The Journal of Agricultural Sciences - Sri Lanka
Vol. 17, No 3, September 2022. Pp 388-415
http://doi.org/10.4038/jas.v17i3.9920

A Review on the Management of Country Bean (*Lablab purpureus* L.) Diseases in Bangladesh

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Received:06th July 2021 / Accepted: 20th June 2022

ABSTRACT

Purpose: *Country bean (Lablab purpureus L.) is an important pulse crop consumed as a vegetable in the central and south-western regions of Bangladesh after eggplant and tomato. It promises to ameliorate nutritional demand from vegetables and has an excellent possibility for the world market. But the production is hampered due to infection of several diseases in field conditions.*

Research Method: *This study was undertaken based on secondary data of existing literature from Bangladesh and other parts of the world. So far, many research works were done on this issue but those were not available to the policymakers, extension workers, and public in a systematic manner to date.*

Findings: *In this paper, we tried to bring forth different aspects of phytopathological problems of country bean. It usually undergoes stresses from different soilborne to seed-borne pathogens and expresses symptoms from the seedling stage to maturity. Crop protection largely depends on the integration of host plants, seeds, agronomic practices, environmental footprints, and the use of appropriate agrochemicals based on the epidemiology of target pathogens. Here, we have also described effective management strategies against respective pathogens of the diverse category. These microorganisms attack at different stages of crop growth and can affect the host plants enormously to cause maximum yield loss.*

Research Limitations: *The study focused on the management of country bean diseases based on biological and chemical approaches. It presents limited information on specific technologies in different agro-ecological zones.*

Originality/ Value: *This study identified research gaps among Bangladesh and other countries. It also provides information to combat country bean diseases to the economic threshold level for ensuring sustainable crop yield.*

Keywords: *country bean, lab lab bean disease management, plant pathogen, cultural control, chemical control*

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INTRODUCTION

Country bean (*Lablab purpureus* L.), locally known as "*Sheem*", is one of the most important, popular, nutritious and protein-rich vegetable-cum-pulse crops in Bangladesh. It belongs to the family Leguminosae and sub-family Papilionaceae (Jayasinghe *et al.,* 2015). It is widely grown in the world and consumed in many countries of the world including Bangladesh. It is mostly self-fertilizing and the number of bearing chromosomes is 2n=22. The crop is recognized worldwide by numerous names such as Field bean, Tonga bean, Hyacinth bean, Kikuyu bean, Lablab bean, Country bean, Indian bean, and Dolichos bean. It is described to be initiated in India (Sibiko *et al.* 2013) and formerly spread to other parts of the world. It is mostly cultivated in the winter season as a Rabi crop but is now cultivated in the whole year in Bangladesh. It is significantly grown after tomato and brinjal in Bangladesh. Usually, it is recognized as an income breeding crop of Bangladesh. It is extensively grown in Cumilla, Noakhali, Sylhet, Dhaka, Kishoregonj, Tangail, Jasohore, Pabna, Dinajpur, and Cartogram intensively but for the last ten years, it has been extended to Khulna, Barisal, Mymensingh, and other parts of the regions in our country (Singh and Gupta, 2019). This crop fixes atmospheric nitrogen which improves the soil fertility status (Karla, 2009). The bean is a good source of proteins, carbohydrates, essential elements, and vitamins. The green seeds and garden-fresh pods are utilized as a vegetable to prepare curries, ripe seeds are also used as pulse crops, frequently as soup "*dhal*" (Sultana, 2001) and matured seeds are sometimes dried and kept for the future. It is a good source of nutrition like protein, starch, phytochemicals, dietary fiber, minerals, vitamins, and other essential components (Saikia *et al.,* 1999). The 100 g of edible parts of the bean contains 110 mg calcium, 4.7 mg iron, 35 mg vitamin C, 2.4 mg vitamin A and 4.2 g protein (Anonymous, 2013). The protein percentage of country bean is 4.5% in the green pod and 25% in dry seed and has a great demand for both young pods and mature seeds irrespective of rich and poor. Moreover, it contains thiamin, niacin, riboflavin, iron, and vitamin C (0.1, 0.7, 1.7, 0.06, and 9.0 mg/100 gm) (Rehana, 2006). The green pods and green seeds provide delicious protein-rich vegetables (Wortman *et al.* 2004) and antifungal protein (Ye *et al.* 2000), a good source of zinc and iron (Buruchara *et al.* 2011), and have a low glycemic index (Widers, 2006).

Farmers grow various morphotypes of the bean in our country (Islam *et al.,* 2002). About 50 bean species are spread all over the world, especially in subtropical and tropical zones of America, Africa, Australia, and Asia (Khalil, 2000). These species are morphologically different from each other (Rahman *et al.,* 1985). The heritable and non-heritable characteristics are varied from plant to plant (Islam *et al.,* 2011). The number of leaves, plant height, pods number, plant brunches, and bean yield are varied from one crop to another. The polygenic nature of bean crops makes them be affected by the surrounding environment. The number of country bean flowers and pods varies from plant to plant (Khan *et al.,* 2019).

However, its production is hampered due to the attack of a large number of diseases that cause severe damage to the country bean. The average yield loss in the bean varied from 20 to 100% due to the above diseases (Singh and Schwartz 2015). The diseases that attack the bean are classified into 3 groups viz. major, intermediate and minor based on their importance. The diseases are Anthracnose (*Colletotrichum lindemuthianum*), Angular leaf spot (*Phaeoisariopsis griseola)*, Ascochyta blight (*Phoma exigua* and /*Ascochyta phaseolorum*), Asian bean rust/rust bean (*Uromyces ciceria,U. phaseoli*), Cercospora leaf spot of bean *(Cercospora cruenta*), Charcoal rot (*Macrophomina phaseolina*), bacterial blight (*Xanthomonas campestris* pv. Phaseoli), mosaic virus (BCMV) vector-aphid, Foot and root rot bean (*Fusarium oxysporum, Rhizoctonia solani, Sclerotium rolfsii),* Fungal alpha-amylases, Fusarium wilt or vascular wilt (*Fusarium oxysporum* f.sp.), Halo blight (*Pseudomonas syringae*pv. *Syringae* and pv. *phaseolicola*), Leaf blight (*Leptosphaerulina trifoli),* Leaf rot (*Sclerotinia sclerotiorum),* Powdery leaf spot (*Mycovellosiella phaseoli*), Powdery mildew (*Oidium sp., Erysiphe polygony),* Root rots a complex of root and stem rots (*Pythium* spp., *Rhizoctonia solani*, and *Fusarium solani*), Scab (*Sphaceloma* state of *Elsinoe phaseoli*), Web blight (*Thanatephorus cucumeris* or *Rhizoctonia solani*), White mould (*Sclerotinia sclerotiorum*), Wilt of bean (*Fusarium oxysporum, Pythium sp., Sclerotium sp., Rhizoctonia sp*.), Yellow mosaic (BYMV) vector-aphid, and so on. These diseases must be handled appropriately to prevent crop loss and increase production. The prerequisites for proper management of the disease are information regarding these diseases and their causative agent and the conducive environment in which these disease-causing organisms thrive. To manage these diseases, farmers mostly prefer chemical pesticides at inappropriate doses without considering any other management options such as physical, biological, and botanicals. This may be because they lack information regarding such management tools.

Researchers previously designed several experiments to study different bean diseases and their management through combing several integrated approaches. Mostly these studies are conducted on single disease of bean and there is a need to accumulate all the information available on bean diseases and their management to get a complete scenario about what is going on and what are the avenues to work on. Considering the above facts, the current study was designed to review the information on the effect of diseases on the country's bean production and we have also described possible management strategies to overcome production losses due to different diseases. As human food, as Animal feed, improve economy, provide nutritional requirement for human, improve digestion system, Fuel material, improve soil fertility status are some diversified uses of country bean plant, fruits and products.

METHODOLOGY

To evaluate the current state of the research on the importance of country bean (*Lablab purpureus* L.), a review of existing journal literature, books, report, blogs, and newspapers were carried out. Keywords (Country bean, Disease management, Plant pathogen, Cultural control, Chemical control) search in the google, google scholar, web of science (www.thomsonreuters.com/web-of-science) database and search of full-text Science Direct database (www.sciencedirect.com) were carried out. Information were also collected from government organizations and NGOs via personal communication. The reviews or literature reviews will be studied to categorize further studies for inclusion, and results of meta-analyses will not be included in the analysis.

Chemical composition:

The legume plant growth and development are directly dependent on nutrient sources (Tool *et al.,* 2021), which include high nutritional value proteins, carbohydrates, volatile vitamins such as niacin, folic acid, and dietary fiber, vitamin C, and micro and macronutrients. Bean's seed was primarily high in carbohydrates (42-68%) and proteins (24-41%), especially albumins (7%), glutelins (7%) and globulins (79%)], lipids (2.30-3.91%), vitamins (0.02-0.03%), minerals (1-4%), water (7-11%) and also contain the saturated and unsaturated fatty acid. Ca, K, P, Na, Mg, Al, S, Ba, B, Cr, Co, Fe, Cu, Li, Ga, Ni, Mn, Sr,Zn, and Pb were among the consequential minerals listed in Table 2.Adama and Jimoh, 2012 also stated that the bean contained the chemical composition and the chemical compositions were Na_2O, K_2O, MgO, Pb_2O_5, Fe_2O_3, Al_2O_3, CaO, SiO_2, and losses on ignition (1.21, 5.62, 2.01, 5.82, 11.51, 13.05, 15.71, 39.01 and 6.00)%; respectively. Vioque *et al.,* 2012 noted that the bean is abundant in hexane extraction as polyphenols. Pastor *et al.,* 2011 also observed that the bean seed is abundant in polyphenols.

The Environment and Diseases

The disease triangle is a phenomenon used to term the interface between three components of disease viz. host, pathogen, and environment (Scholthof, 2007; Figure 01). The triangle shows the amount of disease development where each arm of the triangle represents each of the three components. Disease development and severity depend on these elements. For the successful development of a disease, the host must be virulent, a susceptible pathogen must be present and the prevailing environment must be favorable. The environment is such a component that affects the rest two components.

Table 01: Keyword search

No.	Keyword Search	Articles Number
1	Country bean or *Lablab purpureus* L.	350
2	Disease management	300
3	Plant pathogen	120
4	Agronomic disease control	114
5	Chemical control	150
6	Limit of article	201
7	Manually screened	115
8	Articles included in the review	200

Table 02: Chemical constituents of country bean

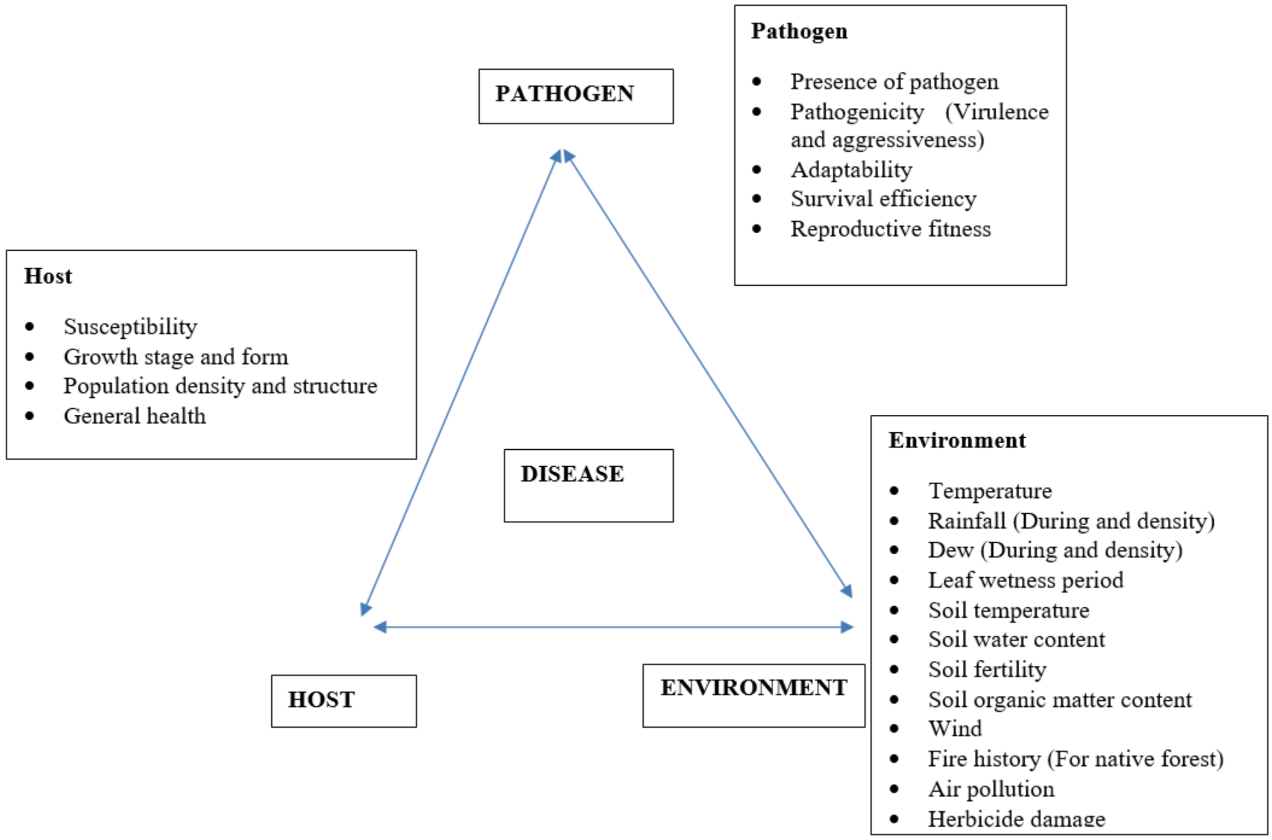
Chemical constituents	Type and amount (%)	References
Carbohydrate	42-68	Hossain and Mortuza 2006; Alghamdi, 2009.
Proteins	24-41 [globulins (79%), albumins (7%), glutelins (7%)]	Hossain and Mortuza 2006; Alghamdi 2009; Crépon *et al.,* 2010; Sahile *et al.,* 2011.
Lipids	2.30-3.91	Hossain and Mortuza 2006; Alghamdi 2009.
Saturated fatty acid	Palmitic acid, Stearic acid	Prabhu and Rajeswari, 2018
Unsaturated fatty acid	Myristic, pentadecanoic, arachidic, behenic acid, oleic acid, linoleic acid, and linolenic	Prabhu and Rajeswari, 2018
Vitamins	0.02-0.03 [Folic acid, Niacin, Vit-C]	Larralde and Martinez 1991
Minerals	1-4 [Ca, P, K, Mg, Ng, S, Al, B, Ba, Co, Cr, Cu, Fe, Ga, Li, Mn, Ni, Pb, Sr, and Zn]	Hossain and Mortuza 2006.
Water	7-11	Hossain and Mortuza 2006; Alghamdi 2009.

The virulence of a pathogen (presence of the pathogen, ability to cause disease, conformation, survival adeptness, fecundity) and susceptibility of a host (susceptibility, population density, stage of growth and form, and general health and structure) depend on temperature, relative humidity, rainfall, light intensity dew, soil temperature, period of leaf wetness, soil organic matter, soil fertility, fire history, herbicide damage and wind (Roberts and Paul, 2006). Disease development, incidence, and severity mostly depend on temperature (Khan *et al.,* 2020). Bean anthracnose (*C. lindemuthianum*) occurs mostly in cool weather. It develops at temperature 18-27º C but the maximum intensity was found at 21ºC (Sindhan, 1983), 17 ºC (Mohammed, 2013). Charcoal rot of country bean is favored by high temperature (Smith and Wyllie, 1999). Low temperature favors some other diseases of country bean such as root rot caused by *Fusarium, Pythium, Sclerotium* and *Macrophomina* (Paparu *et al.,* 2018). They usually develop below 25 ºC. The relative humidity is another important influencing factor of disease development. Ascocyta blight of bean occurs mostly in cool and moist weather (Gossen,2011). Most of the pathogens like high humidity as they can grow well above 80% relative humidity. Spore germination of *C. lindemuthianum* occurs at a relative humidity above 92% (Goodwin, 2003). *Rhizoctonia solani* causes root rot of beans if soil moisture goes above 80% and the same pathogen causes web blight when relative humidity goes above 85% (Upmanyu and Gupta 2005). According to Clarkson *et al.,* (2014) *Sclerotinia sclerotiorum* causes disease, 80–100% faster compared to 50-70%. At 75 percent relative humidity*, Xanthomonas axonopodis pv. phaseoli* on common bean had the highest disease incidence, whereas, at 50 percent relative humidity, it had the lowest (Hailu *et al.,* 2017). Precipitation is an important weather parameter that has an indirect effect on temperature and moisture and a direct effect on disease development and spread. Leaf wetness caused due to precipitation; directly affects disease development. Spores of some pathogens may wash away through rainwater and infect many other host plants (Buruchara *et al.,* 2010). During 2004-2005 an epidemic of charcoal rot was developed in Northern Ethiopia due to high precipitation rate, high relative humidity (85%), and higher leaf wetness (18–24 h) (Sahile, 2008). Apothecia formation of *Sclerotinia sclerotiorum* is favored by high rainfall (Nahar *et al.,* 2020). Some plant pathologists elaborate disease triangles by adding one or more parameters such as human and time (Agrios, 2005). However, the optimum for disease enlargement may be altered in altered masses.

Diseases of Bean

In India: Bean is an important and cost-effective protein source for the poor people of the world from ancient times. Various soil-borne, seed-borne and foliar diseases are important constraints in profitable common bean cultivation in India (Joshi *et al.,* 2009). *Colletotrichum lindemuthianum* fungus is accountable for the most important foliar disease named Anthracnose of Dolichos bean in India (Papitha *et al.,* 2020). Sharma *et al.* 2008 documented that 75% bean yield loss was due to anthracnose in North-Western Himalayas. Manjunath *et al.,* (2012) in their 2-year roving survey reported that anthracnose can cause foliar infection up to 55% at Karnataka in India. Leaf blight is another important fungal foliar disease of hyacinth bean (*Lablab purpureus*) caused by *Choanephora cucurbitarum* that was first observed in September 2014 in West Bengal, India, and disease incidence of this disease is 5-20% (Das *et al.,* 2017). It is reported that Bean rust caused by *Uromyces appendiculatus* causes yield loss of almost 65% per year (Mersha and Hau 2011). Another major concern on common bean production in India is White mold triggered by *Sclerotinia sclerotiorum* (Chauhan *et al.,* 2020; Heffer and Johnson 2007; Prajapati and Narain, 2008).Web blight is caused by *Rhizoctonia solani* that was reported to cause yield loss of Urdbean about 20–30% (Kumar *et al.,* 2018). *Rhizoctonia solani* can also cause root rot of cluster bean (Shivran *et al.,* 2020). In Mysore District of Karnataka State, India, Bean common mosaic virus Infecting *Lablab purpureus* has been seen for the first time (Udayashankar *et al.,* 2011). Dolichos yellow bean mosaic virus spread by a vector named whitefly *Bemisia tabaci*. has been documented to cause severe yield loss in India (Singh *et al.,* 2012). It causes green and yellow patches on leaves, in later stages leaves may appear perverted, deformed, and curled, as a result, plants show stunted growth.

In Africa: Due to different abiotic and biotic stresses, rate of agriculture production has not kept pace with the annual population growth rate in some countries in the last few years (Forthcoming and Xavery *et al.,* 2006). Among the biotic stresses, diseases are the most important concern across Eastern and Southern Africa. Average yield loss due to diseases ranges from 20% to 100% (Singh and Schwartz 2015). Degu *et al.,* (2020) identified 11 diseases of haricot bean in Ethiopia. They classified them into 3 groups as major, intermediate, and minor based on their importance. Anthracnose (*Colletotrichum lindemuthianum*), floury leaf spot (*Mycovellosiella phaseoli*), Cercospora leaf spot (*Cercospora cruenta*), and Angular leaf spot (*Pseudocercospora griseola*) were categorized as major, and rust (*Uromyces appendiculatus*), ascochyta blight (*Phomaexigua var. exigua/ Ascochyta phaseolorum acc*), web blight (*Rhizoctonia solani* teleomorph *Thanatephorus cucumeris*) bean common mosaic virus (BCMV) (potyvirus) as intermediate, and halo blight (*Pseudomonas syringae pv. phaseolicola)*, common bacterial blight (CBB) (*Xanthomonas* *axonopodis pv phaseoli*), downy mildew (*Phytophthora phaseoli)* were categorized as minor diseases. The anthracnose and angular leaf spot are the major obstacles in bean production in Africa (Wortmann and Allen 1994). Dovala-Chicapa *et al.,* 2016, reported CBB, anthracnose, ALS, root rot, ascochyta blight, rust, and BCMV as the most important bean diseases in Angola. Over the last 20 years, Pythium root rot has become an important disease of beans in different regions of Central Africa and Eastern (Otsyula *et al.,* 2003). About 70% of yield losses have been reported in local bean production in Kenya and Rwanda due to Pythium root rot (Nzungize *et al.,* 2012). Not only Pythium, there is a group of pathogens that contribute to root rot of common bean; they are *Fusarium spp., Sclerotium* spp., and *Macrophomina* spp (Eke *et al.,* 2020, Bedine *et al.,* 2020). Root rot of common bean causes yield loss of about 221000 metric tons in a year in Saharan Africa (Paparu *et al.,* 2018). Root rot was usually found in the upland areas of Uganda (Buruchara and Rusuku, 1992; Opio *et al.,* 2007) but Paparu *et al.,* 2018 reported that the pattern of root rot has changed due to changing environmental conditions, now a day, it attacks the crops in low and mid-altitude areas. Steadman *et al.,* (2002) mentioned rust (*Uromyces appendiculatus*) of the dry bean as one of the most serious diseases in Lesotho, Tanzania, Kenya, Zimbabwe, Madagascar, Mozambique and it causes 100% losses in South Africa. Scab disease was first observed on Leucospermum in 1981 in South Africa (Phillips, 1994; Swart *et al.,* 2001). Bacterial brown spot disease (BBS) caused by *Pseudomonas syringae pv. Syringae* causes 55% grain yield losses of dry beans in South Africa (Salegua *et al.,* 2020).



Kerr and Keane, 1997

Figure 01: Disease triangle

Table 03: Diseases of Country bean

SL no.	Name of the disease	Causal organism
1	Anthracnose	*Colletotrichum lindemuthianum*
2	Angular leaf spot	*Phaeoisariopsis griseola*
3	Ascochyta blight	*Phoma exigua Ascochyta phaseolorum*
4	Asian bean rust bean	*Uromyces ciceria, U. phaseoli*
5	Cercospora leaf spot of bean	*Cercospora cruenta*
6	Charcoal rot	*Macrophomina phaseolina*
7	Bacterial blight	*Xanthomonas campestris* pv. Phaseoli
8	Bean common mosaic	Bean common mosaic virus (BCMV) vector-aphid,
9	Foot and root rot bean	*Fusarium oxysporum, Rhizoctonia solani, Sclerotium rolfsii*
10	Fusarium wilt or vascular wilt	*Fusarium oxysporum* f.sp**.**
11	Halo blight	*Pseudomonas syringae*pv. *Syringae* and pv. *phaseolicola*
12	Leaf blight,	*Leptosphaerulina trifoli*
13	Leaf rot	*Sclerotinia sclerotiorum*
14	Powdery leaf spot	*Mycovellosiella phaseoli*
15	Powdery mildew	*Oidium sp., Erysiphe polygony*
16	Root rots a complex of root and stem rots Yellow mosaic (BYMV)	*Pythium* spp., *Rhizoctonia solani*, and *Fusarium solani*
17	Scab	*Sphaceloma* state of *Elsinoe phaseoli*
18	Web blight	*Thanatephorus cucumeris* or *Rhizoctonia solani*
19	White mould	*Sclerotinia sclerotiorum*
20	Wilt of bean	*Fusarium oxysporum,Pythium sp. ,Sclerotium sp., Rhizoctonia sp.*
21	Bean yellow mosaic	Bean yellow mosaic virus (BYMV)

In Bangladesh: Now a day, it is also cultivated round the year in Bangladesh. Many biotic and abiotic stresses greatly hamper its production. Many bacterial, fungal, and viral diseases affect its production. The principal fungal diseases of the country bean are Cercospora leaf spot (Khan *et al.,* 2020) and anthracnose (Khalequzzaman 2015) which affect both foliage and pod. Yield loss has been reported up to 90% in country bean due to anthracnose (Fernández *et al.,* 2000). Wilt of the bean, and foot and root rot bean caused by some soil-borne fungus (*Fusarium oxysporum, Sclerotium rolfsii, Rhizoctonia solani*) can cause seedling mortality (Siddique *et al.,* 2014, Khan *et al.,* 2020). Inflorescence rots and pod rot of country bean are caused by White mold disease (*Sclerotinia sclerotiorum)* (Rahman, *et al.,* 2020). Nahar *et al.,* 2020 reported up to 100% White mold infection at the surveyed field in the northwest region of Bangladesh. White mold (*Sclerotinia sclerotiorum)* of pea has recently emerged as a new threat to pea production in Bangladesh (Islam *et al.,* 2020). In Bangladesh, *Sclerotinia sclerotiorum* was also reported for the first time to cause stem and pod blight of common bean (Prova, *et al.,* 2014). Powdery mildew (*Oidium sp., Erysiphe polygony*) and Asian bean rust/ rust of bean (*Uromyces ciceria, U. phaseoli*) are also regarded as economically important diseases of country bean (Khan *et al.,* 2020). The serious bacterial disease of common beans is Bacterial blight or common blight (*Xanthomonas axonopodis* pv. *Phaseoli*) halo blight (*Pseudomonas syringae* pv. *Phaseolicola*), bacterial wilt (*Curtobacterium flaccumfaciens* pv. *flaccumfaciens)* and bacterial brown spot (*Pseudomonas syringae* pv. *Syringae*) (Bako. 2002). Among all the bacterial diseases, almost 40% yield loss was occurred by common blight which is the most important one (Coyne *et al.,* 2003, Karavina *et al.,* 2011). The common bean mosaic virus and yellow mosaic virus are reviewed as the most serious viral diseases of beans (Phabiola *et al.,* 2016). These are seed-borne and also transmit through vectors. These viruses are most prevalent in Bangladesh as the hot and humid climate favors its perpetuation in insect vectors (Akhter *et al.,* 2019). The bean productivity is affected by climate change drivers (Hadi *et al.,* 2020). Major diseases of the bean are Charcoal rot (*Macrophomina phaseolina*), angular leaf spot (*Pseudocercospora griseola*), ascochyta blight (*Didymella fabae*), leaf spot (*Leptosphaerulina trifolii*), web blight (*Rhizoctonia solani),* scab of beans *(Elsinoe phaseoli)*, and root-knot nematode (*Meloidogyne incognita*) (Table 3) which are also considered as major constraints in country bean production.

Major Diseases of Country Bean and their Management

1. Anthracnose

Colletotrichum lindemuthianum, a seed-borne fungus, causes bean anthracnose. It is regarded as the most serious disease of common bean production worldwide. It is a major problem in North, Central, and South American bean production, with up to 95% losses in Colombia, as well as Europe, Africa, Australia, and Asia. It was first described in 1875 based on specimens collected in Germany (Walker, 1957). A dark brown sunken lesion occurs on the lower leaves surface as a symptom. The infected plant leaves develop blackening along veins, particularly on the underside. Infection primarily affects leaves, stems, and pods, but it may also affect petioles, leaf veins, stems, and seeds. On the pods, tiny reddish-brown, slightly sunken spots emerge, which quickly develop into large, dark-sunken lesions. On these lesions, masses of pink spores form in rainy weather. On the stems and leaf stalks, black-sunken spots similar to those on the pods appear. It can result in up to 90% or more yield losses, particularly in susceptible bean varieties grown in pathogen-friendly conditions. (Fernández *et al.,* 2000, Sharma *et al.,* 2007, Miklas *et al.,* 2006).

Management: Using disease-free seed, resistant cultivar, intercropping with maize, crop rotation, and sanitation can reduce the damage. Soil solarization for one month before sowing is effective to reduce both the severity and incidence of anthracnose (Mohammed *et al.,* 2013). Bean cultivars G2333, TU, Kaboon, K10, K13, SEL 1308 and BRS Cometa were found effective against *C. lindemuthianum* in Uganda and Brazil (Awori *et al.,* 2018). It has been documented that soaking infected seeds in hot water for 15 hours at 64 to 72°F, followed by another soak at 117°F for 25 minutes, destroys the fungus without affecting germination (Bush, 2009). Botanicals and biopesticides include 10% extracts of *Adenocalymma alliaceae, Azadirachta indica*, and *Lawsonia inermis*, 0.4 percent talc formulations of *Trichoderma viride*, and *Pseudomonas fluorescens*. (Ravi, 2000). Bean anthracnose was found to be reduced by seed treatment with Mancozeb @ 3 g/kg seeds and foliar spray with Carbendazim @ 0.5 kg/ha (Mohammed *et al.,* 2013). Bean anthracnose can also be handled with *Trichoderma harzianum*, 1 percent Bordeaux mixture, and tilt 250 EC. (Khalequzzaman, 2015).

2. Angular leaf spot (ALS)

Angular bean leaf spot, triggered by *Pseudocercospora griseola* (Crous and Braun), was thought to be a minor disease in Latin

America until the 1980s, mostly in Brazil (Rava *et al.,* 1985). Though, by mid-1980, ALS had established itself as a major limitation to dry bean production in Central America, Brazil, and Southern and Eastern Africa (Aggarwal *et al.,* 2004; Rava *et al.,* 1985). Melzer and Boland (2001) reported that it occurs sporadically in temperate countries, including Canada and the United States, and that it was recently documented for the first time in northern areas of Spain (Landeras *et al.,* 2017). Pods and foliage are both affected by the disease. Leaf lesions begin as small grey or brown spots that become necrotic and angular as they are confined by veins of the leaf, while pod symptoms are circular to elliptical brown-red lesions. The spots on the leaves gradually coalesce, resulting in premature defoliation (Saettler 1991; Correa-Victoria *et al.,* 1989) In Latin America and Africa, ALS can result in up to 80% yield losses (Stenglein, *et al.,* 2003; De Jesus Junior *et al.,* 2001; Rava *et al.,* 1985; Muthomi *et al.,* 2011).

Management: To reduce the damage caused by *Pseudocercospora griseola*, several control strategies were recommended, including pathogen-free seed planting, field sanitation, crop rotation, and/or plant resistance (Celetti *et al.,* 2005). Fungicides such as carbendazim can be used for seed treatment. Copper fungicides or mancozeb are needed for control of leaf or pod spots.

3. Bean Rust

In the south-eastern part of Brazil, rust (*Uromyces appendiculatus*) is one of the most common foliar diseases of bean plants. On the surface of leaves, pods, and petioles, *U. appendiculatus* causes reddish-brown pustules containing uredia, resulting in severe defoliation. Rusty brown spores rub off on the finger when touched and make it distinct from other spots. Rust caused up to 70% yield losses in Brazil (Brenes *et al.,* 1983) and up to 80% in Colombia (Schwartz *et al.,* 1981). Depending on the timing and severity of infection, it can result in up to 100% yield losses in the absence of adequate control measures (Stavely, 1991).

Management: Use of rust-resistant variety, intercropping of bean with maize (Boudreau *et al.,* 1994; Fininsa, C.1996), and adjustment of sowing date (Chhetry and Mangang, 2012) have marked positive impact on reducing rust disease. *Trichoderma spp.*is effective (Burmeister and Hau, 2009) and plant extract of basil, black cumin, neem, black pepper, hibiscus, sweet acacia celery fennel, laurel, rosemary, etc. can significantly control rust development (Arslan *et al.,* 2009).

4. Cercospora leaf spot

The pathogenicity of *Cercospora zonata* was first described by Yu (1947) in China. *Cercospora zonata*, is a fungus that causes irregular, tan spots on lower leaves which are popularly known as Cercospora leaf spots. Excessive leaf drop and plant stunting are symptoms of a severe infection. Infection is worsened by prolonged rainfall and high humidity. These fungi are found in Colombia (Skiles *et al.,* 1959), the United States (Zaumeyer *et al.,* 1957), Puerto Rico, Trinidad, Argentina, Jamaica, and Venezuela (Wellman, 1977), and Brazil (Shands *et al.,* 1964). On *Phaseolus aureus*, yield losses due to this disease are significant in the Philippines and minor in the United States (Zaumeyer *et al.,* 1957).

Management: Cercospora leaf spot affects the majority of commercial cultivars, and the severity of the disease is strongly linked to faba bean rotations. Planting disease-free seed, resistant cultivar and use of botanicals (neem leaf extract, Biskatali leaf extracts, Arjun leaves extract, Debdaru leaves extract, garlic cloves extract) are quite effective in controlling Cercospora leaf spot of country bean (Dey *et al.,* 2017; Uddin, 2013). Recent findings have shown that early applications of carbendazim, tebuconazole, chlorothalonil, and triadimefon are the most effective fungicide control strategies (Kimber, 2011).

5. Charcoal rot

Macrophomina phaseolina causes charcoal rot, which is the most damaging disease of country beans, especially in arid areas (Iqbal and Mukhtar, 2014). Chocolate spots of faba bean occurred in epidemic form during the 2004-2005 cropping season in northern Ethiopia (Sahile *et al.,* 2008). It is a pathogenic fungus that causes cushion-shaped black sclerotia and can be found in soil and seeds (Wheeler, 1975). Country bean is susceptible to *M. Phaseolina* at different growth stages and the fungus attack all plant parts (Agrios, 2005). Pinhead-sized dark-colored pycnidia occur on epicotyls and hypocotyls, accompanied by seedling death due to xylem vessel obstruction. Leaflets turn yellow and wilted as the disease progresses. It sometimes destroys the entire canopy which limits the photosynthetic ability of plants thus productivity is reduced (Eisa *et al.,* 2006). When plants are split open, a silver or light gray discoloration can be observed in lower and taproot. In this stem and taproot tissue, black specks (microsclerotia) will be visible. Microsclerotia will be present in the outer tissues, which will be black and dusty. Economic losses could range from 80% (Sen, 2000) to 100% (Bashir and Malik, 1988). When the plant is stressed by adverse environmental factors, the pathogen thrives (Wrather *et al.,* 2001).

Management: The risk of charcoal rot is reduced by crop rotation with soybean crops or any other cultural practices that alleviate plant stress. Trichoderma species, especially *T. hamatum* and *T. harzianum* may help to manage charcoal rot biologically (Khaledi and Taheri, 2016). *Pseudomonas* and *Bacillus* can serve as biocontrol agents against *Macrophomina phaseolina* (Dave *et al.,* 2020). A group of fungicides such as Benomyl, Carbendazim, and Copper oxychloride have significant inhibitory effects on the growth of fungus at 150 ppm concentration (Iqbal and Mukhtar, 2020).

6. Fusarium wilt

Fusarium oxysporum causes a vascular wilt disease which is commonly known as Fusarium wilt. It was observed for the first time on climbing bean (*Phaseolus vulgaris L.*) during 1990 in Africa (Buruchara and Camacho, 2000). Yellowing and wilting on one side of the plant occurs due to root infections; the wilt is permanent, and plants can die prematurely. Other symptoms include brown staining of the xylem vessels which can be seen when the stems are cut. In susceptible common bean cultivars, the disease preferred high soil moisture and mild temperatures and causes up to 80% yield reductions (Sartorato and Rava 1994; Salgado *et al.,* 1996).

Management: Crop rotation for a long period; maintaining proper irrigation, organic amendments of soil (Ha and Huang, 2007), and intercropping with wheat (Dong *et al.,* 2020) can significantly reduce fusarium wilt disease. In common bean, seed treatment with *Trichoderma, Gliocladium, Streptomyces, Pseudomonas,* and *Bacillus* species may protect plants from fusarium wilt (Dubey *et al.,* 2007; Carvalho *et al.,* 2014; Guimarães *et al.,* 2014; Mahmoud, 2016).

7. White mold

Sclerotinia sclerotiorum is a fungus that causes white mold on beans. It is endemic and widespread in the United States, Canada, Argentina, and Brazil (Teixeira *et al.,* 2019), and can result in up to 100% yield losses on susceptible varieties under favorable conditions. (Schwartz and Singh, 2013). *Sclerotinia sclerotiorum* was reported for the first time in country bean in Bangladesh during 2012 and nearly 5% of the plants rotten due to this disease (Prova *et al.,* 2014). On infected leaves, branches, stems, and pods, white mold appears as wet, soft spots or lesions at first. These lesions develop into rotting, watery mass tissues covered by white moldy development (Mahalingam *et al.,* 2017). Stems and branches infected by this pathogen may wilt and die; leaving a bleached and dried appearance. During periods of high humidity, cottony white growth can appear on lesions. Numerous black, irregular resting spores called sclerotia are found on and within infected plant parts.

Management: Since no bean variety is truly immune to white mold, it is extremely difficult to manage (del Río *et al.,* 2004; Agrios, 2005; Steadman and Boland, 2005; Schwartz and Steadman, 1989; Schwartz and Singh, 2013). Disease management practices include crop rotation with non-hosts like cereals and corn, suggested row widths and planting rates, varietal improvement, and effective use of irrigation and fertilizer. Vitavax, Companion, Bavistin, Score, Mancozeb, and Thiram can effectively control stem and pod rot of bean (Prajapati *et al.,* 2008).

8. Aschocyta blight

Phoma exigua-caused Ascochyta blight is an economically significant disease of country beans. It was first reported on infected seeds in Australia and Canada in the 1970s. It was reported once in South Africa during the 1980s. Its sexual state which is called teleomorph was first reported by Jellis and Punith (1991) on overwintering *V. faba* straw in the UK (Kohpina *et al.,* 2000). It was subsequently found in Australia (Jellis *et al.,* 1998), Syria (Bayaa and Kabbabeh, 2000), and Spain (Rubiales and Trapero-Casas, 2002). The pathogen becomes more active at the temperature between 16-24 °C and becomes inactive above 30°C. Symptoms appear on the leaf, pod, and stem of the infected plant. Tiny, round, brown spots appear on the top and bottom sides of leaves at first. They grow larger, more irregular in form, and collage together to cover the whole surface of leaves as the disease progresses. Leaf lesions can turn black and necrotic, then zonate to form a concentric ring in which multiple pinhead-sized black fruiting bodies known as pycnidia can form. The stem lesions are longer, sunken, and deeper than the leaf lesions. Pod lesion is divided into two zones with a pale center and dark margins. Infected seeds shrink and discolor, with yellowish-brown stains on the outer seed coat, reducing their market value dramatically. Yield loss in faba bean due to this disease was recorded usually 35–40% but can be as high as 90% (Atienza *et al.,* 2016).

Management: Using pathogen-free seed, destroying inoculum sources, adjusting planting dates, applying seed treatments, and using foliar fungicides such as Chlorothalonil (2.24 kg/ ha), Benomyl (0.55g/ 1), and Zineb (2.4 g/ 1), can help to control this disease (Davidson and Kimber, 2007, Khan *et al.,* 2010).

9. Foot and root rot of bean

In the warmer lowlands of Cameroon, *Fusarium spp., Sclerotium* spp., *Pythium spp.,* and *Macrophomina spp*. were found to cause bean foot and root rot (Eke *et al.,* 2020, Bedine *et al.,* 2020). Under favorable environmental conditions, yield losses due to this disease have been documented as 70% (Otsyula *et al.,* 2003) and 100% (Bedine *et al.,* 2020; PPRC, 1996) in susceptible bean cultivars. It is a type of seedling disease. Initially, a water-soaked lesion is found at the collar region of the seedling at the soil level. As the disease advances the lesion becomes dark sunken and can extend down the main taproot, which may turn brick red and hollow. Affected plants show stunted growth with an unthrifty color of the foliage, exhibiting signs of malnourishment and eventually die.

Management: The use of resistant varieties, Crop rotation with non-host crops such as corn, wheat, barley or alfalfa can reduce the risk of damage. Soil amendments with crop residue can reduce the damage by enhancing the activities of natural biological control agents (Voland *et al.,* 1994; Paparu 2018). Trichoderma-based products were found effective in controlling soil-borne fungus (Belete *et al.,* 2015; Bedine *et al.,* 2020). Seed treatment with Thiram, Benomyl, Captafol can also reduce the damage.

10. Scab of bean

Scab of beans caused by *Elsinoe phaseoli* is reported for the first time from South Africa in 1981 (Phillips 1994; Swart *et al.,* 2001). The pathogen attacks every part of the foliage. Leaf lesions have mainly appeared on the upper portion of the leaves and the lesions are typically circular corky outgrowth. In severe cases, a shot-hole appearance is found on the center of the lesion. Stem lesions are also corky but are elongated and often silvery grey. Pod lesion causes considerable distortion. An affected plant may die prematurely. Yield losses of up to 50% were recorded in South Africa and up to 70% in Kenya (Phillips, 1994). It is a wind-borne disease.

Management: Using healthy seed, resistant variety and crop rotation are common management practices to control scabs of bean (Agrios, 2005). Benomyl sprays can also be used to reduce disease progression.

11. Web blight

The fungus *Rhizoctonia solani* (anamorph) and *Thanatephorus cucumeris* (teleomorph) are responsible for web blight disease. It is considered a major disease of beans in East Africa (Godoy-Lutz *et al.,* 2008). Hot humid weather and moderate temperature are the favorable conditions of this disease and the yield losses have been reported up to 90%. Symptoms produced by both stages differ from each other. The asexual stage produces small water soaked lesion which later becomes dark brown to grey and coalesces together to cover the entire leaves. The mycelial growth of the fungus holds the severely infected leaves together in a web-like structure. The sexual stage produces small dark brown necrotic spots with a light center. These spots may coalesce and the necrotic tissue falls off and gives a cockeye symptom.

Management: Dubey, (2003) reported that foliar application and seed treatment with botanical (cake and leaf extract of *Pongamia glabra*), bioagent (*Trichoderma viride*), and fungicide (Carboxin) can effectively manage web blight of red bean. The use of healthy seed, resistant variety crop rotation, maintaining planting distance, biological control are effective methods for managing the web blight of red bean (Kumar *et al.,* 2017). Seed treatment with Carboxin @ 2 g/kg seed + Seed inoculation of Rhizobium @ 20 g/ kg Seed + Soil treatment with Trichoderma viridi @ 5kg incubated in 50 kg vermicompost for 72 hrs. + Foliar spray of 10 % kranj leaf extract at 30 DAS and Propiconazole-25SC @ 0.1% at 45 DAS reduced disease incidence (80.08%) and increased the yield (44.32%) (Singh *et al.,* 2020).

12. Floury leaf spot

Floury Leaf Spot of bean is a serious haricot bean disease in Ethiopia which is caused by *Mycovellosiella phaseoli*. It is commonly found in Ecuador, Honduras Nicaragua, Venezuela, Colombia, Panama, Brazil, Guatemala, and the Dominican Republic (Vieira *et al.,* 1977). It is highly prevalent in the areas of the warm and humid region (Lemessa, 2005). Symptom initially appears on older foliage. After that, new foliage is affected. Symptom includes white floury fungal growth on lower surface of leaves which must not be confused with powdery mildew. Powdery mildew appears on the upper surface of the leaves. The leaf upper surface shows some light green to chlorotic lesions corresponding to the lower leaf lesions.

Management: *Pseudomonas fluorescens* a biocontrol agent found effective in controlling the floury leaf spot of rajmash bean up to 59.6% at Himachal Pradesh, India (Mondal, 2004). Planting disease-free clean seed and Seed treatment with Thiophanate (2 g/ l) or Benomyl (0.55 g/l) (Buruchara *et al.,* 2010) can also decrease the yield loss.

13. Bacterial blight

Bacterial blight or common bean blight is caused by *Xanthomonas axonopodis* pv. *Phaseoli* (Sultana *et al.,* 2018). For the first time, the disease was identified in the U.S.in 1892. Recently, it was recognized as a severe disease of bean in southern Ethiopia (Tadesse *et al.,* 2009; Mengesha, and Yetayew, 2018) and it was reported for the first time in Belgium during August 2019 (Bultreys, and Gheysen, 2020). Seedling symptoms include angular, water-soaked lesions on the opposite sides of the primary leaves. Water-soaked spots on leaves enlarge and become necrotic (Belachew *et al.,* 2015); a zone of yellow discoloration may be surrounding the spot; and finally, the plant looks like burnt after lesions coalesce (Gilbertson and Maxwell 1992; Hall, 1994; Harveson, 2009); red-brown, circular and sunken lesion may have appeared on pods (Chen *et al.,*2012); during humid conditions ooze may be found in pod lesions. High rainfall and humidity favor the disease, and maximum development occurs at around 28°C. Depending on weather conditions the seriousness of blight varies from year to year. Mostly warm condition favors its growth and causes yield loss of almost 40% (Karavina *et al.,* 2011).

Management: Use of certified seed, resistant varieties (Popovic *et al.,* 2012), adjustment of sowing date, crop rotation with maize (Fininsa, 1996) can significantly decrease the infection rate. Seed treatment with appropriate antibiotics can kill the pathogen. Before the appearance of symptoms spraying plants with copper-based fungicide is also effective in controlling bacterial blight.

14. Bacterial brown spot

Pseudomonas syringae pv. *Syringae* causes a Bacterial brown spot of country bean. It was reported by Walter Burkholder in 1930 for the first time in New Jersey (Hagedorn, 1986). It was a disease of minor importance in the USA until mid-1960 (Hagedorn, 1986). It was seen at first on a limited basis in dry bean fields during 1969 in Western Nebraska. But its damage and incidence have increased during the past 20 years (Schwartz *et al.,* 2011). The disease causes most damages when humidity levels are above 95% and temperatures range from 27 to 30°C. Disease symptoms are tiny, dark brown necrotic spots on the leaves with yellow tissue zone; pods become necrotic brown color; pods may be wrapped and pervert in the area of infection, and white to cream-colored bacterial ooze may be present on the wound.

Management: Crop rotation, sanitation, planting disease-free seeds, avoiding working in wet fields, growing disease-resistant varieties, and use of copper-based bactericides aid to reduce the rate of bacterial infection.

15. Halo blight

Pseudomonas syringae pv. *Phaseolicola* is a bacterium that causes halo blight of bean disease (Duman and Soylu 2019). It is an economically main disease of bean in the United States, Europe, Africa, and many other countries (Rico *et al.,* 2003). This disease was first recognized in Spain in 1993 and New York State (U.S.) in the early 1920s (Rico *et al.,* 2003). Firstly, a small water-soaked spot develops on the diseased plants on the lower left side. After a few days, the tiny spot turns necrotic and becomes visible on the upper surface; chlorotic tissue may have appeared around the spots; In severe cases leaves become distorted; on pods, red-brown lesions may be visible; ooze may be present on the wound of pods or the pods may turn tan in color. The disease is most destructive where temperatures are moderately cool usually less than 80°F and relative humidity is above 95%.

Management: Planting of disease-free seed, use of resistant cultivar (Rico *et al.,* 2003), and seed treatment with an antibiotic (kasugamycin 0–25 g a.i./kg or streptomycin 2–5 g a. i. /kg seed) can help to reduce contamination at the surface of the seed coat (Taylor and Dudley 1977). Crop rotation with non-host every 2 years and destroying bean debris after harvest also help to reduce the infection.

16. Bacterial Wilt

Bacterial Wilt of dry bean was primarily recognized in South Dakota navy bean field in 1922 which caused by the *Curtobacterium flaccumfaciens* pv. *flaccumfaciens*. In irrigated Midwest and high plains of USA, it became a major bacterial disease. Bacterial wilt of dry beans was reported for the first time in Iran during 2012 (Osdaghi *et al.,* 2016), and the purple variant of *Curtobacterium flaccumfaciens* pv. *Flaccumfaciens* was reported for the first time in Canada during 2005 (Huang *et al.,* 2006). Firstly, symptoms are visible as interveinal chlorosis, leading towards leaf wilting. A chlorotic margin was also observed around the necrosis of leaf tissue. In the later stage of infections on the common bean trigger overall defoliation as well as plant death. Symptoms also included seed discoloration and the seed coat may display pink, orange, purple, or yellow discoloration because the bacteria enter into the vascular system of the host plants. The external portions of pods do not show any symptoms (Harveson, 2013).

Management: Planting disease-free high-quality seed, resistant cultivars, crop rotation, and sanitation are the common management practice. The severity of bacterial wilt can be reduced by the application of *Bacillus cereus* and *Pseudomonas fluorescens* strains together, (Corrêa *et al.,* 2014). Copper-based bactericides like copper oxychloride, copper hydroxide, and copper sulfate can effectively be used to control the bacterial wilt of the bean.

17. Bean common mosaic virus

BCMV is the most serious virus disease of country beans in hot and medium rainfall areas. BCMV was firstly reported in Russia in 1894 and known in the United States since 1917, at which time it caused severe yield losses of as much as 80% (Morales, 2003). It was recognized for the first time in India in October 2008 (Udayashankar *et al.,* 2011). The disease develops different types of symptoms in affected plants like green vein banding, mosaic, secondary leaf malformation, leaf curling, and plant stunting. It causes wrinkles in the leaves and sometimes the leaf rolled up. Symptoms vary with the variety and strain of pathogen. In the end, the plants become stunted or it is eventually dead. Depending upon bean cultivar and virus strain transmission via seed may be increased (Morales and Castano, 1987). Many aphid species transmit the virus non-persistently, mainly *Aphis fabae* and *Myzus persicae*.

Management: Virus-affected plant parts must be removed from fields and destroyed. Controlling vectors is the main principle to reduce viral diseases in the plant. Besides control of aphid vectors by application of oil, timely sowing of crops, planting certified seeds, optimum densities of plants, and maize intercropping may also reduce viral infection. However, for reducing agricultural losses by these viruses, a virus-resistant cultivar (Usha, Borsha, Broad purple fruit, Broad green fruit and Maya) is the best option (Morales, 2003).

18. Bean Yellow Mosaic

Boning (1927) was identified BYMV in faba bean for the first time in Germany. After that, it was also identified to occur on the faba bean in Greece, Egypt, Italy, Israel, Libya, Lebanon, Spain, Morocco, Tunisia, Turkey, and Syria (Nienhaus and Saad, 1967; Fortass and Bos, 1991; Mouhanna *et al.,* 1994; Najar *et al.,* 2000). It is widely distributed in the Mediterranean countries because of the warm temperature which favors the aphid population which is the vector of this disease. Several species of aphids transmitted it from infected to the healthy plants through non-persistent way and seed to seed transmission rate is usually low (Elbadry *et al.,* 2006). BYMV plants initially show yellow or green mosaic markings on the leaves which were later mottled, crinkled, deformed, and reduced in size. Photosynthetic rate, pigment contents, and transpiration rate were remarkably decreased in BYMV infection after three weeks of virus inoculation (Radwan *et al.,* 2008). As a result, the plant shows stunted growth, reduction in nodulation, and considerable yield losses (Osman and El-Sheikh 1999, Elbadry *et al.,* 2006). Necrotic ring spotting and rusty seeds were occasionally found in infected bean plants with BYMV (Kaiser, 1973) and the numbers of seeds per pod may also be affected.

Management: After viral infection in a plant, there is no treatment and the plant should be uprooted from the field and eradicated. Some preventive measures may be taken for future bean crops such as BARI Sheem 1, crop rotation, and planting beans away from alfalfa, clover, rye, other legumes, or flowers such as gladiolus because these crops can act as alternate hosts which helps in overwintering of the virus. To control bean yellow mosaic virus Aphid control is mandatory which can be achieved by the use of some insecticidal soap or neem oil. Malathion-57 EC @ 0.2% can also be used to control insect vector.

CONCLUSIONS AND FUTURE DIRECTION

This review illustrated that there are huge research gaps on diseases of country bean in Bangladesh. The bean diseases are vital constraints of country bean cultivation at any growing stage and reduce yield significantly.

Diseases management like managing different diseases of country bean need intensive care and appropriate control strategy on right time. Awareness of growers, proper management plan, and availability of inputs can make it possible to fight currently occurring deadly diseases of country bean to obtain a satisfactory yield. Strong linkage between researcher-extension personnel can boost technology transfer to growers for preparedness for disease outbreak and proper management. More research is needed to improve existing practice and introduce sustainable tactics for controlling plant diseases in long run. As virulent strains/races are reported repeatedly in different countries, scientists may emphasize developing resistant varieties by applying modern biotechnological tools. Marker-assisted selection breeding, application of CRISPR/Cas can make a sustainable solution for disease resistant variety development. Taking the advantage of its morphological nature, bean crop may be included in controlled environment agriculture to harvest the best output by proving precise input. Therefore, the future of agriculture will be more precise, unlike today.

REFERENCES

Abawi, G.S., Ludwig, J.W., and Gugino, B.K. (2006). Bean root rot evaluation protocols currently used in New York. *Annual Report of the Bean Improvement Cooperative* 49: 83-84.

Adama, A., and Yinusa, A.J. (2012). Effect of Locust Bean Pod Ash on Strength Properties of Weak Soils. *Au Journal of Technology* 16(1): 27–34.

Aditya, D.K. (1993). Vegetables Production and development in Bangladesh. Consultancy report, AVRDC-USAID (ARPTI) project, 22 November, 1992-31, May 1993. Horticulture Research Center, BARI, Joydebpur. pp. 3-24.

Aggarwal, V.D., Pastor-Corrales, M.A., Chirwa, R.M., and Buruchara, R.A. (2004). Andean beans (*Phaseolus vulgaris* L.) with resistance to the angular leaf spot pathogen (*Phaeoisariopsis griseola*) in southern and eastern Africa. *Euphytica* 136(2): 201-210.

Agrios, G.N. (2005). Plant Pathology (5th edition). Elsevier-Academic Press. San Diego, CA.

Akhter, M.S., Akanda, A.M., Kobayashi, K., Jain, R.K., and Mandal, B. (2019). Plant virus diseases and their management in Bangladesh. *Crop Protection* 118: 57-65.

Alghamdi, S.S. (2009). Chemical composition of faba bean (*Vicia faba* L.) genotypes under various water regimes. *Pakistan Journal of Nutrition 8*(4): 477-482.

Anonymous. (2008). Queensland Department of Primary Industries, Brisbane, Queensland, Australia. Information of pest PC, 2:11.

Anonymous. (2013). Krishi Diary (in Bengali), Agriculture Information Service, Khamarbari, Farmgate, Ministry of Agriculture, Dhaka, Bangladesh, pp. 73.

Arslan, U., Ilhan, K., and Karabulut, O.A. (2009). Antifungal activity of aqueous extracts of spice against bean rust (*Uromyces appendiculatus*). *Allelopathy Journal* 24(1): 207-214.

Atienza, S.G., Palomino, C., Gutiérrez, N., Alfaro, C.M., Rubiales, D., Torres, A.M., and Ávila, C.M. (2016). QTLs for ascochyta blight resistance in faba bean (*Vicia faba L.*): validation in field and controlled conditions. *Crop and Pasture Science* 67(2): 216-224.

Awori, E., Kiryowa, M., Souza, T. L. P. O., Vieira, A. F., Nkalubo, S. T., Kassim, S., and Tusiime, G. (2018). Resistance Sources to Bean Anthracnose Disease in Uganda and Brazil. *Journal of Agricultural Science and Food Research* 9(225): 2

Bako Agricultural Research Center (BARC) (2002). Bako research center; crop protection division progress report for 2001/2. Bako Agricultural Research Center, Bako Ethiopia.

Bashir, M.A., and Malik, B.A. (1988). Diseases of major pulse crops in Pakistan. *Tropical Pest Management*34: 309- 314. https://doi.org/10.1080/09670878809371262.

Bedine, B., Sameza, M.L., Iacomi, B., Tchameni, S.N., and Boyom, F.F. (2020). Screening, identification and evaluation of *Trichoderma spp*. for biocontrol potential of common bean damping-off pathogens. *Biocontrol Science and Technology* 30(3): 228-242.

Belachew, K., Gebremariam, M., and Alemu, K. (2015). Integrated management of common bacterial blight (*Xanthomonas axonopodis pv.phaseoli*) of common bean (*Phaseolus vulgaris*) in Kaffa, South west Ethiopia. *Malays Journal of Medical Biology Research* 2:147-152

Belete, E., Ayalew, A., and Ahmed, S. (2015). Evaluation of local isolates of *Trichoderma spp.* against black root rot (*Fusarium solani*) on Faba bean. *Journal of Plant Pathology and Microbiology*.

Boudreau, M.A., and Mundt, C.C. (1994). Mechanism of alteration in bean rust development due to intercropping, in computer stimulated epidemics. *Ecological applications* 4(4): 729-740.

Brenes, B.M., Chaves, G.M., and Zambolim, L. (1983). Estimativas de perdas no rendimento do feijoeiro comum (*Phaseolus vulgaris*) causadas pela mancha angular (*Isariopsis griseola* Sacc.). *Fitopatologia Brasileira* 8: 599.

Bultreys, A., and Gheysen, I. (2020). First report of *Xanthomonas phaseoli pv. phaseoli* and *Xanthomonas citri pv. fuscans* causing common bacterial blight of bean in Belgium. *New Disease Reports* 41: 6-6.

Burmeister, L., and Hau, B. (2009). Control of the bean rust fungus *Uromyces appendiculatus* by means of *Trichoderma harzianum*: leaf disc assays on the antibiotic effect of spore suspensions and culture filtrates. *BioControl* 54(4): 575.

Buruchara R.A., and Scheidegger U.C. (2011). Development and Delivery of bean varieties in africa: The Pan-Africa bean research Alliance (PABRA) model. *African* Crop Science *Journal* 19(4): 227-245.

Buruchara, R., Mukankusi, C., and Ampofo, K. (2010). Bean Diseases and Pest Identification and Management. Kampala, UG: International Center for Tropical Agriculture (CIAT); Pan-African Bean Research Alliance (PABRA)-Handbook for Small Scale Seed Producers.

Buruchara, R.A., and Camacho, L. (2000). Common bean reaction to *Fusarium oxysporum f. sp. phaseoli,* the cause of severe vascular wilt in Central Africa. *Journal of Phytopathology* 148(1): 39-45.

Buruchara, R.A., and Rusuku, G. (1992). Root rots in the Great Lakes Region. Proceedings of the Pan-African Bean Pathology Working Group Meeting, Thika, Kenya. May 26–30, 1992. CIAT Workshop Series 23: 49–55.

Bush, E. (2009). Anthracnose on Snap Beans. Virginia Pest Management Guide for Home Grounds and Animals (VCE Publication 450-719). Virginia Cooperative Extension, Virginia State University, USA. P. 46.

Cardona-Alvarez, C., and Walker, J.C. (1956). Angular leaf spot of Bean. *Phytopathology* 46(11).

Carvalho, D.D.C., Lobo Junior, M., Martins, I., Inglis P.W., and Mello, S.C.M. (2014). Biological control of *Fusarium oxysporum f. sp. phaseoli* by *Trichoderma harzianum* and its use for common bean seed treatment. *Tropical Plant Pathology* 39: 384–391.

Celetti, M.J., Melzer, M.S., and Boland, G.J. (2005). Integrated management of angular leaf spot (*Phaeoisariopsis griseola* (Sacc.) Ferr.) on snap beans in Ontario. *Plant health progress* 6(1): 2.

Chauhan, S., Katoch, S., Sharma, S.K., Sharma, P.N., Rana, J.C., Singh, K., and Singh, M. (2020). Screening and identification of resistant sources against *Sclerotinia sclerotiorum* causing white mold disease in common bean. *Crop Science* 60(4): 1986-1996.

Chhetry, G.K.N., and Mangang, H.C. (2012). Evaluation of ecofriendly management practices of French bean rust (*Uromyces appendiculatus*) in organic farming system. *International Journal of Advancements in Research and Technology* 1(4): 2278-7763.

Chongo, G., Buchwaldt, L. andeson, K., Gossen, B.D., Lafond, G.P., May, W.E., Johnson, E.N., and Hogg, T. (2003). Foliar fungicides to manage Ascochyta blight (*Ascochyta rabiei*) of chickpea in Canada. *Canadian Journal of Plant Pathology* 25: 135-142.

Chowdhury, A.R., Ali, M., Quadir, M.N.A., Talukder, M.H. (1989). Floral biology of country bean (*Lablab purpureas* L. sweet). *Thai Journal of Agricultural Science* 22: 56-67.

Clarkson, J.P., Fawcett, L., Anthony, S.G., and Young, C. (2014). A model for *Sclerotinia sclerotiorum* infection and disease development in lettuce, based on the effects of temperature, relative humidity and ascospore density. *PLoS One* 9(4): e94049.

Corrêa, B.O., Schafer, J.T., and Moura, A.B. (2014). Spectrum of bio control bacteria to control leaf, root and vascular diseases of dry bean. *Biological Control* 72: 71–75.

Coyne, D.P., Steadman, J.R., Godoy-Lutz, G., Gilbertson, R., Arnaud-Santana, E., and Beaver, J.S. (2003). Contributions of the Bean/Cowpea CRSP to management of bean diseases. *Field crops research* 82(2): 155-168.

Crépon, K., Marget, P., Peyronnet, C., Carrouee, B., Arese, P., and Duc, G. (2010). Nutritional value of faba bean (*Vicia faba* L.) seeds for feed and food. *Field Crops Research* 115(3): 329-339.

Crous, P.W., Liebenberg M.M., Braun, U., and Groenewald, J.Z. (2006). Re-evaluating the taxonomic status of *Phaeoisariopsis griseola*, the causal agent of angular leaf spot of bean. *Studies in Mycology* 55: 163–173. doi:10.3114/sim.55.1.163.

Das, S., Dutta, S., and Mandal, B. (2017). First report of *Choanephoracucurbitarum*, causing leaf blight of hyacinth bean in India. *Journal of Plant Pathology* 99(2*).*

Dave, K., Gothalwal, R., Singh, M., and Joshi, N. (2020). Facets of rhizospheric microflora in biocontrol of phytopathogen *Macrophomina phaseolina* in oil crop soybean. *Archives of Microbiology*. pp. 1-8.

Davidson, J.A., and Kimber, R.B. (2007). Integrated disease management of ascochyta blight in pulse crops. *Ascochyta blights of grain legumes*. pp. 99-110

De Jesus, W.C., Do Vale, F.X.R., Coelho, R.R., Hau, B., Zambolim, L., Costa, L.C., and Filho, A.B. (2001). Effects of angular leaf spot and rust on yield loss of *Phaseolus vulgaris*. *Phytopathology*91(11): 1045-1053. doi:10.1094/ PHYTO.2001.91.11.1045.

Degu, T., Yaregal, W., and Gudisa, T. (2020). Status of Common Bean (*Phaseolus vulgaris L.*) Diseases in Metekel Zone, North West Ethiopia. *Journal of Plant Pathology Microbiology* 11: 494. doi: 10.35248/2157-7471.20.11.494

Del Río, L.E., Kurtzweil, N.C., and Grau, C.R. (2000). Petiole inoculation as a tool to screen soybean germplasm for resistance to *Sclerotinia sclerotiorum*. *Phytopathology* 90: 176.

Dey, S., Haque, A.H.M.M., Hasan, R., Biswas, A., and Sarker, S. (2017). Efficacy of Botanicals and Chemicals to Control Cercospora Leaf Spot Disease of Country Bean in Field Condition. *Journal of Applied Life Sciences International*, pp. 1-7.

Dovala-Chicapa, A.C., David, A.N., Baptista, L.J., Ndala, A.P., Buta, T.H., Muondo, J.J., and Mónica, M.M. Bean diseases and pest in Angola.

Dubey, S.C. (2003). Integrated management of web blight of urd and mung bean. *Indian Phytopathology*56(4): 413-417.

Dubey, S.C., Suresh, M., and Singh, B. (2007). Evaluation of *Trichoderma* species against *Fusarium oxysporum f. sp. ciceris* for integrated management of chickpea wilt. *Biological control* 40(1): 118-127.

Duman, K., and Soylu, S. (2019). Characterization of antagonistic and plant growth-promoting traits of endophytic bacteria isolated from bean plants against *Pseudomonas syringae pv. Phaseolicola*. *Bitki Koruma Bülteni* 59(3): 59-69.

Eisa, A., Nawal, G.M., El-Habbaa, S.M., and Omar, (2006). Efficacy of antagonists, natural plant extracts and fungicides in controlling wilt, root rot and chocolate spot pathogens of faba bean *in vitro*. *Annals Of Agricultural Science Moshtohor* 44 (4): 1547-1570.

Eke, P., Wakam, L.N., Fokom, R., Ekounda, T.V., Boat, M.A.B., and Boyom, F.F. (2020). Common bean (*Phaseolus vulgaris L.*) root rot in humid lowland: Occurrence, and assessment of biotic and agronomic factors for mitigation prospects. *Rhizosphere* 16: 100256.

El-Badry M., Taha R.M., El-Dougdoug K.A., and Gamal-Eldin, H. (2006). Induction of systemic resistance in faba bean (*Vicia faba L.*) to bean yellow mosaic potyvirus (BYMV) via seed bacterization with plant growth promoting Rhizobacteria. *Journal of Plant Diseases and Protection* 113(6): 247–251.

Fernández, M.T., Fernández, M., Casares, A., Rodriguez, R., and Fueyo, M. (2000). Bean germplasm evaluation for anthracnose resistance and characterization of agronomic traits: A new physiological strain of *Colletotrichum lindemuthianum* infecting *Phaseolus vulgaris* L in Spain. *Euphytica* 114: 143–149.

Fininsa, C. (1996). Effect of intercropping bean with maize on bean common bacterial blight and rust diseases. *International Journal of Pest Management* 42(1): 51-54.

Fortass, M., and Bos, L. (1991). Survey of faba bean (*Vicia faba* L.) for viruses in Morocco. *Netherlands Journal of Plant Pathology* 97(6): 369-380.

García-Guzmán, G., Trejo, I., and Sánchez-Coronado, M.E. (2016). Foliar diseases in a seasonal tropical dry forest: Impacts of habitat fragmentation. *Forest Ecology and Management* 369: 126-134.

Godoy-Lutz, G., Kuninaga, S., Steadman, J.R., Powers, K. (2008). Phylogenetic analysis of *Rhizoctonia solani* subgroups associated with web blight symptoms on common bean based on ITS-5.8s rDNA. *Journal of General Plant Pathology* 74: 32-40.

Goodwin, M. (2003). Crop Profile-Dry Beans (including white and colored) *Phaseolus vulgaris*.

Gossen, B.D., Hwang, S.F., Conner, R.L., and Chang, K.F. (2011). Managing the ascochyta blight complex on field pea in western Canada. *Prairie Soils Crops Journal* 4: 135-141.

Guimarães, G.R., Pereira, F.S., Matos, F.S., Mello, S.C.M., and Carvalho, D.D.C. (2014). Supression of seed borne *Cladosporium herbarum* on common bean seed by *Trichoderma harzianum* and promotion of seedling development. *Tropical Plant Pathology*39: 401–406.

Ha, M.T., and Huang, J.W. (2007). Control of Fusarium wilt of asparagus bean by organic soil amendment and microorganisms. *Plant Pathology,* 16: 169-180.

Hadi, A., Naz, N., Rehman, F.U., Kalsoom, M., Tahir, R., Adnan, M., Saeed, M.S., Khan, A.U., and Mehta, J. (2020). Impact of Climate Change Drivers on C4 Plants; A Review, *Current Research in Agriculture Farming* 1(4): 13-18. doi: http://dx.doi.org/10.18782/2582-7146.118.

Hagedorn, D.J., and Inglis, D.A. (1986). Handbook of bean diseases. Publication-University of Wisconsin, Cooperative Extension Service.

Hailu, N., Fininsa, C., Tana, T., and Mamo, G. (2017). Effect of temperature and moisture on growth of common bean and its resistance reaction against common bacterial blight (*Xanthomonas axonopodis pv. phaseoli strains*). *Journal of Plant Pathology and Microbiology* 8(9): 1000419.

Harveson, R.M. (2013). The multicolored bacterium APS Features. https://doi.org/10.1094/APSFeature

Hossain M.T., Hossain, S.M., Bakr, M.A., Matiar, A.K.M., Uddin, S.N. (2010). Survey on major diseases of vegetable and fruit crops in Chittagong region. *Bangladesh Journal of Agricultural Research* 35(3): 423-429.

Hossain, M.S., and Mortuza, M.G. (2006). Chemical composition of Kalimatar, a locally grown strain of faba bean (*Vicia faba* L.). *Pakistan Journal of Biological Sciences* 9(9): 1817-1822.

Hossain, T., and Haider, J. (1993). Biochemical alternation in country bean due to yellow vein mosaic virus. *Annals of Bangladesh Agriculture* 2(1): 13-16.

Huang, H.C., Erickson, R.S., Yanke, L.J., Chelle, C.D., and Mündel, H.H. (2006). First report of the purple variant of *Curtobacterium flaccumfaciens pv. flaccumfaciens*, causal agent of bacterial wilt of bean, in Canada. *Plant Disease* 90(9): 1262-1262.

Iqbal, U. and Mukhtar, T. (2014). Morphological and pathogenic variability among *Macrophomina phaseolina* isolates associated with mungbean (*Vigna radiata L.*) Wilczek from Pakistan. *The Scientific World Journal:* 9.

Iqbal, U., and Mukhtar, T. (2020). Inhibitory effects of some fungicides against *Macrophomina phaseolina* causing charcoal rot. *Pakistan Journal of Zoology* 52(2): 709.

Islam M.S., Rahman M.M., and Mian M.A.K. (2011). Genetic Variability, Heritability And Correlation Study In Hyacinth Bean. *Bangladesh Journal of Agricultural Research*36(2) : 351-356.

Islam, M.R., Prova, A., Rubayet, M.T., Masum, M.M.I., and Hossain, M.M. (2020). White Mold on Pea Caused by *Sclerotinia sclerotiorum*: A New Threat for Pea Cultivation in Bangladesh. Preprints 2020, 2020080570 (doi: 10.20944/preprints202008.0570.v1).

Islam, T., Haque, M.M., and Rabman, M. M. (2002). Catalogue on hyacinth bean germplasm. PGRC., BARI, Gazipur. pp. 55.

Jayasinghe, R.C., Premachandra, W.T.S.D. and Neilson, R. (2015). A study on *Maruca vitrata* infestation of Yard-long beans (*Vigna unguiculata* subspecies *sesquipedalis*). *Heliyon*1(1). https://doi.org/10.1016/j.heliyon.2015.e00014

Joshi, D., Hooda, K.S., Bhatt, J.C., Mina, B.L., and Gupta, H.S. (2009). Suppressive effects of composts on soil-borne and foliar diseases of French bean in the field in the western Indian Himalayas. *Crop Protection* 28(7): 608-615.

Karavina, C., Mandumbu, R., Parwada, C., and Tibugari, H. (2011). A review of the occurrence, biology and management of common bacterial blight. *Journal of Agricultural Technology* 7(6): 1459-1474.

Karavina, C., Mandumbu, R., Parwada, C., and Tibugari, H. (2011). A review of the occurrence, biology and management of common bacterial blight. *Journal of Agricultural Technology* 7(6): 1459-1474.

Karla,V.K. (2009). Integrated control of the pest complex of mustard. PhD Thesis, Department of Entomology, Haryana Agricultural University, India, pp.17-19.

Katungi, E., Farrow, A., Chianu, J., Sperling, L., and Beebe, S. (2009). Common. bean in Eastern and Southern Africa: a situation and outlook analysis. International Centre for Tropical Agriculture.

Keikotlhaile, B.M., Spanoghe, P. (2011). Pesticide residues in fruits and vegetables, pesticides-formulations, effects, fate. In Tech, Rijeka, Croatia, pp. 243-252.

Kerr, A. and Keane, P.J. (1997). Prediction of disease outbreaks. In J.F. Brown and H.J. Ogle (eds.) Plant Pathogens and Plant Diseases. Rockvale Publications, Australia.

Khaledi, N., and Taheri, P. (2016). Biocontrol mechanisms of *Trichoderma harzianum* against soybean charcoal rot caused by *Macrophomina phaseolina*. *Journal of plant protection research* 56(1).

Khalequzzaman, K.M. (2015). Management of Anthracnose of Hyacinth Bean for Safe Fresh Food Production. *Asian Journal of Applied Science and Engineering* 4:102-109.

Khalil, M.M. (2000). Study of flower and pod production of country bean (*Lablab purpureus*). MS Thesis. Dept. of Crop Botany. BAU, Mymensingh.

Khan, A.U., Choudhury, M.A.R., and Islam, M.I. (2020).Seasonal Abundance of Insect Pest and Varietal Performance of Country Bean in Sylhet Sadar, Bangladesh. Eliva Press SRL. pp. 1-67.

Khan, A.U., Choudhury, M.A.R., Dash, C.K., Khan, U.H.S., and Ehsanullah, M. (2020). Insect Pests of Country Bean and Their Relationships with Temperature. *Bangladesh Journal of Ecology* 2 (1): 43-46.

Khan, A.U., Choudhury, M.A.R., Ferdous, J., Islam, M.S., and Rahman, M.S. (2019). Varietal Performances of Country Beans Against Insect Pests in Bean Agroecosystem. *Bangladesh Journal of Entomology* 29(2): 27-37.

Khan, A.U., Choudhury, M.A.R., Islam, M.S., and Maleque, M.A. (2018). Abundance and Fluctuation Patterns of Insect Pests in Country Bean. *Journal of the Sylhet Agricultural University* 5(2): 167-172.

Khan, A.U., Choudhury, M.A.R., Khan, A.U., Khanal, S., and Maukeeb, A.R. M. (2021). Chrysanthemum Production in Bangladesh: Significance the insect Pests and Diseases Management: A Review. *Journal of Multidisciplinary Applied Natural Science* 1(1): 33-43. Online: November 26, 2020. https://doi.org/10.47352/jmans.v1i1.10

Khan, A.U., Choudhury, M.A.R., Talucder, M.S.A., Hossain, M.S., Ali, S., Akter, T. and Ehsanullah, M. (2020). Constraints and solutions of country bean (*Lablab purpureus* L.) Production: A review. *Acta Entomology and Zoology* 1(2): 37-45. DOI: https://doi.org/10.33545/27080013.2020.v1.i2a.17.

Khan, A.U., Khan, A.U., Khanal, S. and Gyawali, S. (2020). Insect pests and diseases of cinnamon (*Cinnamomum verum* Presi.) and their management in agroforestry system: A review. *Acta Entomology and Zoology* 1(2): 51-59. Available at doi: https://doi.org/10.33545/27080013.2020.v1.i2a.19

Khan, A.U., Khan, A.U., Khanal, S. and Gyawali, S. (2020). Insect pests and diseases of cinnamon (*Cinnamomum verum* Presi.) and their management in agroforestry system: A review. *Acta Entomology and Zoology* 1(2): 51-59. Available at doi: https://doi.org/10.33545/27080013.2020.v1.i2a.19

Khan, H.R., Paull, J.G., Siddique, K.H.M., and Stoddard, F.L. (2010). Faba bean breeding for drought-affected environments: A physiological and agronomic perspective. *Field Crops Research* 115(3): 279-286.

Kimber, R.B.E. (2011). Epidemiology and management of cercospora leaf spot (*Cercospora zonata*) of faba beans (*Vicia faba*) (Doctoral dissertation).

Kohpina, S., Knight, R., and Stoddard, F.L. (2000). Evaluating faba beans for resistance to ascochyta blight using detached organs. *Australian journal of experimental agriculture*40(5): 707-713.

Kumar, S., Kumar, A., and Tripathi, H.S. (2018). Urdbean web blight and its management strategies-A review. *Agricultural Reviews* 39(3): 210-217.

Kumari, R., Khan, M.R., Bagri, G.K., Bagri, D.K., and Bagdi, D.L. (2017). Soil application of different species of *Trichoderma* for the management of charcoal rot of faba bean caused by *Macrophomina phaseolina*. *Journal of Pharmacognosy and Phytochemistry* 6(6): 1483-1486.

Landeras, E., Trapiello, E., Braña, M., and González, A.J. (2017). Occurrence of angular leaf spot caused by *Pseudocercospora griseola* in *Phaseolus vulgaris* in Asturias, Spain. *Spanish Journal of Agricultural Research* 15:e10SC03. doi:10.5424/sjar/2017153-10798

Larralde, J., and Martinez, J.A. (1991). Nutritional value of faba bean: effects on nutrient utilization, protein turnover and immunity. *Options Mediterranees–Ser. Seminaires* 10: 111-117.

Lemessa, F., and Tesfaye, A. (2005). Evaluation of bean (*Phaseolus vulgaris*) genotypes for multiple resistance to angular and floury leaf spot diseases. *Tropical science* 45(2): 63-66.

Lv, J., Dong, Y., Dong, K., Zhao, Q., Yang, Z., and Chen, L. (2020). Intercropping with wheat suppressed Fusarium wilt in faba bean and modulated the composition of root exudates. *Plant and Soil* pp. 1-12.

Mahalingam, T., Guruge, B.M.A., Somachandra, K.P., Rajapakse, C.S., and Attanayake, R.N. (2017). First report of white mold caused by *Sclerotinia sclerotiorum* on cabbage in Sri Lanka. *Plant Disease*101(1): 249-249.

Maheshwari, S.K., Singh, D.V., and Singh, S.B. (2000). Effect of temperature and pH on growth and sporulation of *Alternaria alternata* causing Alternaria leaf spot of *dolichos bean*. *Annals of Plant Protection Sciences*, 8(1): 33-35.

Mahmoud, A.F.A. (2016). Evaluation of certain antagonistic fungal species for biological control of faba bean wilt disease incited by *Fusarium oxysporum*. *Journal of Phytopathology and Pest Management* pp.1-14.

Manjunath, B., Jayaram, N.E.E.T.H.A., Ramappa, H.K., Byre, G., Kumar, G.N., and Kumar, H.B. (2012). Status and distribution of anthracnose disease of Dolichos bean in southern Karnataka. Department of Plant Pathology, UAS, GKVK, Bengaluru, Karnataka, 5(2):140-142.

Melzer, M.S., and G.J. Boland. (2001). First report of angular leaf spot caused by *Phaeoisariopsis griseola* on bean in Ontario, Canada. *Plant Disease* 85:919. doi:10.1094/PDIS.2001.85.8.919D

Mendes, B.M.J., and Bergamin Filho, A. (1989). Influence of temperature, wetness duration, and leaf type on the quantification of monocyclic parameters of bean rust. *Journal of Phytopathology*126(2): 183-189.

Mengesha, G.G., and Yetayew, H.T. (2018). Distribution and association of factors influencing bean common bacterial blight (*Xanthomonas axonopodis pv. phaseoli*) epidemics in Southern Ethiopia. *Archives of Phytopathology and Plant Protection* 51(19-20): 1066-1089.

Mersha, Z., and Hau, B. (2011). Reciprocal effects of host and disease dynamics in the bean rust pathosystem. *Journal of Plant Diseases and Protection* 118(2): 54-62.

Miklas, P.N., Kelly, J.D., Beebe, S.E., and Blair, M.W. (2006). Common bean breeding for resistance against biotic and abiotic stresses: from classical to MAS breeding. *Euphytica* 147: 105–131.

Mohammed, A. (2013). An Overview of Distribution, Biology and the Management of CommonBean Anthracnose. *Journal of Plant Pathology and Microbiology* 4: 193. doi:10.4172/2157-7471.1000193

Mohammed, A., Ayalew, A., and Dechassa, N. (2013). Effect of Integrated Management of Bean Anthracnose (*Colletotrichum lindemuthianum* Sacc. and Magn.) Through Soil Solarization and Fungicide Applications on Epidemics of the Disease and Seed Health in Hararghe Highlands, Ethiopia. *Journal of Plant Pathology and Microbiology* 4: 182.

Monda, E.O., Asanga, D.O., Okemo, P.O., Ndegwa, A., and Mariita, M. R. (2009). Efficacy of selected plant extracts against bean rust disease (*Uromyces appendiculatus*) on French bean (*Phaseolus vulgaris*). *Journal of tropical microbiology and Biotechnology* 5:1.

Monda, E.O., Munene, S., Ndegwa, A. (2003). Snap bean production constraints in Kenya. *African Crop Science* 6:683-687.

Mondal, K.K. (2004). Integrated management strategies for fuscous blight and floury leaf spot of rajmash. *Indian Phytopathology*57(2): 135-139.

Monter, B.R., Cruz, C.V., and Domingo, P.M. (2012). Plant disease for bean rust control *Uromyces appendiculatus.Agrociencia* 1(3): 99-106, *International Journal of Advancements in Research and Technology* 1(1).

Muthomi, J.W., Muimui, K.K., and Kimani, P.M. (2011). Inheritance of resistance to Angular Leaf Spot in yellow beans. *African Crop Science Journal* 19(4): 267- 275.

Nahar, M.S., Naher, N., Alam, M.J., Hussain, M.J., Yasmin, L., Mian, M.Y., and Rosa, C. (2020). Survey, morphology and white mold disease of country bean (*Lablab purpureus L*.) caused by *Sclerotinia sclerotiorum* (Lib.) de Bary in-relation to soil physico-chemical properties and weather conditions in Bangladesh. *Crop Protection* 135: 104825.

Najar, A., Makkouk, K.M., Boudhir, H., Kumari, S.G., Zarouk, R., Bessai, R., and Othman, F.B. (2000). Viral diseases of cultivated legume and cereal crops in Tunisia. *Phytopathologia mediterranea*39(3): 423-432.

Nasser, L.C.B. (1976). Efeito da ferrugem em diferentes estádios de desenvolvimento do feijoeiro e dispersão de esporos de *Uromyces phaseoli* var. typica Arth. M.S. thesis. Universidade Federal de Viçosa, MG, Brazil.

Nienhaus, F., and Saad, A.T. (1967). First report on plant virus diseases in Lebanon, Jordan, and Syria. *Zeitschrift für Pflanzenkrankheiten (Pflanzenpathologie) und Pflanzenschutz*, pp. 459-471.

Nzungize, J.R., Lyumugabe, F., Busogoro, J.P., and Baudoin, J.P. (2012). Pythium root rot of common bean: biology and control methods. *A review. BASE*.

Opio, F., Ugen, M., Namayanja, A., Mugagga, I. and Mawejje, D. (2007). Improving food security in southwestern Uganda by transferring and promoting resistant varieties and integrated management packages for BRR. Biotechnology, Breeding and Seed Systems for African Crops Conference, 23–30 March 2007. Maputo: IIAM.

Osdaghi, E., Taghavi, S.M., Hamzehzarghani, H., Fazliarab, A., Harveson, R.M., and Lamichhane, J.R. (2016). Occurrence and characterization of a new red-pigmented variant of *Curtobacterium flaccumfaciens*, the causal agent of bacterial wilt of edible dry beans in Iran. *European Journal of Plant Pathology* 146(1): 129-145.

Osman. A.G. and Elsheikh, E.A.E. (1994). Possibility of controlling Bean yellow mosaic virus using nitrogen fixation in faba bean. *University of Khartoum Journal of Agricultural Sciences* 2(1): 93-108.

Otsyula, R.M., Buruchara, R.A., Mahuku, G., and Rubaihayo, P. (2003). Inheritance and transfer of root rots (*Pythium*) resistance to bean genotypes. *African Crop Science Society* 6: 295-298.

Paparu, P., Acur, A., Kato, F., Acam, C., Nakibuule, J., Musoke, S., and Mukankusi, C. (2018). Prevalence and incidence of four common bean root rots in Uganda. *Experimental Agriculture 54*(6): 888-900.

Papitha, K., Sanjeevkumar, K., Balabaskar, P., and Kumar, S. (2020). Bioefficacy Evaluation of *Serratia Marcescens* Against Anthracnose (*Colletotrichum Lindemuthianum* (Sacc. and Magnus) Briosi and Cavara) Disease in Dolichos Bean. *Plant Archives 20*(1): 493-496.

Pastor, C.E., Juan, R., Pastor, J.E., Alaiz, M., Giron, C.J. and Vioque, J. (2011). Antioxidative activity in the seeds of 28 Vicia species from Southern Spain. *Journal of Food Biochemistry* 35(5): 1373-1380.

Phabiola, T.A., Suastika, G., Nurulita, S., Nyana, I.D.N., Temaja, I.G.R.M., and Sudana, M. Mungbean Yellow Mosaic India and Bean Common Mosaicviruses Induced Severe Epidemic of Yellowing and Mosaic Vein Banding Diseases, Respectively, on Yardlong Bean in Bali, Indonesia.

Phillips, A.J.L. (1994). Occurrence of scab of *Phaseolus vulgaris* caused by *Elsinoë phaseoli* in South Africa. *Plant pathology* 43(2): 417-419.

Popovic, T., Starovic, M., Aleksic, G., Zivkovic, S., Josic, D., Ignjatov, M. and Milovanovic, P. (2012). Response of differentbeans against common bacterial blight disease caused by *Xanthomonas axonopodis pv.Phaseoli*. *Bulgarian Journal of Agricultural Science* 18: 701-707.

PPRC (Plant Protection Research Center). (1996). Progress report for the period of 1995/96. Ambo (PPRC). Ambo, Ethiopia, pp. 53.

Prabhu, S.D., and Rajeswari D.R. (2018). Nutritional and Biological Properties of *Vicia faba*L .: A Perspective Review. *International Food Research Journal* 25(4): 1332–40.

Prajapati, C.R., and Narain, U. (2008). Effect of fungicides and neem formulations on management of sclerotinia rot of Dolichos bean (*Dolichos lablab L.*). *Agricultural Science Digest* 28(2): 133-135.

Prova, A., Akanda, M.A.M., Islam, S., Sultana, F., Islam, M.T., Hossain, M.M. (2014). First report of stem and pod blight of hyacinth bean caused by *Sclerotinia sclerotiorum*. *Journal of Plant Pathology* 96: 603-611.

Radwan, D.E.M., Lu, G., Fayez, K.A., and Mahmoud, S.Y. (2008). Protective action of salicylic acid against bean yellow mosaic virus infection in *Vicia faba* leaves. *Journal of Plant Physiology* 165(8): 845-857.

Rahman, M.S., Ahmed, M.S., and Haque, K.R. (1985). Study on the morphological characters of twenty local collections of country bean. Bangladesh Hort. 13(1+2): 51-55.

Rava Seijas, C.A., Sartorato, A., and Porto de Carvalho, J.R. (1985). Yield losses in dry bean (*Phaseolus vulgaris L.*) caused by angular leaf spot (*Isariopsis griseola* Sacc.). *Annual Report of the Bean Improvement Cooperative* 28: 5–6.

Ravi, S., Sabitha, D., Valluvaparidasan, V., and Jayalakshmi, C. (2000). Production of *Colletotrichum lindemuthianum* free French bean seeds. *Legume Research* 23: 170-173.

Rehana, M.J. (2006) Effects of phosphorous and mulching on the growth and yield of French bean. MS thesis, Department of Horticulture, Bangladesh Agricultural University, Mymensingh-2204, pp. 1-92.

Rico, A., López, R., Asensio, C., Aizpún, M.T., Asensio-S.-Manzanera, M.C., and Murillo, J. (2003). Nontoxigenic strains of *Pseudomonas syringae pv. phaseolicola* are a main cause of halo blight of beans in Spain and escape current detection methods. *Phytopathology* 93(12): 1553-1559.

Roberts, M.R., and Paul, N.D. (2006). Seduced by the dark side: Integrating molecular and ecological perspectives on the influence of light on plant defence against pests and pathogens. *New Phytologist* 170: 677–699.

Rover, D.C. (1998). Microbial safety evaluations and recommendations on fresh produce. *Food Control* 9(6):321-347.

Rubiales, D., and Trapero Casas, A. (2002). Occurrence of *Didymella fabae*, the teleomorph of Ascochyta fabae, on faba bean straw in Spain. *Journal of Phytopathology* 150(3): 146-148.

Sahile, S., Ahmed, S., Fininsa, C., Abang, M. M., and Sakhuja, P. K. (2008). Survey of chocolate spot (*Botrytis fabae*) disease of faba bean (*Vicia faba L*.) and assessment of factors influencing disease epidemics in northern Ethiopia. *Crop protection* 27(11): 1457-1463.

Sahile, S., Fininsa, C., Sakhuja, P. K., and Ahmed, S. (2008). Effect of mixed cropping and fungicides on chocolate spot (*Botrytis fabae*) of faba bean (*Vicia faba*) in Ethiopia. *Crop protection* 27(2): 275-282.

Sahile, S., Sakhuja, P. K., Fininsa, C., and Ahmed, S. (2011). Potential antagonistic fungal species from Ethiopia for biological control of chocolate spot disease of faba bean. *African Crop Science Journal* 19(3): 213-225.

Saikia, P.C., Sarker, C.R., Boura, I., (1999). Chemical composition, anti-nutritional factors and effect of cooking on nutritional quality of rice bean (*Vigna umbellate*). *Food Chemistry* 67:347-352.

Salegua, V., Melis, R., Fourie, D., Sibiya, J., and Musvosvi, C. (2020). Screening Andean Diversity Panel Dry Bean Lines for Resistance to Bacterial Brown Spot Disease Under Field Conditions in South Africa. *Plant Disease*104(9): 2509-2514.

Sanjeev kumar K., Balabaskar, K., and Kumar, S. (2020). Bioefficacy Evaluation of *Serratia marcescens*against Anthracnose (*Colletotrichum Lindemuthianum* (Sacc. and Magnus) Briosi and Cavara) Disease In Dolichos Bean. *Plant Archives* 20(1): 493-496.

Sarma, B., Sarma, A., Handique, G.K., and Handique, A.K. (2010). Evaluation of Country Bean (*Dolichos lablab*) Land Races of North East India for Nutritive Values and Characterization through Seed Protein Profiling. *Legume Research-An International Journal* 33(3):184-189.

Scholthof, K.B.G. (2007). The disease triangle: pathogens, the environment and society. *Nature Reviews Microbiology* 5(2): 152-156.

Schwartz, H.F., and Singh, S.P. (2013). Breeding common bean for resistance to white mold: A review. *Crop Science* 53(5): 1832-1844.

Schwartz, H.F., and Steadman, J.R. (1989). White mold. In: H.F. Schwartz and M.A. Pastor Corrales, editors, Bean production problems in the tropics. 2nd ed. CIAT, Cali, Colombia. pp. 211–230

Schwartz, H.F., Correa, V.F., Pineda, D.P.A., Otoya, M.M., and Katherman, M.J. (1981). Dry bean yield losses caused by Ascochyta, angular, and white leaf spots in Colombia. *Plant Disease* 65: 494-496.

Schwartz, H.F., Gent, D.H., Franc, G.D., and Harveson, R.M. (2011). Bacterial Brown Spot. *Legume ipmPIPE Diagnostic Pocket Series. Legume ipmPIPE*.

Sen, B. (2000). Biological control: A success story. *Indian Phytopathology* 53: 243-249

Shands, H., Vieira, C., and Zaumeyer, W.J. (1964). Observations on dry bean diseases in Brazil. *Plant Disease* 48: 784-787.

Sharma, P. N., Sharma, O. P., Padder, B. A., and Kapil, R. (2008). Yield loss assessment in common bean due to anthracnose (*Colletotrichum lindemuthianum*) under sub temperate conditions of North-Western Himalayas. *Indian Phytopathology* 61(3):323.

Sharma, P.N., Padder, B.A., Sharma, O.P., Pathania, A., and Sharma, P. (2007). Pathological and molecular diversity in *Colletotrichum lindemuthianum* (bean anthracnose) across Himachal Pradesh, a north-western Himalayan state of India. *Australasian Plant Pathology* 36:191–197.

Shivran, M., Ghasolia, R.P., Bajaya, T., and Choudhary, M. (2020). Evaluation of environmental factors for optimum growth of *Rhizoctonia solani* causing root rot of cluster bean (*Cyamopsis tetragonoloba*). *International Journal of Conservation Science*8(3): 2178-2181.

Shtienberg, D., Kimber, R.B.E., McMurray, L., and Davidson, J.A. (2006). Optimisation of the chemical control of ascochyta blight in chickpea. *Australasian Plant Pathology* 35(6): 715-724.

Sibiko, K.W., Ayuya, O.I., Gido, E.O. (2013). Mwangi JK. An analysis of economic efficiency in bean production : evidence from eastern Uganda. Journal of Economics and Sustainable Development, 4(13): 1-10.

Sindhan, G.S. (1983). Effect of temperature and relative humidity on the development of anthracnose french bean. *Progressive Horticulture, Lucknow* 15(1/2): 132-135.

Singh, G., and Gupta, S.K. (2019). Role of temperature, relative humidity and rainfall in the development of French bean rust (*Uromyces appendiculatus*). *Indian Phytopathology*72(2): 271-280.

Singh, J., Kumar, A., and Sharma, S. R. (2020). Efficacy of Integrated Management of Web Blight of Mungbean in Kymore Plateu and Satpura Hills Agroclimatic Zone of Madhya Pradesh, India. *Int. J. Curr. Microbiol. App. Sci*, 9(3): 450-458.

Singh, P.K., Rai, N., Singh, D.V., and Singh, A.P. (2012). Incidence of Dolichos yellow mosaic virus (DYMV) and yield potential in Indian bean (*Lablab purpureus*) F1'S. *Journal of Agricultural Technology* 8(4): 1469-1474.

Singh, S.P., and Schwartz, H. F. (2015). Breeding common bean for resistance to diseases: A review. *Crops Science* 50: 2199-2223.

Skiles, R.L., and Cardona-Aivarez, C. (1959). Mancha Gris, a new leaf disease of bean in Colombia. *Phytopathology* 49:133-135.

Smith, G., and Wyllie, T. (1999). Charcoal rot, in Compendium of Soybean Disease, 4th Edn, ed St. Paul (Minnesota, MN: American Phytopathological Society), pp. 29–31.

Steadman, J.R., and Boland, G. (2005). White mold. In: H.F. Schwartz, J.R. Steadman, R. Hall, and R.L. Forster, editors, Compendium of bean diseases. 2nd ed. Am. Phytopath. Soc., St. Paul, MN. pp. 44–46.

Steadman, J.R., Pastor-Corrales, M.A., and Beaver, J.S. (2002). An overview of the 3rd bean rust and 2nd bean common bacterial blight international workshops, March 4-8, 2002, Pietermaritzburg, South Africa. *Annual Report-Bean Improvement Cooperative*45: 120-124.

Stenglein, S., Ploper, L.D., Vizgarra, O., and Balatti, P. (2003). Angular leaf spot: a disease caused by the fungus *Phaeoisariopsis griseola* (Sacc.) Ferraris on *Phaseolus vulgaris* L. *Advances in applied microbiology* 52: 209-244.

Sultana, N. (2001) Genetic variation of morphology and molecular markers and its application to breeding in Lablab bean. PhD Thesis, Kyshu University, Fukuoka, Japan, pp. 143.

Sultana, R., ISLAM, S., ISLAM, A., and Sikdar, B. (2018). Identification of pathogen causing common bacterial blight (CBB) of bean through the biochemical and molecular pathway and their management system. *Journal of Entomology and Zoology Studies* 6: 752-757.

Swart, L., Crous, P.W., Kang, J.C., Mchau, G.R., Pascoe, I., and Palm, M.E. (2001). Differentiation of species of *Elsinoë* associated with scab disease of Proteaceae based on morphology, symptomatology, and ITS sequence phylogeny. *Mycologia* 93(2): 366-379.

Tadesse, T., Ahmed, S., Gorfu, D., Beshir, T., Fininsa, C., Abraham, A., Ayalew, M., Tilahun, A., Abebe, F. and Meles, K. (2009). Review of research on diseases food legumes.In: Tadesse, A. (ed). Increasing crop production through improved plant protection. Volume 1. Proceeding of the 14thannual conference of the plant protection society of Ethiopia (PPSE). 19-22 Decembers 2006, AddisAbaba, Ethiopia. PPSE and EIAR, Addis Ababa Ethiopia pp. 598.

Taylor, J. D., and Dudley, C. L. (1977). Seed treatment for the control of halo blight of beans *(Pseudomonas phaseolicola*). *Annals of Applied Biology* 85(2): 223-232.

Teixeira, P. H., Lima, R.C., Bonicontro, B.F., Mendes, O.L., Soares, B.A., Carneiro, J.E., and Vieira, R.F. (2019). Management of white mold in common bean using partial resistance and fungicide applications. *Crop Protection*124: 104867.

Toor, M.D., Adnan, M., ur Rehman, F., Tahir, R., Saeed, M.S., Khan, A.U., and Pareek, V. (2021). Nutrients and Their Importance in Agriculture Crop Production; A Review, *Indian Journal of Pure and Applied Biosciences* 9(1): 1-6. doi: http://dx.doi.org/10.18782/2582-2845.8527.

Udayashankar, A.C., Chandra Nayaka, S., Niranjana, S.R., Lund, O.S., and Prakash, H.S. (2011). First report of Bean common mosaic virus infecting *Lablab purpureus* in India. *Plant disease* 95(7): 881-881.

Uddin, M., Bakr, N., Islam, M.A., Hossain, M.R., and Hossain, M.I. (2013). Bioefficacy of Plant Extracts to Control Cercospora Leaf Spot of Mungbean (*Vigna radiata*). *International Journal of Agricultural Research, Innovation and Technology* 3: 60-65.

UPMANYU, S., and Gupta, S.K. (2005). Influence of environmental factors on the progress of root rot and web blight (*Rhizoctonia solani*) of French bean. *Indian Phytopathology*58(1): 79-83

Vargas, E. (1980). La roya. Problemas de Producción del Fríjol: Enfermedades, Insectos, Limitaciones Edáficas e Climáticas de *Phaseolus vulgaris*. H. P. Schwartz and G. E. Gálvez, eds. CIAT, Cali, Colombia) pp. 17-36.

Vieira, C. (1967). O Feijoeiro-Comum. Cultura, Doencas e Melhoramento. pp. 84-124. 1mprensa Universitaria, Vicosa, Brazil.

Vieira, C. and Shands, H.L. (1965). A mancha farinhosa do feijoeiro comum. *Revista Ceres* 71: 311-314. 39.

Vieira, C., J.F.C. Neto and J.T. Athayde. (1977). Mancha-gris e manchafarinhosa do feijoeiro no estado do Espirito Santo. *Revista Ceres* 24: 425-426

Vioque, J., Alaiz, M. and Girón, C.J. (2012). Nutritional and functional properties of *Vicia faba* protein isolates and related fractions. *Food Chemistry* 132(1): 67-72.

W.J. and Thomas, H.R. (1957). A monographic study of bean diseases and methods for their control. U.S.D.A. *Agricultural Technology* Bull. No. 868: 255.

Wellman, F.L. (1977). Dictionary of Tropical American Crops and Their Diseases. pp. 312-321. The Scarecrow Press 1nc., Metuchen, New Jersey, pp. 495.

Widers, I.E. (2006). The beans for health alliance: a public-private sector partnership to support research on the nutritional and health attributes of beans. *Annual Reproduction of Bean Improvement Crop*49(1): 3-5.

Wortman, S.C., Kirkby, A.R., Eledu, A.C., and Allen, J.D. (2004). Atlas of *Phasealus vulgaris* L. production in Africa. Cali, Colombia, International Centre for Tropical Agriculture, CIAT, pp. 131.

Wortmann, C.S., and Allen, D.J. (1994). African bean production environments: their definition, characteristics and constraints. *Occasional Publication Series* 11.

Wrather, J.A., Anderson, T.R., Arsyad, D.M., Tan, Y., Ploper, L.D., and Puglia, A. P. (2001) Soyabean disease loss estimates for the top 10 soybean producing countries in Can. *Journal of Plant Pathology* 23: 115-121.

Xavery, P.R., Kalyebara, C., Kasambala, and Ngulu, F. (2005). The impact of improved bean varieties in Northern Tanzania. Selian Agricultural Research Institute (SARI) Tanzania in collaboration with the Pan-African Bean Research alliance (PABRA) and the International Centre for Tropical Agriculture (CIAT).

Ye, X.Y., Wang, H.X., and Ng, T.B. (2000) Dolichin, a new chitinase-like antifungal protein isolated from field beans (*Dolichos lablab*). *International* Journal of *Applied* Biochemistry and Biotechnology269(1): 155-159.

Yu, T.F. (1947). Cercospora leaf spot of broad bean in china. *Phytopathology* 37: 174-179.

Zaumeyer, W.J. and Thomas, H.R. (1957). A monographic study of bean diseases and methods for their control. *Technical Bulletins*, United States Department of Agriculture, Economic Research ServiceNo. 868, 255 p. Available at Doi: 10.22004/ag.econ.169625.