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Survey and documentation of *Potyvirus* infecting cluster beans (*Cyamopsis tetragonoloba* (L.) Taub.)

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Abstract
Cluster bean (guar) scientifically called as *Cyamopsis tetragonoloba* (L.) *Taub.* belongs to the family Leguminosae. Cluster bean mosaic disease caused by *bean common mosaic virus* belongs to the family *Potyviridae* is one of the major viral diseases which affects the yield of cluster beans. A roving survey was conducted in major cluster bean growing areas of Madurai and Coimbatore. The *potyvirus* disease incidence ranged from 26 to76 percent. Maximimum per cent disease incidence was observed in the fields of cluster beans grown in the orchard of Agricultural College and Research Institute, Madurai i.e., (76 per cent) and the least (26 per cent) in the fields of Periyailanthaikulam village of Madurai district. In plants infected with *Potyvirus*, symptoms like downward curling, mosaic patches, vein necrosis were observed. Infected plants had produced minimum numbers of flowers and pods, pods were thin with immature and discoloured seeds.

Keywords: Cluster bean, leguminosae, *Potyviridae,* bean common mosaic virus etc.

Introduction

Cluster bean (*Cyamopsis tetragonoloba* (L.) Taub.) commonly known as guvar bean, gavar and gawar is mainly grown in arid and semi-arid regions and has drought tolerance (Kumar and Rodge, 2012). The crop has been cultivated in different countries of the world like India, Pakistan, USA, Italy, Morocco, Germany and Spain (Punia *et. al.,* 2009*)* [11]. Among all the countries, India constitutes about 80 per cent of the world's total production (Bhatt, *et. al.,* 2016) [3]. The main cluster bean growing states are Rajasthan, Haryana and others areas receiving annual rainfall from 315mm to 750 mm (Shivaran, *et al.,* 2020). Among the states, Rajasthan and Gujarat regions occupy the largest area of cultivation about 80 percent. The area under the production of beans in India was 219 million hectares (Mha), and productivity 2269 metric tons (MT), with yield about10.4 MT/ha in the year 2020-2021. This legume is a valuable plant in a crop rotation cycle as it lives in symbiosis with nitrogen fixing bacteria (Anupama, *et al.,* 2017) [1]. The green pods of the gaur are grown for multiple purposes *viz.* vegetable, fodder, green manure, and for endospermic gum (guar gum). Guar gum is naturally present in endosperm of the seed (Bhatt, *et al.,* 2016) [3]. Guar gum is used in oil and petroleum industries, food industries pharmaceutical industries, paper industries and mining fields (Manivannan, *et al.,* 2015) [7]. It also used in folk medicine as it acts as appetizer, digestive aid and useful in anti-hyper glycaemic and hypolipidemic effects (Badr, *et al.,* 2014) [2].

This crop is affected by many fungal, bacterial and viral diseases. Among them, viral diseases becoming a major threat for cluster bean production. Bean common mosaic virus (BCMV) is one the important and widespread viral diseases affecting many legume crops across the world. The BCMV is a *Potyvirus* belongs to the family *Potyviridae*. It is a helical rod-shaped virus measuring about 750nm length and 15nm diameter size and transmitted by mechanical inoculation or sap, seed and the insect vectors belong to the family *Aphididae* in a non-persistent manner (Gillaspie, 1998) [4]. The loss due to BCMV range from 6 to 98 per cent. In general, BCMV infection cause three types of symptoms *viz*., leaf rolling, blistering mosaic pattern, vein banding ad stunted plant growth *etc*. The symptoms like mottling and malformation of bean plants were caused by the seedborne inoculum. Systemically infected plants bear smaller, few number of pods and discoloured seeds. Other diagnostic symptoms include leaf distortion, blistering, dwarfing, downward curling, necrosis, local lesions and malformation of flowers and buds etc. Bean common mosaic virus (BCMV) disease of cluster bean showed characteristic symptoms.

Initial symptoms were reduction in leaf lamina by downward curling of leaves. In level of severity symptoms like mosaic, puckering and necrosis were also observed in infected leaf. In addition, the leaves became leathery and distorted at maturity. The infected plant produced lesser number of flowers and pods with few light weight, small, discoloured seeds with less yield (Pathania, 2012) [10]. *BCMV* could be spread by seed, sap inoculation and vectors like aphid (*Aphis croccivora*) (Pathania, 2012) [10]. Survey and assessment of diseases are essential to device suitable control measures.

Materials and Methods
Survey and documentation of bean common mosaic disease
A roving survey was conducted during kharif season (2020-2021) in various cluster bean growing areas like *viz*., Palamedu, Thathakavundanpatti, Kinnimangalam Periyailanthaikulam, Chellanagoundanpatti, Kovilappangudi, Podumbu, Singampunemeri, AC&RI Madurai, Kattakulam kanmai, Ramayagoundenpatti, Thirumangalam, Alagapuri, Pudhupatti and TNAU Coimbatore. In each field 5 plots (10x10 m2) were selected and observed for the viral disease incidence by counting the total number of plants observed and number of plants infected by potyvirus. Then the percent disease incidence was calculated by using the formula (Wheeler, 1969) [14].

$$\text{Per cent disease incidence} = \frac{\text{Number of diseased plants Total}}{\text{Number of plants examined}} \times 100$$

During the survey cluster bean plants were also observed for the different types of *Potyvirus* symptoms and documented for further study.

Results and discussion Survey
Roving survey was conducted to assess the bean common mosaic disease incidence in major cluster bean growing areas. The maximum percent disease incidence was observed in the fields of cluster bean located in AC & RI, Madurai campus (76.0%) followed by Podumbu (66.0%), Alagapuri (60.0%) and kovilappangudi (56.0%) respectively. The least in the fields of Periyailanthaikulam 26 percent disease incidence. The main reason for the variations in the disease incidence and severity might be due to variation in the sources of inoculum, climate condition and vector. In some areas farmers grown cluster bean year-round as pure or inter crop. (Table 1. and Fig. 1)

Documentation of Bean common mosaic symptoms
Cluster beans grown in and around Madurai district in Tamil Nadu were surveyed for the occurrence of different viral diseases. The survey results shown that many of the plants observed were infected with virus belongs to the family *Potyviridae* which cause mosaic disease. The plant with symptoms of *Potyvirus* were documented. The diagnostic symptoms recorded were downward curling, mosaic patches. Leaves were leathery and distorted at time of maturity. In severe cases the leaves shown necrosis of veins, lead to death of the plant Infected plants produced few numbers of flowers and pods, pods were thin with immature and discoloured

seeds (Fig.2). Pathania (2012) [10] reported that the symptoms appeared in *Potyvirus* infected cluster beans plants from germination to the harvest stage. Initial symptoms were reduction in leaf lamina by downward curling of leaves. In level of severity symptoms like mosaic, puckering and necrosis were observed in infected leaf. The leaves become leathery and distorted at maturity. The infected plant produced lesser number of flowers and pods with small discoloured seeds and *Bean common mosaic virus* was confirmed by ELISA. Nalini *et al.,* (2006) [9] reported the *bean common mosaic virus* (BCMV) seed transmission and symptoms in french beans. Seed transmission was observed in the fully expanded primary leaves of 10-day- old french bean seedlings with symptoms of mosaic and vein-banding. Later, first trifoliate and the subsequent trifoliate developed mosaic and mottle symptoms, typical symptoms of BCMV infection confirming the seed transmission. Melgarejo *et al.,* (2007) [8] reported the effect of BCMV and *bean common mosaic necrosis virus* (BCMNV) in Lima bean, the symptoms were noticed. In younger leaves symptoms include mild and yellow mosaic, leaf blistering and reduced leaf size, resulting in leaf deforming mosaic symptoms. Kapil *et al.,* (2011) [12] has reported that BCMV and BCMNV infecting common bean have similar symptoms, except black root and top necrosis by BCMNV and necrosis by BCMV. BCMV induces the formation of cylindrical ''pinwheel'' inclusions in the cytoplasm of infected cells of susceptible cultivars. Jo *et al.,* (2021) [5] identified the seven common bean (*Phaseolus vulgaris* L.) plants of cultivar "Tigerskin" grown in South Korea has shown symptoms such as light and dark mosaic, leaf distortion and leaf roll, and mottling in the leaves and the viral agent was identified as BCMV. Sarmiento *et al.,* 2021 [13] observed the symptoms included green mosaic patterns along leaf veins, stunted growth, and chlorosis in *A. purpurata* plants. Infected leaves were collected and total nucleic acids were extracted for testing by PCR by using genus-degenerate primers, Direct Sanger sequencing and analysis of the resultant PCR products from the two samples using the potyviral primers indicated the presence of BCMV. BLASTn search showed that the consensus potyviral sequence (MN073501) shared 97% identity to the BCMV clone zz1 (KM878928), infecting sesame (*Sesamum indicum*) in China.

Table 1: Percent disease incidence in different regions.

S.no.	Place	Percent Disease Incidence
1	Palamedu	48.0
2	Thathakavundanpatti	32.0
3	Kinnimangalam	50.0
4	Periyailanthaikulam	26.0
5	Chellanagoundanpatti	52.0
6	Kovilappangudi	56.0
7	Podumbu	66.0
8	Singampunemeri	42.0
9	AC&RI Madurai	76.0
10	TNAU Coimbatore	38.0
11	Kattakulam kanmai	34.0
12	Ramayagoundenpatti	36.0
13	Thirumangalam	30.0
14	Alagapuri	60.0
15	Pudhupatti	44.0
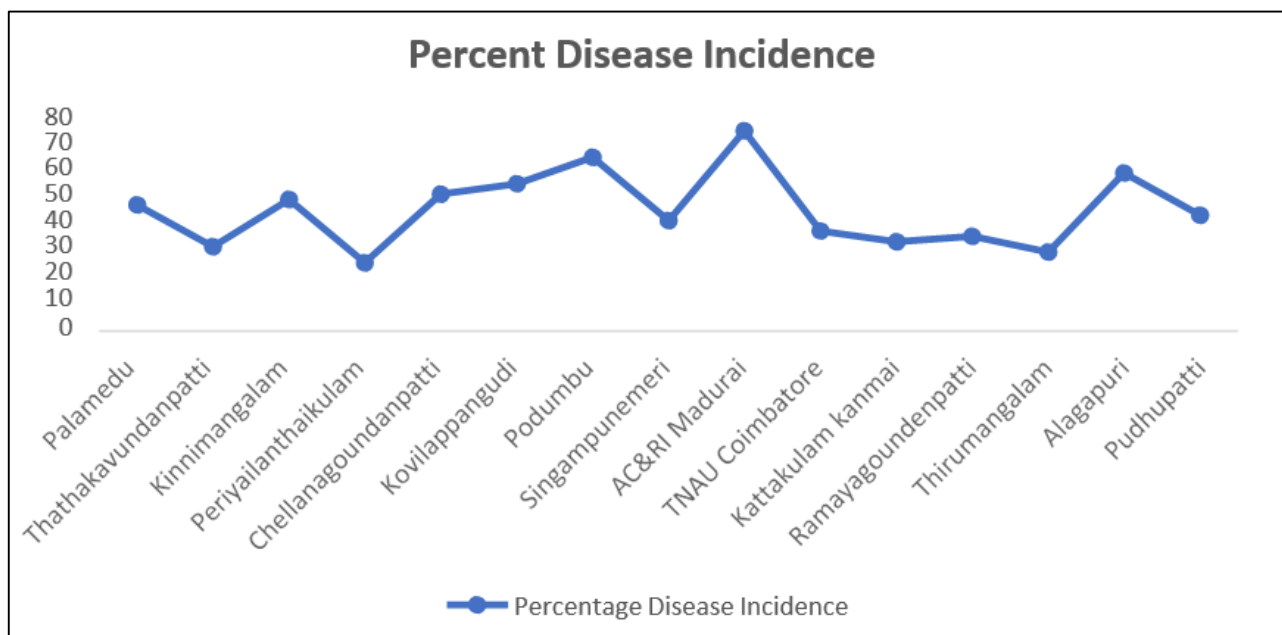
Fig 1: Bar chart indicating percent disease incidence in different regions

a.	b.	c.	d.	e.

Fig 2: Documentation of symptoms observed in *potyvirus* infected cluster beans (CB) plants. a. Infected CB plant showing mosaic symptoms on leaves. b. Infected leaves from CB showing mosaic patches. c. Infected CB plant showing downward leaf curling symptoms. d Infected CB plant showing severe downward leaf curling symptoms and leaf distortion.. e. CB plant infested by aphids showing symptom of vein necrosis.

Conclusion

The production and productivity of cluster bean was affected by Bean common mosaic virus, a *potyvirus*. In this study the impact of BCMV on cluster bean in Madurai and Coimbatore was assesses through survey and documentation. Infected plants showed the symptoms of downward leaf curling, mosaic patches, vein necrosis of leaves and stunted growth .The disease severity may lead to lower production of flowers and pods, thereby reducing the yield. Further study at molecular level has to be done to identify the virus species for devising suitable management practices.

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