IJAIR

International Journal of Agriculture Innovations and Research
Volume 5, Issue 2, ISSN (Online) 2319-1473
Manuscript Processing Details (dd/mm/yyyy) :
Received : 07/09/2016 | Accepted on : 13/09/2016 | Published : 10/10/2016

General Characteristics and Genetic Improvement Status of Mung bean (Vigna radiata L.) in Ethiopia : Review Article

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***Abstract* – Mung bean is an important food legume with rich source of proteins, vitamins, and minerals where protein and micronutrient paucity are most omnipresent. It play key role in various cropping systems and sustainable agriculture production due to nitrogen fixing ability and low water requirement. However, its agricultural productivity is drastically limiting in Ethiopia due to low genetic diversity and even if there are some genotypes, they are not improved genotypes. This factor making the mung bean unknown to all farmers of the country and its production is being limiting. However some researches have been done they are describes morphological diversity of the crop which might not exactly isolate superior genotypes for the farmers. This review article aimed on general characteristics, farming systems, genetic improvement of mung bean and improvement required. Based up on this objective basically this paper recommends if mung bean genotypes would get genetic improvement by molecular markers for the development of disease resistant variety, high yielding variety and environment adapting variety so that farmers can satisfy from the production.**

***Keywords* – Mung Bean, Genetic Improvement, Characteristics, Vigna Radiata.**

I. Introduction

Agriculture is under increasing pressure to produce greater quantities of food and feed on limited land resources for the projected nine billion people on the planet by 2050[20] From the types of agricultural crops, legumes have been produced in East Africa for many years. The crops referred to as grain legumes or pulses i.e., beans, cowpeas, pigeon peas, mung beans, chickpeas and lentils. These crops are grown in the Eastern Africa region in varying hectareage, depending on preferences and adaptation to agro-ecological zones. From these, Cowpeas, chick peas, pigeon peas and mung beans are grown in lower, drier and warmer areas. Specifically, this review aimed to focus on general characteristics, farming systems, genetic improvement of mung bean and improvement required based up on the findings of different scholar. As a result it is possible to fill the gap facing to mung bean by doing research after this review has been show the specific gap regarding to the previous authors.

1.1. General About Mung Bean

1.1.1. Description

Mung bean is described as the binomial name *Vigna radiata* (L.) Wilczek [24] which belongs to the angiosperm dicot crops with family Fabaceae. Mung bean is an annual, 0.3 to 1.5 m tall, erect or sub erect plant, sometimes slightly twining at the tips. It is deep rooted, much branched with long petioles. The leaves are alternate, trifoliate, and dark or light green, the leaflets ovate and vary from 5 to 12cm wide and 2 to 10cm long. The inflorescence is an axillary raceme with a peduncle 2 to 13 cm long. The flower is yellow and the keel petal is spirally coiled with a horn-like appendage [41] Pods are 6 to 10cm long, slender, short and hairy. Seedsare globose, weight 15 to 85 mg, mostly green but sometimes yellow, tawny brown, black or mottled and germination is epigeal [6] It is very early maturing crop, Special features include high yield; good nutritive value, the earliness and drought resistant features, the reasonable cost of production and the ability to stimulate striga without being parasitized [28]

1.1.2. Distribution

Mung bean (*Vigna radiata* L.) widely grown in south and south-east Asia. Over 80% of the mung bean is produced in South Asia. The short duration it needs to grow and its wide adaptability together with the easier way of its digestibility makes mung bean cultivation to spread all over the world [52] At present mung bean cultivation spreads widely because of its superior digestibility in Africa, South America, Australia and in many Asian countries, and has been identified as high yielding pulse crop [52] The widespread allocation of mung bean in the tropics and subtropics of Africa, North America and Australia is relatively recent. Presently, it is the most important grain legume in Thailand and the Philippines; it ranks second in Sri Lanka and third in India, Burma, Bangladesh and Indonesia. In India, mung bean is cultivated either as summer or spring season or rainy season. It is also grown in winter in South India [41]It is a minor crop in Australia, China, Iran, Kenya, Korea, Malaysia, the Middle East, Peru, Taiwan and United States. Apparently, it has been introduced in different regions of Ethiopia like Shewa, Hararge, Ilubabor, Gamogofa, Tigray and Gondar [24] In southern Ethiopia, Farmers in some moisture stress areas (Gofa, Konso, south Omo zone and Konta) have been producing mung bean to supplement their protein needs and also effectively use scanty rainfall [4]

1.1.3. Genetic Diversity

Worldwide, a total of 43,027 mung bean accessions are available at core collections or Gene Bank at different stations. To date, over 110 mung bean cultivars have been released by world vegetable center (AVRDC) in South and Southeast Asia and around the world [1]A large collection of mung bean germplasm encompassing 415 cultivated (*Vigna radiata* var. *radiata*), 189 wild (*Vigna radiata* var.

sublobata) and 11 intermediate accessions from diverse geographic regions have been characterized using 19 azuki bean SSRs[40]Mung bean has highest diversity in South Asia, supporting the view of its domestication in the Indian subcontinent and showing that Australia and Papua New Guinea is a center of diversity for wild mungbean. A core collection of 106 accessions representing most genetically diverse of these germplasm has been made[45]

The ability of mung bean short growth duration allows adaptation too many cropping systems and rotations, hence, diversifying cropping systems [43] Morphological characterization is as an important step in description and classification of crop germplasm because a breeding program mainly depends upon the magnitude of genetic variability. Germplasm is useful not only in selection of core collection but also its utilization in breeding program. Various numerical taxonomic techniques have been successfully used to classify and measure the pattern of genetic diversity in germplasm, as in mung bean. The multivariate analysis and cluster analyses have been utilized for the evaluation of germplasm when studying various traits [12] Variance of relatively highly heritable quantitative traits provides an estimate of genetic diversity [36] Investigating the extent of genetic diversity available is important to maintain, evaluate and utilize germplasm effectively [33] And also, exploitation of the gene pool is of paramount important in the development of high yielding cultivars and resistant to various stresses [33] Genetic diversity/variability could be the local variety and improved variety. One of the varieties nylon is common in Ethiopia, Kenya and Tanzania. Mung bean is an economically important short duration legume crop in Ethiopia, but there is lack of information on extent of genetic diversity [13]The previous study done by [13] shows as there were thirteen accessions of mung bean i.e., MB6148-05-12, Mong whole, Black bean, Asha, MH-85-11, MBBR-1, MB6173B-33, Showa Robit, MH-97-6, Egypt, Gofa local, Kenya and NV26 where collection was from Melkasa Agricultural Research Center.

1.2. Importance

1.2.1. Food and Fodder

Although mung bean can be for food and fodder, its consumption is varying from place to places. It is produced for both human consumption and as fodder [26] The crops are utilized in several ways, where seeds, sprouts and young pods are consumed as sources of protein, amino acids, vitamins and minerals, and plant parts are used as fodder and green manure[35]Mostly it has a potential to make up the gap of protein shortage since its seeds are rich in protein and amino acids, thus serve as a protein source for human consumption. It has been reported by different scholars as mung bean contains nutrition value. Mung bean can provide significant amounts of protein (240 g/kg), carbohydrate (630 g/kg) and a range of micronutrients in diets [2] Mung bean protein and carbohydrates are easily digested and create less flatulence than those derived from other legumes [17] Parts of mung bean like pods and sprouts are eaten as vegetables and are a source of vitamins and minerals [25] However, its seeds contain24.3% protein and 0.67% fats [30]It is reach in essential amino acids particularly lysine and its magnitude is 504 mg/g [38]which makes it a good additional for most cereal based diets which lack this essential amino acid [8]

Additionally, due to its palatable taste and nutritional quality, mung bean has been used as an iron-rich whole food source for baby food [14]Mung bean seeds and soup are also a rich source of alkaloids, coumarin and phytosterin that play an important role in promoting the physiological metabolism of human beings and animals[41] Mung bean seeds are free from anti-nutritional factors such as trypsin inhibitor, phytohemagglutins and tannin [10]

1.2. Production

Mung bean (*Vigna radiata* L.) is an important legume crop and considered the most economically important Vigna crop. Its Annual world production is estimated at 3 million metric tons harvested from about 5.5 million hectares [53], of which 90% is in South Asia, especially in Bangladesh, Burma, India, Indonesia, Pakistan, Philippines, Sri Lanka and Thailand [42] However, [53] reported that the world annual production area of mung bean is about 5.5 million hectare with a rate increase of 2.5% per annum [50]

Mung bean cultivation is gaining popularity day by day among the farmers and Ethiopia's mung bean export has grown slightly to 1363 tons in 2002 from 822 tons in 2001[31] Though its production in Ethiopia is very negligible when it is compared to other pulse crops, small holder farmers in drier marginal environments grow mung bean and it has been an important grain legume for resource poor farmers in these areas.

II. Farming Characteristic

1.2. Cropping Systems

The most important characteristic of mung bean crop is its short life cycle and ability of biological nitrogen fixation in root nodules by a symbiotic relationship with a specific bacterium that fulfill the crop needs for nitrogen [27;29] Due to this it is a useful crop in drier areas and has a good potential for crop rotation and relay cropping with cereals using residual moisture in the soil. July to August is the main growing season and harvesting is done in October. So that it is grown mostly in rotation with cereals.

It was observed that mung bean is mainly grown as a mixed, inter and relay crop [32] and therefore, is widely grown to improve nitrogen status of soil or to break the disease pest cycles. Mung bean intercropped in cereals, sugarcane, sunflower or jute. The yield of rice following a mung bean intercrop can increase by up to 8% through the nitrogen fixed by mung bean in the soil and due to reduced pest and disease pressure. Its seed yield decreases when it is intercropped, but the total productivity of the system and land use efficiency markedly increases by intercropping. The intercropping of maize with mung bean increased the total system productivity. It was proved to be more productive and efficient system in utilizing land compared to sole cropping [39]

1.3. Fertilizer Requirement

Mung bean can be grown as manure, hay, cover crop and forage. So that it has the ability to restore soil fertility through symbiotic nitrogen fixation [28] Meanwhile, its remarkable quality of fixing atmospheric nitrogen enriches soils [45] and its low soil water and fertility requirements increases cropping systems productivity and resilience [24]On an average, it fixes atmospheric nitrogen about 300 kg/ha annually [44]

1.4. Environmental Adaptability

Mung bean is important grain legume in semi-arid ecologies. Generally mung bean is mostly grown under dry land farming systems where erratic rains often expose the crop to moisture stress[5] Environmental variance had its own contribution on the performance of the traits in addition to genotypic variance [13] Breeders usually under take a series of genotypes evaluation across locations and over years before a new genotype is released to be produced by growers. It may complicate the process of selection and recommendation of superior genotypes to target environments [16]because genotype versus environmental interaction is a common phenomenon [54; 9] Breeding programs deliver germ plasm that fit their wide range of environmental conditions[3]

2.3.1. Salinity

Salinity stress is a serious problem in arid and semi-arid tropics plains in irrigated areas. It is recognized as major constraint in the production of this crop where 50 mMNaCl can cause yield losses greater than or equal 70% [21] Availability of adequate soil moisture for crop growth depends on rainfall, water holding capacity and depth of soil in rain fed areas. Earlier reports showed gradual reduction in seed germination, plant height, shoot and root length, dry matter, biomass, root, stem and leaf weights with progressive increase in salinity stress in mung bean plants [34]The report of [41] also says that reduced yield in mung bean under salt stress may be due to reduced efficiency per day of plant to fill the developing seeds, which may lead to reduced number of seeds per pod or plant and dry matter yield of individual seed. [37]also reported that NaCl stress caused a drastic effect on the roots as compared to shoots, accompanying reductions in length, number of root hairs and branches, while the roots became stout, brittle and brown in color.

2.3.2. Temperature Requirement

Mung bean (*Vigna radiata* L.) is a warm season annual grain legume and the optimum temperature range for good production is 27-30°C [22]The optimum temperature range for growth is between 27°C and 30°C means that the crop is usually grown during summer. Seed can be planted when the minimum temperature is above 15°C[15]

2.3.3. Rain Fall Requirement

Mung bean is a warm season crop requiring 90–120 days of frost-free conditions from planting to maturity (depending on the variety).Adequate rainfall is required from flowering to late pod fill for purposes of ensuring good yield. Late plantings which result in flowering during the high temperature to low moisture periods will reduce yield. High humidity and excess rainfall late in the season can result in disease problems and harvesting losses due to delayed maturity [15] Mung bean is usually grown at low to medium elevations in the tropics as a rain fed crop. It ranks second to drought resistance after soybean [19]

3.3.4. Soil Requirements

Mung beans do best on fertile, sandy loam soils with good internal drainage and a pH in the range of 6.3 and 7.2. Mung beans require slightly acid soil for best growth. If they are grown in rotation, lime to attain pH of the most acid sensitive crop. Root growth can be restricted on heavy clays. Mung beans do not tolerate saline soils and can show severe iron chlorosis symptoms and certain micronutrient deficiencies on more alkaline soils[15]

III. Genetic Improvement

Mung bean is diploid in nature with 2n=2x=22 and have small genome sizes estimated to be 0.60 pg/1C (579 Mbp) which is similar to those of the other Vigna species [35] Genetic improvement for mung bean is the strategy used to develop superior lines which are early and uniformly maturing, disease resistant, tolerant to environment, pest and insect resistant and high yielding.

Molecular markers offer particular potential in enabling breeders to target desirable physiological traits, especially those that are time consuming to measure and or are subject to large genotype versus environment interaction. Molecular markers provide a potentially useful tool for improving the rates of gain from plant breeding, and are likely to have a major impact on the genetic improvement of a wide range of species [47]The molecular markers allow rapid identification of plant genotypes (hybrids, clones, somaclonal variants, and cultivars) with high efficiency and low labor cost [55] The use of molecular markers for resistance genes is particularly powerful as it removes the delays in breeding program associated with the phenotypic analysis [56] Breeding techniques like wide hybridization, mutation and other novel techniques can also help in creating genetic variation for particular traits [20]

There is huge demand for mung bean in the international market particularly in south-east Asia. The mung bean germplasm is available as wild, cultivated and weedy populations, but very little is known about population structure, diversity, gene flow, and introgression in Ethiopia [41]Even in mung bean producing areas, its farming is based on local cultivars that are low yielder, late maturing and susceptible to disease. These varieties are challenged by current climate change. However, the improved varieties are no yet exposed to farmers in moisture stress areas particularly in south Omo, Ethiopia [51] Possible strategies are important in the improvement of mung bean in order to achieve genotypes for salt tolerance [41], disease resistant and high yielding.

3.1. Resistant

Resistivity is a potential by which plants can with stand to types of diseases and produce high yield. This resistivity is due to the expression of responsible to protein which protect disease from the plant. Genes for 8 traits encompassing 1 insect pest, 2 diseases and 5 seed related characters were mapped with molecular markers in mung bean [35]

3.1.1. Virus Resistance

Developing mung bean genotypes with improved determinate growth habit and synchronous maturity is essential. Moreover, majority of these cultivars are susceptible to mung bean yellow mosaic virus (MYMV) disease which is a major cause of failure in mung bean cultivation in many growing countries. The disease is characterized by yellow mosaicon leaves of infected plants that results in considerable yield losses. [46;30] reported that yield loss due to yellow mosaic virus disease in mung bean was about 76 to 100% where whitefly (*Bemisia tabaci*) is a responsible vector transmitting mung bean yellow mosaic virus.

A marker generated from Randomly Amplified Polymorphic DNA (RAPD) primer OPAJ20 was found to bed instantly linked with the resistance gene. Inter simple sequence repeat (ISSR) and SCAR markers linked to the resistance in blackgram [7;49] has exerted a potential for locating the gene in mung bean. [25]suggested that mung bean probe Mng247 associated with soybean mosaic virus resistance[23] might be useful in identifying mung bean yellow mosaic virus resistance gene.

3.1.2. Fungus Resistance

Powdery mildew is a fungus occurs widely in pea, mung bean and urdbean and it seriously affects the photosynthetic activity of the plants. In mung bean two independent dominant genes, 'Pm1'and 'Pm2' have been identified for conferring resistance to powdery mildew. The genetic studies on powdery mildew helped in developing stable resistant cultivars in mung bean [11]

3.1.3. Insect Resistance

An effective and environment friendly management option against insect pest in different legume crops could be achieved by improving the genetic resistance of the host plant [48] Nevertheless, most of the breeding programs pursued previously focus more on improving seed yield and quality than improving resistance against storage insect pests. This is despite the importance of the latter beyond the direct losses to the farmer along the product value chain to the consumer, both rural and urban[18]

The genetic control of resistance to insect pests may range from monogenic and oligogenic for insects like *C. chinensis* and *C. maculatus*in mung bean [48] Incorporation of different resistance genes into the same cultivar (*i.e.*, gene pyramiding) to control the different biotypes is possible as has been demonstrated with the breeding of mung bean for multiple resistances to different biotypes of bruchids [10]

Conclusion

Generally it has been reported that as mung bean is one important legume crop that has a vital role in economic value, nutrition value and as it adds nitrogen fertilizer to soil through bacterial symbiosis. It also has large genetic diversity whether it is wild or cultivated which its production is high in different countries like Asia. Regarding to Ethiopian country, although mung bean is not indigenous to Ethiopia, its cultivation exists at some low land regions. However, mung bean genotypes farmers using to farm in Ethiopia is very few and still there were no improved cultivar which can tolerate to different geographical location, resistant to diseases and insects, produce high yield and nutrition quality. There were many studies which deal with genetic variation and yield and yield related traits of mung bean which based up on morphological determination between mung bean genotypes. But most importantly, genetic improvement of the exiting genotype sat molecular DNA level using biotechnological approaches can easily identifies superior genotype which can adapt to different geographical location, resistant to diseases and insects, produce high yield. Based up on the existing gap the writer of this review article tried to recommend as the following.

Recommendation

It is expected if researchers and different from concerning bodies would improve mung bean genotypes found in Ethiopia since the crop has multidimensional importance for the farmers**.**

Acknowledgment

I would like to thank all friends and editors who helped me in writing to publishing of this review**.**

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International Journal of Agriculture Innovations and Research
Volume 5, Issue 2, ISSN (Online) 2319-1473

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