulses. Among non-cereal food crops, the strategic importance of pulses in augmentation of islands agriculture for sustainable agriculture cannot be underestimated or minimized. Pulses are grown both as intensive and subsistence crop and are the affordable source of dietary protein to the farmers. They work wonder as natural nitrogen fixation plant having immense ameliorative effect on the soil. The main importance of pulse in islands agriculture is;

1. Pulses are rich in proteins and found to be main source of protein to vegetarian people of these Islands.
2. Pulses being legumes fix atmospheric nitrogen into the soil and it can play important role in crop rotation, mixed and intercropping.
3. As these crops can help maintaining the soil fertility through adding organic matter into the soil in the form of leaf mould and boos organic agriculture in the region.
4. Pulses are generally requires less manuring and are helpful for checking the soil erosion as they have more leafy growth and close spacing.
5. It is second important food and field crops of Islands after rice and due to the short duration nature of major pulse crops of these region i.e. mungbean and urdbean, the second crop may be taken on same land in a year.

Farmers' can be grown on all types of soil and climatic conditions and can give ready cash to farmers'.

Technologies for increasing Mungbean and Urdbean Production for Andaman & Nicobar Islands

Mungbean (*Vigna radiata* L. Wilczek)

Mungbean (*Vigna radiata* L. Wilczek) subgenus *Ceratotropis*, is an indigenous vegetable legume and one of the most important pulse crops in South and Southeast Asia. The mungbean has been grown in India since ancient times. It is also referred to as green gram, golden gram and chop suey bean. Mungbean is one of the most important pulses crops grown during the kharif, rabi and summer season in the different parts of countries. It can be grown year-round at home or commercially. Mungbeans are grown widely for use as a human food (as dry beans or fresh sprouts), dhal, fried snacks and desserts etc. Mungbean seeds and dhal are rich in easily digestible protein which adds much-needed diversity to the cereal-based diets of the poor. The mungbean seeds also contain iron, calcium, phosphorus, zinc, folate and certain vitamins. Mungbean seed sprouts are a good source of vitamin C having good quality of vegetable protein and it can be easily digest and replace inadequate animal protein in human diets in tropical areas. This crop can also be used as a green manure crop and forage crop for livestock since it can produce a large amount of biomass and then recover after grazing to yield abundant seeds. It can also be used in broilers diets as a non-traditional feed for poultry. If the mungbean seed does not meet sprouting standards it can be used as a livestock food for protein content.

Mungbean in Andaman and Nicobar Islands

Mungbean (*Vigna radiata* L. Wilczek), is one of the important pulse crop among the pulse crops being cultivated in Andaman and Nicobar Islands and is widely cultivated as major pulse crop during rabi seasons (November to January). It is cultivated as a post rice crop and/ or rice-fallow on residual soil moisture with a considerable importance of its adaptation to short growth duration and low water requirement besides soil fertility restorer. Mungbean has been introduced from different parts of the country mainly by Indian settler. The mungbean is used for different purposes; the major portion is utilized in making *dal, desserts, sprouts*, curries, soup etc. Mungbean has good source of inexpensive vegetable protein and source to meet out the requirements of iron, calcium, vitamins and essential amino acids in daily diets of vegetarian and non-vegetarian islands population. On the other hand, it has a very good nutritional property with sprouting there is an increase in the thiamine, niacin and ascorbic acid, thus mungbean sprouts are increasingly becoming popular in certain vegetarian diets. Mungbean are thought to be beneficial as an antidiabetic, low glycaemic index food, rich in antioxidants. Other properties like easy digestibility

and low proportions of flatulence factors also add to its value among the pulse crops. Moreover, its food values lie in high and easily digestible protein. Mungbean is popular pulse crop in the Bay islands due to their suitability in various crop rotation practices and well suited in both dry and irrigated conditions. But their full yield potentials are not being realized. It is because of several constraints including climatic conditions, adaption of varieties, disease and insect problems and poor crop management practices. In the Andaman and Nicobar Islands pulse cultivation the average productivity of mungbean are low (549.57 kg/ ha) as compared to other coastal and traditional as well as non-traditional region pulse growing states of the country.

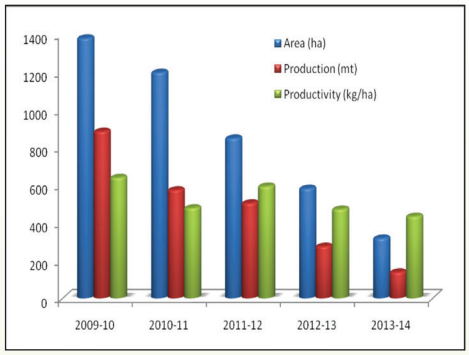

Table 2: Area and production of mungbean in Andaman and Nicobar Islands during last five years (2009-14)

Area, production and productivity of mungbean	Production year				
	2009-10	2010-11	2011-12	2012-13	2013-14
Area (ha)	1382.47	1200	850.44	583.5	319.15
Production (t)	886.6	575.5	505.83	275.9	138.88
Productivity (kg/ha)	519.67	641.32	479.58	594.79	472.84

(Source: *Directorate of Economics and Statistics Andaman and Nicobar Administration 2009-14*)

Urdbean (*Vigna mungo* L. Hepper)

Urdbean (*Vigna mungo* L. Hepper) is an annual and widely grown important pulses crop after chickpea, pigeonpea and mungbean. This crop grown during kharif, rabi and summer season in the different parts of countries. It is also referred as black gram, mash, dal kalai, black lentil, mungo bean. India is considered as the primary centre of origin and central Asia as the secondary centre of origin of urdbean. Urdbean is considered to bave been domesticated in India from its wild ancestral form and the center of genetic diversity is India. It shows both erect and crawling growth habit. The area of traditional cultivation of urdbean is confined to the South Asia and adjacent regions (India, Pakistan, Afghanistan, Bangladesh and Myanmar). Urdbeans are grown widely for use as a human food (as dry beans), but can be used as a green manure crop and as forage for livestock. Rich in diversity in their uses of urdbean adds much-needed to the cereal-based cropping system. It also contains carbohydrates, iron, calcium, phosphorus, magnesium, zinc, sodium and vitamins. It is consumed as dhal and food products such as fried snacks, desserts in India and South Asia. It is also use for making of vada, idly, sweet dishes etc. This can be grown year-round at home or commercially in

different part of the country. This crop can be used for both seeds and forage since it can produce a large amount of biomass and then recover after grazing to yield abundant seeds. The seeds of urdbean can also be used in broilers diets and livestock feed as a non-traditional feed.

Urdbean (*Vigna mungo* L. Hepper), in the Andaman and Nicobar Islands

Urdbean (*Vigna mungo* L. Hepper), in the Andaman and Nicobar Islands popularly known as *Urad dal* is one of the important pulse crop among the pulse crops being cultivated in Andaman and Nicobar Islands. It has also been introduced in the Andaman and Nicobar Islands from the other parts of the country and tropical areas mainly by Indian settlers. This crop is also known as Masakalai dala (Bengali), Minimulu (Telgu), Paruppu (Tamil), Uddina bele (Kannada) and Uzhunnu Parippu (Malyalam). The urdbean is used for different purposes; the major portion is utilized in making *dal vada*, idali making, dosa, muruku (South Indian dish), curries, soup etc. It also has a very good source of inexpensive vegetable protein and source to meet out the requirements of iron, calcium, vitamins and essential amino acids in daily diets of vegetarian and non-vegetarian islands population. Urdbean, is a widely cultivated pulse crop during rabi seasons in these islands as a post rice crop and/ or rice fallow crop with a considerable importance of its adaptation to short growth duration and low water requirement besides soil fertility restorer. This crop is also popular due to their suitability in various crop rotation practices and well suited in both dry and irrigated conditions. But their full yield potentials are not being realized. It is because of several constraints including climatic conditions, adaption of varieties, disease and insect problems and poor crop management practices. In the Bay Islands an average productivity of urdbean are low (508.94 kg/ ha) as compared to other coastal and traditional as well as non-traditional region pulse growing states of the country.

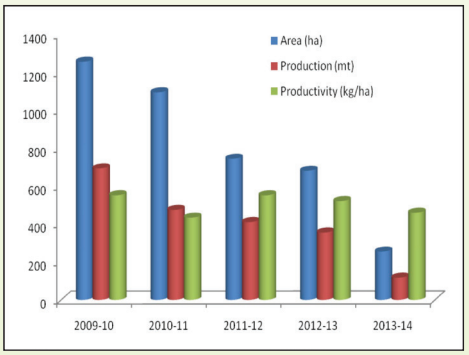

Table 3: Area and production of urdbean in Andaman and Nicobar Islands during last five years (2009-14)

Area, production and productivity of mungbean	Production year				
	2009-10	2010-11	2011-12	2012-13	2013-14
Area (ha)	1257.16	1095	744.9	681.4	255.1
Production (t)	693.86	475	410.92	355.6	117.46
Productivity (kg/ha)	551.93	433.79	551.64	521.87	460.45

(Source: *Directorate of Economics and Statistics Andaman and Nicobar Administration 2009-14*)

Mungbean and Urdbean may be emerging crop for nutritional security

Mungbean and urdbean which are predominant pulse crops of these islands have 2 to 3 times more protein than many cereals and are vital source of protein, fiber and carbohydrates especially for the poor who often cannot afford animal products. The composition of pulses protein is such that it makes up the deficiencies of certain essential amino acids of cereals and millets. Because of this, the mixed diet of the pulses and cereals to have better biological value than either of the components. These crops contain high amounts of protein, macro and micronutrients and vitamins (Table 2), for balanced nutrition. They are rich in lysine, an essential amino acid (Table 3) which is found only low levels in cereal protein. They also complement cereals in terms of nutrition. Although food legumes some anti-nutritional elements, most of these are denatured during cooking.

Nutritional Facts of Mungbean mature seeds, raw

Table 4: Amount of nutrients and minerals per 100 g of mungbean mature seeds, raw

Nutrients	Contains per 100 g	Minerals	Contains per 100 g
Energy	347 K Calories	Calcium	132.00 mg
Carbohydrate	62.62 g	Iron	6.74 mg
Sugar	6.60 g	Magnesium	189.00 mg
Dietary Fiber	16.30 g	Manganese	1.03 mg
Total Fat	01.15 g	Phosphorus	367.00 mg
Water	09.05 g	Potassium	1246.00 mg
Protein	23.86 g	Copper	0.94 mg
Ash	03.32 g	Zinc	2.68 mg
Cholesterol	00.00 mg	Sodium	15.00 mg
		Selenium	8.20 µg

Amount of vitamins per 100 g of mungbean mature seeds, raw.

Vitamins	Contains per 100 g	Vitamins	Contains per 100 g
Thiamin (Vit. B_1)	0.621 mg	Folate (Vit. B_9)	625.00 µg
Riboflavin (Vit. B_2)	0.233 mg	Vitamin C	4.800 mg
Niacin (Vit. B_3)	2.251 mg	Vitamin E	0.51 mg
Pentothenic acid (Vit. B_5)	1.910 mg	Vitamin K	9.00 µg
Vitamin B-6	0.382 mg	Choline	0.00 mg

(*Source:* USDA Nutrient Database)

Nutritional Facts of Urdbean mature seeds, raw

Table 5: Amount of nutrients and minerals per 100 g of urdbean mature seeds, raw.

Nutrients	Contains per 100 g	Minerals	Contains per 100 g
Energy	341 K Calories	Calcium	138.00 mg
Carbohydrate	58.99 g	Iron	7.57 mg
Sugar	0.00 g	Magnesium	267.00 mg
Dietary Fiber	18.30 g	Manganese	0.00 mg
Total Fat	01.64 g	Phosphorus	379.00 mg
Water	10.80 g	Potassium	983.00 mg
Protein	25.21 g	Copper	0.94 mg
		Zinc	3.35 mg
		Sodium	38.00 mg

Amount of vitamins per 100 g of urdbean mature seeds, raw.

Vitamins	Contains per 100 g	Vitamins	Contains per 100 g
Thiamin (Vit. B_1)	0.273 mg	Folate (Vit. B_9)	216.00 µg
Riboflavin (Vit. B_2)	0.254 mg	Vitamin C	0.00 mg
Niacin (Vit. B_3)	1.447 mg	Vitamin E	0.00 mg
Pentothenic acid (Vit. B_5)	0.000 mg	Vitamin K	0.00 mg
Vitamin B-6	0.281 mg	Choline	0.00 mg

(*Source:* USDA Nutrient Database)

Mungbean and urdbean crops enrich the soil fertility:

Pulses fix atmospheric nitrogen in their root nodules. Pulses can fix atmospheric N to meet their own N needs and also to benefit the succeeding cereal crop. There is comparatively little quantitative information on the amount to fixed N_2 available to crops following legumes in a cropping system. In pulses (grain legumes), usually the above – ground plant parts are harvested and removed and therefore the residual effect must largely be derived from the underground plant biomass and the leaf fall during crop growth. The residual effect of legumes does not necessarily reflect the direct contribution of fixed Nitrogen, but could simply be due to sparing effect of soil Nitrogen in rice and other crops grown after Mungbean and urdbean. It helps in nitrogen economy (25-35 kg/ha) of the farmer's apart from improving soil fertility through addition of0.5 – 1.5 tonnes / ha organic matter.

Ideal for Rabi season cultivation as a post rice crop: Water requirement of pulses crops is generally low. Further they have deep root system which enables them to extract soil moisture from deeper layers. On account of these characteristics they can be successfully grown during Rabi season after as a post rice crop.

Promote pulses in rice based cropping system: Generally the mungbean & urdbean are short duration pulse crops have helped in increasing cropping intensity particularly in the rice based cropping system. Due to continuous cropping of cereal – cereal based system, this has resulted in emergence of many problems like, over – mining of soil nutrients, decline in factor productivity, reduction in profitability, lowering ground water table and build up of pests, including weeds, diseases and insects, causing serious concerns for sustainability of the system.

Diversified use: The green pods of cowpea and mungbean and urdbean are used as vegetables. Pulses like, Mungbean, urdbean and cowpea provide nutritious green fodder for the cattle. Dry sticks of pigeonpea are an excellent fire-wood and are also used for thatching, basket making, broom, packing material etc..

Climate change influencing pulse production: Andaman and Nicobar Islands is most vulnerable to climate change. Intergovernmental Panel on climate change (IPCC) projected rise of temperature by 3-4 degrees by 2050 over current levels. The predicted changes in temperature and their associated impacts on water availability, pests, disease, and extreme weather events are all likely to affect substantially the potential of pulse production.

Pulse crops cultivation in Andaman & Nicobar Islands: General constraints

Crop management and weather

- Cultivation of mungbean and urdbean under relay cropping and mostly grown as rainfed crop leads to poor plant population and thereby low yields.
- Sowing of mungbean and urdbean under rice fallow conditions if delayed, there is drastic reduction in the productivity of these pulse crops, sometimes it grows as a mixed crop / border crop / intercrop.
- Poor plant stand and terminal moisture stress are the two major constraints for rabi and rice-fallow cultivation of mungbean and urdbean in these islands agro-ecosystem.
- Adequate population of rabi mungbean and urdbean cannot be maintained under rice fallows especially due to improper levelling.
- Pulses in general do not withstand heavy rains in October – December and sometimes in January and drastic affects in later rains. As these islands witnessed with climatic conditions, high sensitivity of pulses towards environmental fluctuations

Varieties and Seeds

- Non-availability of high yielding varieties suitable for these islands, non-availability quality seeds well in time, thus use of poor quality farm saved seeds and are a major constraint of poor productivity.
- Lack of suitable varieties specific to these island agro-ecosystem as well as fertilizer responsive varieties in pulses.

Plant Protection measures

- Mungbean and urdbean are susceptible to powdery mildew, charcoal rot, cercospora leaf spot and leaf curl virus in these islands in general and also to mungbean Yellow Mosaic Virus (YMV) in some landraces.
- High risk factor is susceptibility to stem fly, aphids, pod borer etc..

General agricultural practices

- Inadequate technology transfer to farming community.

Uncertainty in time of sowing of rice fallow crop. Sowing after the harvest of paddy depends on release of water. If the sowing is delayed for urdbean beyond the prescribed sowing time, the yield per day is reduced. Plant stand in rice fallow condition is not optimum, and as a rainfed crop during rabi, crop yields are uncertain and depend on unpredictable precipitation.

Strategies and approaches for increasing Pulse crops production in Andaman & Nicobar Islands

Bottlenecks (Limitations) in mungbean and urdbean production

S. No.	Bottlenecks	Improvement objective	Advantages to crop
1.	Inderminant growth habit	Derminant growth habit	Increase harvest index
2.	Spreading growth habit	Compact, semi erect growth	Efficient crop geometry
3.	Photo and thermo sensitive genotype	Photo and thermo insensitive genotype	short duration genotype fitting cropping system
4.	Pod shattering	Non shattering of pods	Check losses in grain yield
5.	Susceptibility to insect and diseases	Resistant to insect and diseases	Reduces loss
6.	Non synchronous maturity	Synchronous maturity	Explore possibilities of mechanical harvesting
7.	Absence of desirable genes	Earliness and resistant to stresses	Achieving high yield

Crop diversification options

Keeping in view the ever increasing population of these islands and limited land available for agricultural purpose there is a lot of scope of enhancing pulse production through creating awareness among the farmers of these islands. In particular, there is a need for technological backstopping, developing partnerships with civil society and developing capacity at the local level. To meet the potential challenge of catering to the food and nutrition requirement of island people a quantum increase in pulse productivity is very much essentials. The expansion of agriculture under the islands ecosystem imposed scientific and technological interventions concerning the diversification of mungbean and urdbean, in various cropping system especially in rice based cropping system as post rice crop during the month of November to April.

Rice based legume cropping sequence: A few suggestions

Cropping sequence
Rice – mungbean
Rice – maize + mungbean
Rice – urdbean
Rice – maize + urdbean
Mungbean – rice – mungbean
Mungbean – rice – urdbean
Urdbean – rice – maize + mungbean

Pulse crops genetic improvement for Andaman & Nicobar Islands

Pulses, being rich in protein, are important ingredients in the daily diet of the population of these Islands in different form. The Andaman & Nicobar group of Islands is immensely rich in plant biodiversity and it is also hub of diversity for so many cultivated and wild species of pulses like greengram, blackgram, mungan, beachpea, ranmug, redgram, cowpea etc. Pulse diversity in cultivated crops is presently maintained in home gardens by settlers from the mainland and other adjoining countries (Abraham *et al.*, 2006). Andaman & Nicobar Islands pulse improvement programme was started during early 90's, but the efforts were not consistent and focused. Hence, there is a need to initiate systematic research programme for pulse improvement in a sustainable manner for food and nutritional security of the inhabitants. Andaman and Nicobar Islands experiences a tropical climate, without any extremes except for the rains and thunder storms. Rainfall is common in the Islands, and is generally divided into two phases: May to mid September and November to mid December. Thus, the climate of Andaman and Nicobar Islands during Rabi season is highly favourable for the pulse crops after rice during December onwards.

They are often grown during Rabi season on marginal lands and constitute an important component in the rainfed farming system. In spite of their importance, the efforts done into the development of pulse crops have been quite insignificant whereas problems confronting pulses improvement are enormous. This is the reason that the pulses production in the Islands has not increased in the same dimension as in the case of other crops of the region. Absence of resistant / tolerant genotypes against diseases and insect pests in mungbean, urdbean, cowpea and pigeonpea are one of the main reasons for their low yield in India. During the Rabi season, charcoal rot and cercospora lea spot disease epidemically damages the crop in most of the mungbean and urdbean growing areas of Andaman & Nicobar Islands whenever unpredicted rains and/or long dry spell occurs. Identification of resistant genotypes is one of the most important aspects in the management of viral diseases, which might be the best possible solution to the viral disease problems. For the purpose of identifying resistance/ tolerance in mungbean, urdbean, cowpea and pigeonpea farmers' variety and landraces the pulse improvement programme was initiated and develop three mungbean varieties through selection from landraces. However in urdbean and pigeonpea three each accessions has been identified for their exploitation through pure line selection processes.

Development of high yielding varieties in different pulse crops through introduction and selection

The impressive increase in pulse crops productivity in these Islands in particular during last year (2013-14) has resulted, in addition to other components, primarily due to the introduction of improved mungbean and urdbean varieties, capable of exploiting the environment so provided. Better environment alone cannot lead to better yields from genetically inferior varieties, beyond a certain limit. Similarly, improving the environment beyond a certain limit for any variety may also adversely affect its performance. The present day improved varieties of mungbean possess major combinations of plant ideotype which enable the farmers for wider choice. Further, improved

varieties play key role in enhancing productivity of any crop. Improved variety alone can add 20 -25 % to increased productivity, even if other components of production remain the same. Hence introduction and selection of a variety by exploiting the landraces and/or farmers' variety for pulse production is very important to realise the benefits.

Pre-breeding efforts to break yield ceiling and broaden the genetic base

The indigenous landraces, farm saved seeds/ farmers' variety may ultimately be exploited for improvement of urdbean crops to broaden the genetic base for grain yield and resistance to many biotic and abiotic stresses. However, limited progress has been made in introgression of genes from wild species to the cultivars particularly for these islands agro-ecosystem. Greater efforts are needed in understanding barriers to interspecific hybridization and in identifying ways to overcome these barriers for the development of high yielding varieties having good tolerance ability to abiotic and biotic stresses with respect to the climatic conditions of these islands. Therefore, these indigenous landraces were collected, evaluated and conserved at the ICAR- Central Island Agricultural Research Institute, Port Blair (Singh *et al*., 2014). Identification and utilization of trait specific diverse germplasm accessions is of utmost importance to achieve desired improvement in particular trait. For the purpose of identification of trait specific germplasm accessions, an approach like identification of germplasm was adopted for the development and core set of germplasm accessions and their evaluation for identification of useful germplasm accessions/donors can help in assessing usefulness of pulse crops genetic resources more appropriately.

Identification and utilization of plant genetic resources

Development of high yielding varieties of mungbean and urdbean with wider adaptability has minimized the fluctuations in productivity and has shown stable performance. Pulse crops varieties for islands agro-ecosystem and non-traditional areas like Nicobar group of Islands have also been identified from the national varietal system as well as through the improvement of local landraces at ICAR-Central Island Agricultural Research Institute, Port Blair. A number of farm saved seeds are available with a sufficient quantity of genetic diversity. While these local landraces, farm saved seeds, farmers variety of urdbean / blackgram due to paucity of information on yield and yield attributes (evaluation data), vast variability could not be utilized for pulses improvement particularly for these islands.

Current status of trait specific promising landraces of mungbean and urdbean of Andaman & Nicobar Islands for use in breeding programme

A total of 79 mungbean and 54 urdbean landraces/ cultivated species have been collected and/ or assembled and conserved during the last five years (2011-16). Out of the total mungbean and urdbean landraces the promising 17 promising landraces of mungbean and 12 promising landraces of urdbean has been deposited to the NBPGR, New Delhi for long term preservation and is available for national research under the terms and condition of the Material Transfer Agreement of NBPGR.

List of traits specific promising landraces Mungbean (*Vigna radiata* L. Wilczek) and Urdbean (*Vigna mungo* L. Hepper)

Accession No.	Collector No.	Accession No.	Collector No.
IC-0611649	ANM-12-01	IC-0611649	ANU-12-01
IC-0611650	ANM-12-02	IC-0611650	ANU-12-02
IC-0611651	ANM-12-07	IC-0611651	ANU-12-07
IC-0611652	ANM-14-01	IC-0611652	ANU-14-01
IC-0611653	ANM-14-02	IC-0611653	ANU-14-02
IC-0611654	ANM-14-04	IC-0611654	ANU-14-04
IC-0611659	ANM-11-01	IC-0611659	ANU-11-01
IC-0611660	ANM-11-02	IC-0611660	ANU-11-02
IC-0611661	ANM-11-05	IC-0611661	ANU-11-05
IC-0611662	ANM-11-06	IC-0611662	ANU-11-06
IC-0611663	ANM-11-07-2	IC-0611663	ANU-11-07-2
IC-0611664	ANM-11-08	IC-0611664	ANU-11-08
IC-0611665	ANM-11-11	IC-0611665	ANU-11-11
IC-0611666	ANM-11-12	IC-0611666	ANU-11-12
IC-0611667	ANM-11-15	IC-0611667	ANU-11-15
IC-0611668	ANM-11-38	IC-0611668	ANU-11-38
IC-0611669	ANM-11-44	IC-0611669	ANU-11-44

Pulse crops varieties introduced in the recent past

Identification of pulse varieties is essential for the development of sustainable agriculture and food and nutritional security of the diverse agro-ecosystem of the country through evaluation, characterization and improvement of landraces. With the rigorous efforts of breeders, agronomists, soil scientists working in the ICAR-Central Island Agriculture Research Institute, Port Blair in collaboration with the ICAR-Indian Institute of Pulses Research Kanpur and State University like TNAU, BCKV, ANGRAU, BHU and the Department of Agriculture, A & N Administration a number of varieties of pulses have been evaluated in both station varietal evaluation trial and *on-farm* evaluation trial during the 1985-90's (Sharma, *et al.*, 1985, 86 Majumdar *et al.*, 1990, 91) and on the basis of their *per-se* performance introduced high yielding varieties of different pulse crops for the region. During the period from 1990 to 2014, more than 25 varieties of mungbean, urdbean and cowpea (Zamir *et al.*, 2014, Swarnam *et al.*, 2014, Singh *et al.*, 2014) have been recommended for cultivation in the Andaman and Nicobar Islands.

Criterion for selection of mungbean and urdbean varieties

For realizing optimum productivity of mungbean in islands agro-ecosystem, the choice of an appropriate variety which is adoptable to the varying range of the environment is extremely

essential. Improper choice of the variety would result in low productivity, even when adequate quantities of inputs are applied. It is equally important to use the latest recommended varieties to test their adoptability. The following targets were set before the selection / development of the mungbean variety for the region;

1. The variety to be selected for cultivation must be adapted to the specific agro ecological / production conditions.
2. Developing varieties of all maturities should be of short duration in nature as compared to the existing cultivated landraces and/or farmers' varieties.
3. Providing varieties that will perform well in major growing areas, across seasons and circumstances.
4. Developing varieties with sound agronomic traits.
5. Developing varieties to meet the needs of small and marginal farmers.

Mungbean high yielding varieties recommended for Andaman & Nicobar Islands

Varieties	Source of availability of seeds	Days to maturity	Estimated Yield in Islands (q/ ha)
Vamban-3	NPRS, TNAU, Vamban (TamilNadu)	70 – 75 days	9.0 – 11.0
IPM-02-3	Indian Institute of Pulses Research, Kanpur (UP)	65 – 72 days	10.0 – 11.0
IPM-02-14	Indian Institute of Pulses Research, Kanpur (UP)	65 – 70 days	11.0 – 12.0
LBG-460	RARS, ANGRAU, Lam, Guntur (AP)	70 – 75 days	9.0 – 11.0
HUM-16	Banaras Hindu University, Varanasi (UP)	60 – 70 days	12.0 – 13.0
HUM-12	Banaras Hindu University, Varanasi (UP)	65 – 70 days	10.0 – 11.0
Pusa Vishal	IARI, New Delhi	65 – 70 days	10.0 – 12.0

Urdbean high yielding varieties recommended for Andaman & Nicobar Islands

Varieties	Source of availability of seeds	Days to maturity	Estimated Yield in Islands (q/ ha)
Vamban-5	NPRS, TNAU, Vamban (Tamil Nadu)	70 – 75 days	8.0 – 10.0
Vamban-6	NPRS, TNAU, Vamban (Tamil Nadu)	70 – 75 days	9.0 – 11.0
Vamban-7	NPRS, TNAU, Vamban (Tamil Nadu)	70 – 75 days	10.0 – 11.0
IPU-02-43	Indian Institute of Pulses Research, Kanpur (UP)	65 – 72 days	10.0 – 11.0
Uttara	Indian Institute of Pulses Research, Kanpur (UP)	70 – 75 days	11.0 – 13.0
LBG-752	RARS, ANGRAU, Lam, Guntur (AP)	70 – 80 days	8.0 – 10.0
LBG-645	RARS, ANGRAU, Lam, Guntur (AP)	70 – 80 days	9.0 – 12.0

Varietal Improvement: Selection of high yielding mungbean and urdbean varieties for Rabi and Rice Fallow cultivation

Sustainable efforts during the last four years (2011-15) at the ICAR-Central Island Agriculture Research Institute resulted in significant improvement of pulse crops varieties especially in mungbean such as the wider adaptability for higher yield, early maturity and tolerance to the major biotic stresses with better plant type and seed characteristics. The Institute develop three pulse varieties in mungbean and identified 4 mungbean and 3 urdbean accessions derived from local landraces showing wider adaptability with distinguished characteristics. The pulse crops namely, mungbean and urdbean in these islands encounter a large number of stresses like soil moisture stress (during drought), high temperature (heat), salinity etc. The losses due to these stresses depend on the crop and seasonal variations. Among various stresses affecting mungbean and urdbean productivity in these islands unfavourably, drought and heat are most important during Rabi season. The inherent characteristics of mungbean and urdbean can be grown under harsh environmental conditions have gone against the crops. The crops suffer due to terminal drought, intermittent drought due to high evapo-transpiration rate, temperature extremities including and heat at crop growth and reproductive stage leading to low biomass accumulation. Salinity, water logging due to unforeseen rains etc. are the other reasons for low productivity in these islands. Therefore, there is an urgent need to identify the suitable varieties of urdbean and to develop a technology for increasing mungbean and urdbean production in these islands.

Mungbean Varieties identified and released by IVRC, ICAR-Central Island Agricultural Research Institute for Andaman & Nicobar Islands conditions

CIARI Mung-1 (ANM-11-12)

CIARI Mung-1 (ANM-11-12, IC No.) is a medium duration (68-72 days), synchronous maturity (at 75-80% physiological maturity) high yielding (18.24 q/ha), bold seeded, long pods, more number of seeds per pod, medium statured variety with brown pods, profuse branches (4-7), test weight (>5.42g) and appreciable field resistance to Charcoal rot, powdery mildew and MYMV. CIARI Mung -1 (ANM-11-12) possesses very attractive bold seeded grains, high yielding varieties, it has long pod (13 - 14 cm), brown pod colour with highest corresponding number of seeds/ pod which are considered as favourable plant ideotype features.

CIARI Mung -2 (ANM-11-05)

A CIARI Mung -2 (ANM-11-05, IC No.) is a medium duration (65 - 70 days), synchronous maturity (at 80% physiological maturity) high yielding (16.05 q/ha), bold seeded, long pods, more number of seeds per pod, medium statured variety with black pods, profuse branches (4-

6), test weight (>5.06g) and appreciable field resistance to Charcoal rot, powdery mildew and MYMV. CIARI Mung-2 (ANM-11-05) possesses very attractive bold seeded grains, high yielding varieties, it has long pod (12-13 cm), brown pod colour with highest corresponding number of seeds/ pod which are considered as favourable plant ideotype features.

CIARI Mung -3 (ANM-11-07-2)

CIARI Mung -3 (ANM-11-07-2, IC No.) is an medium duration (64 - 68 days), synchronous maturity (at 90% physiological maturity), high yielding (14.51 q/ ha), small seeded, short statured variety with black pods, profuse branches (3-6), medium test weight (>4.9g) and appreciable field resistance to charcoal rot, powdery mildew, terminal drought and MYMV. CIARI Mung -3 (ANM-11-07-2) possesses very attractive medium seeded grains, high yielding varieties, it has long pod (11.8 cm), black colour pod with highest corresponding number of seeds/ pod (11-13 seeds) which are considered as favourable plant ideotype features.

Mungbean and Urdbean Production Technologies

Greater awareness among the farmers about the use of critical inputs like land, varieties, irrigation, fertilizers and agro-chemicals is helping in increasing the productivity. Many non-monetary or low cost inputs like timely sowing with adequate plant stand, seed treatment, weed management and resource conservation practices also increase crop productivity.

Major pulse based cropping system in the Islands

Generally in the Andaman & Nicobar Islands, mungbean/ urdbean after rice in Rabi season are important sequential cropping system in North and Middle Andaman Islands, while in South Andaman and Little Andaman it is cultivated in rotation of rice and/ or vegetables during rabi season.

Climatic suitability

Urdbean does not require cool climate. The moist humid (> 70% relative humidity) and warm climate with least variation in maximum (31^0 C) and minimum (23^0 C) temperatures of these islands are typically suitable for these crops. The inherent characteristics of water stress tolerance of these crops make them highly suitable for growing under rainfed conditions on the low lying valley areas during dry season. Being a short duration crops urdbean is a warm humid season food pulses can be grown as rabi crop in the island conditions. It likes warm humid, dry and bright weather.

Selection of lands and tillage

A well drained deep soil free from excessive soluble salts with pH ranging from 6.5 to 8.5 and soil texture ranging from sandy loam to clay loam soils is ideal for urdbean cultivation. In these islands, urdbean are grown on a variety of soils. The urdbean in general do not require very fine seed bed. Tillage requirements depends upon the moisture level reaches to field capacity (neither dry nor too wet), one deep ploughing followed by cross harrowing, levelling and planking ensures good germination. Field preparation and sowing of dry season crops in these islands generally depends on the ending of monsoon rainfall after harvest of rice. However, early sowing in the month of November is recommended to avoid onset of drought at the later stage of the crop growth (flowering and ripening).

Seed treatment

For the Prevention of soil and seed borne diseases and better yield, seeds should be treated with antifungal bio-agents, Rhizobium and phosphorus solubilising bacteria. The seeds should be treated with fungicides (2 -3 g Thiram + 1 g Carbendazim kg^{-1} seed) and to avoid Yellow Mosaic Virus treat the seeds with Imidachlorphid @ 1 ml / kg seed before sowing for reducing seed and soil borne fungal diseases. Phosphorus solubilising bacteria (PSB) have been identified, which improve

availability of phosphorus to plants. Thus, seed treatment with PSB is recommended. If urdbean is being grown for the first time, the seeds should be inoculated with *Rhizobium* culture. The seeds should be treated first with fungicides and then with PSB and *Rhizobium*, following the procedure recommended by suppliers. The culture-treated seeds should be dried in the shade and sown as soon as possible thereafter. If the seed is to be treated with pesticides, always apply insecticides first, followed by fungicides, and finally *Rhizobium* culture/ phosphate solubilising bacteria or follow instructions on the packets.

Sowing rate and sowing methods

Quality seed is the key for the establishment of plant and higher crop productivity. The seed should be pure, free from diseases and physically damage with 90 - 95 % viability. Seed rate differs from variety to variety, depending on seed size. The seed should be sown deeply enough to make contact with moist soil at the rate of 18 - 20 kg seeds per ha. A depth of 3-5 cm seems to be ideal for the emergence of urdbean. Line sowing in the crop facilitates intercultural operations. Row-to-row spacing of 30 cm and plant-to-plant spacing of 8-10 cm are generally used, which give about 30 - 40 plants per m^2 is an optimum plant population. Wider row spacing (35 cm) can be used in bold seeded and spreading type urdbean local varieties, which are expected to have greater plant width.

Sowing Time

Urdbean should be sown during the first week of November to second week of January during rabi season but it depends on the rains in the area, however, sowing after January results in low yields. For the rabi crop, urdbean should be sown after the harvest of last crop (rice and/ or kharif vegetables etc.). The first fortnight of November to December is most suitable for rice fallow cultivation. Sowing should be avoided after middle of February because of hot air and high temperature affecting flowering leading to low yields.

Fertilizer Management

Being capable of soil fertilization through symbiotic nitrogen fixation of atmospheric nitrogen, the requirements of nitrogen for these crops are relatively less than phosphorus. But for initial growth and vigour of the seedling, a starter dose of 20-25 kg N/ha is applied as basal dose during final land preparation. For higher growth of its tap root system to accelerate nitrogen fixation, 40-50 kg p/ha should also be applied as basal dose. Hence, applications of 100 kg DAP/ha are sufficient to meet the nutrient requirement of these crops. Depending on the host specificity, different bio-fertilizer species including *Rhizobium* can be mixed with the seed or to be applied in the main field to enhance the nitrogen fixation and improve the yield. If soils are low in potassium (K), an application of 17 to 25 kg K/ ha is recommended. There will be no response to application of K in

soils with high levels of available K. Total quantities of N, P and K should be given as a basal dose. Foliar spray of 2% DAP at flowering has been found beneficial in rainfed crops.

Irrigation and water management

The water requirement of urdbean generally varies between 150 - 250 mm depending on the duration of the varieties and growth of the crops. Normally, pre-sowing irrigation of pulse crops is not required in these islands as the crop is sown on sufficient residual soil moisture in the rice-fallow just after the cessation of monsoon. However, when the sowing is delayed, one irrigation of 60 mm is necessary for quick germination and better growth. Flowering and ripening stage in pulses is most 'critical growth stage' with respect to the irrigation requirement of the crop. Hence, one supplemental irrigation must be provided at this stage for higher yield of the crop. Though the pulses can tolerate water stress, they are highly susceptible for water logging. Therefore, for these islands with characteristic unpredictable high rainfall, care must be taken to provide adequate drainage after rainfall to save the crop from water logging.

Weed management

Weed control in urdbean is essential, since competition between the urdbean and the weed is reduced, thus ensuring higher yields. The presence of weed seed in a seed lot will result in the seed being downgraded to a lower quality. The initial growth rate being very slow, pulse crops generally suffer from severe competitions with weeds up to 25 - 35 days of sowing causing severe reduction in growth and yield. To promote good cultivation practices, inter-tillage by hand should be performed once or twice. Rotary hoeing should be performed as needed to remove weeds until flower initiation. Late emerging weeds will have a smaller effect on yield than would early emerging weeds. Avoid cultivation of damp plants, since this can result in the spreading of bacterial and fungal diseases. Therefore, it is essential to do two hands weeding i.e. once at 20-25 days after sowing and second at 40 - 45 days after sowing to control the growth of weeds in the field. However, at the time of first weeding, hoeing and intercultural operations near the crop rows is required for proper aeration and root growth of the plant.

Crop Protection Technology

Mungbean and urdbean, just like any other legume crop, is susceptible to diseases caused by fungi, bacteria and viruses. Various leaf and stem pathogens, such as powdery mildew and bacterial blight, are frequently seen, especially in growing crops, but do not cause much damage. Charcoal rot, leaf crinkle virus, powdery mildew and cercospora leaf spot cause considerable losses to mungbean and urdbean in these islands as compared to other diseases of like MYMV. Infestation by insect pests during crop season results in considerable yield loss in urdbean. During the vegetative

stage, defoliators e.g., semilooper are common pests. Activity of thrips starts at the bud stage and pose serious problems when the crop attains peak flowering leading to heavy flower drop. Incidence of stored grain pest in storage results in considerable losses.

Major diseases of mungbean and urdbean in the A & N Islands and its control

Charcoal rot (*Macrophomina phaseolina*) is the most prevalent disease of urdbean in Andaman and Nicobar Islands. Charcoal rot normally has little effect on growing plants, but is a significant problem for sprouting seed. Affected plants show rotting of roots and stems of the plant after a month of sowing. The varieties identified for these islands having tolerance against charcoal rot are like IPM-02-3, IPM-02-14, CIARI Mung-1, CIARI Mung-2, CIARI Mung-3, HUM-16, LGG-460 and Pusa Vishal should be cultivated to avoid or control of the disease.

Control: Since this is a fungal disease so the best measure of the control of the disease at the time of appearance of this disease at initial stage plant should be uprooted and burned it so that the sclerotia do not form or survive. Basal application of zinc sulphate @ 25kg / ha or neem cake @ 150 kg/ha at the time of sowing will helps in control of the disease. Seed treatment with Captan 75 WP @ 2.5g /kg and Thiram 80% WP@ 2g/kg of seed before sowing provides significant protection from the disease. Spray with Carbendazim 50 WP @ 1.0 g/ltr or Mancozeb @ 2 g/ltr at an interval of 15 days with the appearance of the symptom.

Mungbean and urdbean Leaf Crinckle Virus (ULCV): Leaf crinckle virus is the widespread disease of urdbean in the Bay Islands as compared to mungbean. Initial symptoms are generally an increase in the size of the third trifoliate leaf and a lighter green colour. This disease is caused by urdbean leaf crinkle virus (ULCV) belonging to Tospovirus. The virus is transmitted by aphids, whitefly and leaf hoppers and through sap. Disease symptoms include crinkling, curling, and puckering of leaves often coupled with stunting and malformation of floral organs. Enlargement in size followed by crinkle surface of lamina are the characteristics symptoms on affected trifoliate leaves. Affected leaves become coarse and leathery. ULCV has the potential to cause heavy yield losses in urdbean and mungbean. In early-infected plants, and production may fail partially and/ or completely.

Control: Planting of resistant mungbean and urdbean varieties is the best control measure. On the initial appearance of the disease all infested plants as soon as noticed should removed from field. For controlling the vector (Whitefly), 2-3 spraying at the interval of 10 days of systemic insecticide

Imidacloprid 70 WS @ 2-5 ml / liter of water should be given immediately after notching the disease. One foliar spray of insecticide Dimethoate 30EC @ 1.7 ml/ha on 30 days after sowing.

Powdery Mildew: Powdery mildew is a major problem for urdbean cultivation and causes severe yield loss in these islands. This disease is caused *Erysiphae polygonii*, which produces conidiophores carrying chains of white conidia. The disease appears on all the part of plants above soil surface. Disease initiates as faint dark spots, which develop into small white powdery spots, coalescing to form white powdery coating on leaves, stems and pods. At the advance stages, the color of the powdery mass turns dirty white. The disease induces forced maturity of the infected plant causing heavy yield losses and its intensity increases in stress condition. The pathogen overwinters and survives on the host tissue in the form of cleistothecia. Unlike most fungal plant pathogens, the powdery mildews do not require the surface of the host plant to be wet for infection, favored by high humidity. It is favored by cooler conditions and is widespread in the late planted crop.

Control: For the control of this disease clean cultivation should be adopt. Delayed sowing of mungbean and urdbean with wider spacing considerably reduce the infestation of the disease. The Powdery mildew can be controlled by application of wettable sulphur 80 WP @ 2 -4 g/ltr or 2-3 spraying of Hexaconazole or Propiconazole @ 1ml/ ltr 2 times at 10 days interval.

Cercospora leaf spot (*Cercospora canescens*) commonly attacks urdbean in the tropics. Infection is characterized by the appearance of leaf spots that are circular and/or irregular in shape with greyish-white centres and reddish-brown to dark brown margins. It can cause yield losses of up to 58%. Removing the crop debris and weed hosts at the time of planting. The disease-resistant cultivars can aid to control the disease.

Control: Cercospora leaf spot can be controlled by seed treatment with Thirum or Captan @ 2 -2.5 g/kg of seed. It can also be controlled by 2-3 spraying of Carbendazim 50WP @ 1g/ltr or Mancozeb 45 WP @ 2g/ltr of water. Subsequent spray should be done after 15 days interval, if required. Spray of Copper Oxychloride @ 3-4 g/ltr water also been effective in control of this disease.

Anthracnose: This disease is caused by fungus *Colletotrichum* sp. is characterized initially by many brown, dry and raised spots on the leaf surface. When the disease is severe several such spots coalesce, the leaves

become yellow and fall off prematurely. The lower surface of the leaf appears red in colour due to the formation of raised spots. The bacterium is also seed-borne. In severe case, the stem and pods also get infected.

Control: Seed should be with Captan or Thiram @ 2.5 g / kg seed reduces the incidence of disease to some extent. Spray of Copper Oxychloride @ 2 - 2.5 g/ltr water also been effective in control of this disease. Subsequent spray should be done after 15 days interval, if required.

Mungbean Yellow Mosaic Virus (MYMV): Mungbean yellow mosaic virus (MYMV) disease is one of the most vicious diseases of mungbean and urdbean in the Indian subcontinent. It is caused by a group of geminiviruses belonging to the genus, begomovirus of the family, Geminiviridae. They are transmitted through whitefly in a persistent manner. The economic losses due to this virus account up to 85% in green gram which is spreading faster towards newer areas. Affected plants shows green patches, leaves become deformed and reduced in size and their margin show upward rolling.

Control: Planting of MYMV resistant mungbean and urdbean varieties is the best control measure. On the initial appearance of the disease all infested plants as soon as noticed should removed and burned. For controlling the vector (Whitefly), 2-3 spraying at the interval of 10 days of systemic insecticide Imidacloprid @ 2 ml / liter of water should be given immediately after notching the disease.

Major Insect-pest of mungbean and urdbean in the A & N Islands and its control

Infestation of insect pest in mungbean and urdbean like, Aphids, Pod borer, Blue butterfly, Stem fly, Jassids, Thrips are the major insects of in these islands. Application of Carbofuron @ 10 kg. a.i./ ha at the time of sowing can control most of the insects.

Aphids: Aphids attacks mungbean and urdbean. The adults are black and shiny. Nymphs are covered with waxy coating that makes them grey and dull. The nymphs and adults are seen in large number on young plants, leaflets, flowers and pods. The nymph sucks the sap of leaves. The affected leaves turns yellow, get wrinkled and distorted. The insect also exude honeydew on which fungus develops, rapidly covers the plant with sooty mould that interferes with the photosynthetic activity of the plant.

Control: Spray of 5% crude neem extract or 5% neem oil 3000 PPM. Spray of Dimethoate 30EC @ 1.7 ml/ltr water and Imidacloprid @ 0.2 ml /ltr water for the control the pest effectively.

Thrips: The adults and nymphs feed on leaves. They scrape the epidermis and such the oozing sap. As a result, light brown patches appear on infested leaves. The affected leaves curl and become dry.

Control: Timely irrigation at interval of 15 days results in low build up of thrips. Seed treatment with Thiomethaxon 70 WS 0.2% + foliar spray with Thiomethaxam 25 WG 0.2% are effective in controlling the disease. Spray of Neem oil @ 2% is also effective to minimize and control the pest effectively.

Pod borer (*Helicoverpa*): Pod borer (*Helicoverpa armigera*) being a polyphagous pest also infests mungbean and urdbean. Caterpillars feed on tender foliage and young pods. Once crops reach flowering, larvae focus on buds, flowers and pods. Young larvae are likely to feed on vegetative terminals, young leaves and flowers before attacking pods. Small pods may be totally consumed by *Helicoverpa*, but larvae target the seeds in large pods. They make holes in the pods and feed on developing seeds by inserting anterior half portion of their body inside the pods.

Control: Deep ploughing for exposure and destroying the pupating larvae. In the early stage of pest incidence, handpicking of the caterpillars and their destruction may minimize the infestation. Ploughing fields after the harvest of crop would expose the pupae, which would be destroyed by birds. Spray the crop with Emamectin benzoate 5SG @ 0.2 g/ltr effectively manage the larval population. Application of Profenophos 50EC @ 2 ml ltr or Crude neem extract 5% @ 50 g/ltr or Neem oil 3000PPM @ 20 ml/ltr water can successfully control the pest.

Spotted Pod Borer (*Maruca testulalis*) : Urdbean and mungbean is severely infested by the spotted pod borer, *Maruca testulalis in* the flowering and podding stage of the crop. The early instars are flower feeders. They scrape on the buds and flowers and cause shedding of floral parts. Later on the caterpillar bores into pods and feeds on the seeds. It has a characteristic habit of webbing leaves, flowers and pods together and feeding on flowers and pods. The webbed mass show silken linings of caterpillar webbings tempered with black excretory pellets. The pod shows an irregular single bore hole. Inside the pod is a dirty greenish brown caterpillar with brownish spots. The pods dry up in due course with no accountable seed yield. Pupation takes place in a silken cocoon in the pod. The adult moth has brownish forewings and the hind wing is grayish white with distal brown markings.

Control: Collection and destruction of infested plant parts. Spraying neem seed kernel extracts 5 %, neem oil 2%, Fenvalerate 20 EC 153 ml or Cypermethrin 25 EC 98 ml per hectare.

Blue Butterflies: Blue butterflies pest is widely distributed in these islands and infests mungbean and urdbean. Small blue butterflies have wings which are bluish on the upper side while the underside is pale brown with narrow whitish bands. Hand wings have one or two black spots and hair like projection. Bluish sculputured eggs are laid singly usually on young buds. Larvae are given, oval, flat and onciform and pupate in soil or plant debris. Larvae chew leaves but preferably feed on buds, flowers and pods.

Control: Spray of Crude neem extract 5% @ 50 g/ltr or Neem oil 3000PPM @ 20 ml/ltr water can successfully control the blue butterflies infestation as neem oil work as anti-feedant repellent. In case of serious infestation, Spray of Carbaryl 50WP @ 4.0 g/ltr effectively manage the population.

Harvesting

To avoid loss because of the shattering habit the pods of these crops pods, the crop is harvested before it is over mature. Harvest conditions and management often determine the success or failure of the crop. It should be harvested either early in morning or late during the evening time. Harvesting should take place when pods become 85% mature and dry and pods become black or brown. One or two rounds of the picking of pods are also recommended to avoid losses because of the shattering. The plants are uprooted or cut with a sickle, are dried on the threshing-floor for a week or ten days and threshed by beating with sticks, and are winnowed with baskets. In contrary to the farmers' practice of uprooting the whole plant for threshing, it is advisable to pick the pods individually in the field itself so that sufficient residual organic matter is recycled in to the soil.

Yield

It is possible to harvest 10-12 quintal of grain of urdbean under the best management conditions in these islands. The well sun dried seeds of mungbean and urdbean should be store in a tight sealed bin by mixing of dried neem leaf to avoid storage insect pest.

Important Hints

- Select the recommended varieties suitable for these islands agro-ecosystem.
- Treat the seed with Captan or Thiram against seed-borne diseases.
- Sow Rabi urdbean from 15 November to 15 January on a proper residual soil moisture required for the crop.
- Apply fertilizers on the basis of soil test.
- Use 18 -20 kg/ha seed rate in Rabi and 25 kg/ha for bold seed size.
- Control weeds at proper time, first weeding at 15-20 days after swing.
- Terminate last irrigation about 50 days after sowing in dry season for achieving synchronous maturity.
- Apply recommended insecticides with prescribed doses at proper time.

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