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RESEARCH PAPER

Incidence, transmission, host range and population dynamics of aphids transmitting bean common mosaic virus of cowpea

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Abstract: Cowpea [*Vigna unguiculata* (Linn.) Wilczek] is an important pulse crop which belongs to family *Fabaceae*. Bean Common Mosaic is a major viral disease in cowpea resulting in significant yield losses to a tune of 70 per cent. The results showed that disease was widespread in all the surveyed areas, with the highest average per cent disease incidence being observed in Bagalkote (29.82%) followed by Vijayapur (27.41%), Dharwad (25.47%) and Belagavi district (18.89%). The disease incidence varied from 3.25 per cent to 69.56 per cent among the villages and from 12.94 per cent to 44.80 per cent among the taluks. The host range and transmission studies revealed that BCMV infecting cowpea is readily transmissible by sap, aphids and through seeds. The mechanical transmission was 71.43 per cent, aphid transmission was found to an extent of 54.42 per cent and the seed transmission of BCMV infecting cowpea was 64.00 per cent. The population of aphid (*Aphis craccivora*) was maximum during the 38th and 39th Standard Meteorological Weeks (SMWs) with the mean value of 92.70 and 81.20, respectively. The aphid population varied at different crop stages. Aphid population build up showed a strong significant negative correlation with rainfall. There was a significant negative correlation with minimum temperature and morning RH.

Key words: Aphid, BCMV, Host range, Incidence, Transmission

Introduction

Cowpea [*Vigna unguiculata* (L.) Wilczek] is an important pulse crop, which belongs to family *Fabaceae*. It is also known as "black eyed bean" or Southern pea in English, while chola or choli, chavli, lobia in various vernacular languages in India. It is used as a vegetable, grain legume, fodder and as a green manure crop. The food legumes being the major source of protein have been grown by farmers for millennia providing nutritionally balanced food to the people. The seeds of cowpea contain 23.40 per cent protein, 18.00 per cent fat, 60.30 per cent carbohydrate and are a rich source of lysine and tryptophan. Like other legumes, cowpea has important beneficial effects in increasing soil fertility status because of its ability to fix atmospheric nitrogen (Sharma *et al*., 2019). In India, it is grown in states of Punjab, Haryana, Delhi and Uttar Pradesh, along with a considerable area in Rajasthan, Karnataka, Kerala, Tamil Nadu, Maharashtra and Gujarat. In India, cowpea occupies an area of about 3.24 lakh ha with an annual production of 1.98 lakh tonnes and average productivity of 822 kg /ha. In Karnataka, area under cowpea is 78,446 ha with annual production of 35,759 t with an average productivity of 460 kg/ ha (Anon., 2022). Cowpea is susceptible to fungal, bacterial and viral diseases to a greater extent along with insects. Disease of cowpea are anthracnose, rust, Cercospora and Pseudocercospora leaf spot, Fusarium wilt, powdery mildew, Rhizoctonia seedling blight, southern blight, stem blight, bacterial blight and viral diseases. Among them, Bean Common Mosaic caused by Bean Common Mosaic Virus (BCMV) is a major viral disease in cowpea. BCMV infecting cowpea produce symptoms like alternate dark and green patches showing severe mosaic mottling on leaves, vein banding, reduction in leaf size, leaf deformation and puckering and downward curling of apical tip of leaves (Aliyu *et al.*, 2012). BCMV is a viral disease that affects cowpea and cause significant yield loss to a tune of 70 per cent (Taiwo and Gonsalves, 1982). The virus is transmitted mechanically, by aphids in a non-persistent manner and through seeds. Seed transmission is the primary mode of dispersal of the virus to new locations. In the recent years, there is an increase in the incidence of BCMV infecting cowpea in northern Karnataka (Shilpashree, 2006; Pavithra 2013).

Material and methods

Survey for the incidence of BCMV infecting cowpea

A roving survey was conducted in Vijayapur, Bagalkote, Dharwad and Belagavi districts of northern Karnataka during *kharif* 2022 to know the occurrence and distribution of Bean Common Mosaic Virus infecting cowpea. The per cent disease incidence was recorded by selecting 10 rows in the field and by counting the total number of plants and number of plants showing BCMV symptoms using the formula given below.

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

The other information with respect to type of varieties grown, cropping system followed and type of symptoms exhibited by the crop *etc*., was recorded. The observations were recorded based on the symptoms observed on the infected cowpea plants like mosaic, puckering, necrosis and vein banding.

Sap transmission

For sap transmission, young leaves (15-20 days old) showing characteristic mosaic, puckering, necrosis, vein

banding symptoms were collected, washed in tap water to remove the dust particles adhering to them and dried between the folds of blotting paper. The leaves were then macerated in chilled mortar and pestle using potassium phosphate buffer (pH 7.0, 0.1M) at the rate of 1ml/g of leaf tissue. The resultant pulp was squeezed through absorbent cotton and the extract thus obtained was used as standard inoculum.

To this standard extract, celite (600 mesh) at the rate of 0.025 g/ml of the extract was added. The inoculum was applied gently on the upper surface of the leaves with a small piece of absorbent cotton wool. Ten plants were maintained to test mechanical inoculation and symptom expression. The inoculated leaves were washed 1-2 minutes after inoculation to remove the excess of inoculum with distilled water from a squeeze bottle and plants were kept under observation for 15-20 days.

Aphid transmission

For aphid transmission, apterous adult aphids were collected from the infected plant in a Petri plate and starved for 30 minutes. Then aphids were transferred to test plants at the rate of twenty aphids per plant for 24 hours of inoculation feeding period. After allowing for 24 hours of inoculation feeding, the aphids were killed by spraying the plants with 0.2 per cent imidacloprid. The inoculated plants were kept in the insect proof micro cages for twenty days for symptom expression. Ten plants were used for aphid transmission studies.

Seed transmission

For seed transmission, seeds were collected from cowpea plants infected with BCMV and sown in polyethylene bags. Twenty five plants were maintained and kept in the insect proof microcages. Seeds collected from healthy plants were kept as control. The plants were observed for symptoms development up to a period of 20 days. The per cent germination and per cent seed transmission were recorded.

Host range

Host range studies were undertaken to know the other hosts for BCMV. The ability of the virus to infect *Leguminosae* family plants species *i.e,* black gram, soybean, green gram, horse gram, field bean and pigeon pea was evaluated. Plants were inoculated with standard extract of virus by mechanical sap inoculation as described earlier. In each plant species, ten plants were inoculated. The inoculated plants were kept in the insect proof microcages and examined periodically for symptom expression. The symptoms expressed by the different plant species were recorded.

Population dynamics

Population dynamics of aphids infecting cowpea was studied at College of Agriculture, Vijayapur during *kharif* 2022 under field condition in a fixed plot size of 15X3 sq. m (45 sq. m). The cowpea plants were raised and maintained without any plant protection measures. Five symptomatic plants were randomly selected for recording the observations. The observations were recorded at weekly interval starting from two weeks after germination till the crop maturity. Aphid population was recorded by counting the number of aphids present in 5 cm length stem or twig per plant. Then aphid population was correlated with the major meteorological factors.

The meteorological data *viz*., temperature, humidity, rainfall and bright sunshine hours during the cropping period were obtained from the Meteorological Observatory, RARS, Vijayapur. A simple correlation was worked out between the population of aphid and abiotic environmental factors using the following formula.

$$r_{xy} = \frac{\Sigma XY - \frac{\Sigma X \Sigma Y}{n}}{\sqrt{\left[\Sigma X^2 - \frac{(\Sigma X)^2}{n}\right]\left[\Sigma Y^2 - \frac{(\Sigma Y)^2}{n}\right]}}$$

Where,

rxy = Simple correlation coefficient X = Abiotic components

Y = The mean number of aphid n = Number of observations

Results and discussion

A roving survey on the incidence of Bean Common Mosaic Virus infecting cowpea crop in districts of northern Karnataka *viz*., Vijayapur, Bagalkote, Dharwad and Belagavi districts was carried out during *kharif* 2022 (Table 1).

The disease incidence of BCMV infecting cowpea ranged from 3.25 per cent to 69.59 per cent in Vijayapur, Bagalkote, Dharwad and Belagavi districts (Table 2). Among the different districts surveyed, the maximum disease incidence was recorded in Bagalkote (29.82%), followed by Vijayapur (27.41%), Dharwad (25.47%) and Belagavi district (18.89%).

Among the 8 taluks of vijayapur district, highest average per cent disease incidence was observed in Vijayapur (44.80%) followed by Sindagi (31.97%), Indi taluk (29.19%), Babaleshwar (28.80%), Nidagundi (22.10%), Talikoti (22.10%), Muddebihal (23.22%) and lowest average per cent disease incidence was observed in Basavana Bagewadi (19.34%) (Fig. 1).

Among 5 taluks of Bagalkote district, highest average per cent disease incidence was observed in Guledagudda (39.25%)

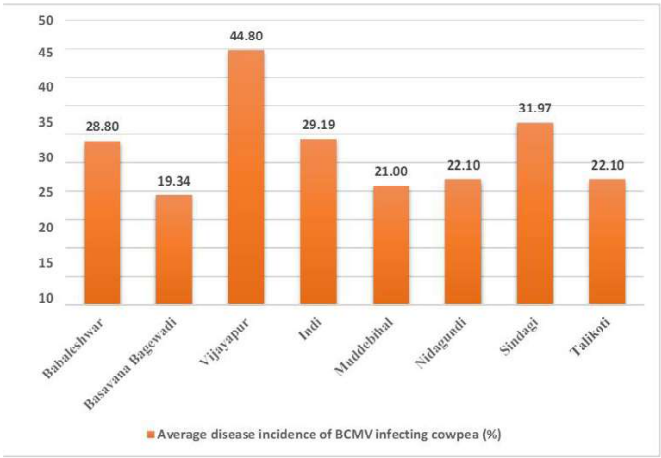


Fig. 1 Average incidence of BCMV infecting cowpea in different taluks of Vijayapur district

Table 1. Survey for the incidence of BCMV infecting cowpea during *kharif* 2022 in northern Karnataka

District	Taluk	Village	Variety	Stage of the crop	Cropping pattern	Acrage	Symptoms observed	Disease incidence (%)
Vijayapur	Babaleshwar	Dudihala	C-152	Vegetative	Sole crop	1.00	Severe mosaic and mottling	34.70
Vijayapur	Babaleshwar	Sarawad	C-152	Flowering	Sole crop	1.75	Mosaic and vein banding	22.90
Vijayapur	Basavana Bagewadi	Ukkali	C-152	Vegetative	Sole crop	2.00	Mosaic and vein banding	19.34
Vijayapur	Vijayapur	Hegadihal	C-152	Vegetative	Sole crop	1.00	Mosaic, blistering and cupping	29.33
Vijayapur	Vijayapur	Aheri	DC-15	Vegetative	Sole crop	1.00	Severe mosaic and mottling	35.50
Vijayapur	Vijayapur	Hitnalli	DC-15 (ACV)	Vegetative	Sole crop	1.00	Severe mosaic and mottling	69.56
Vijayapur	Indi	Hadalasanga	C-152	Vegetative	Sole crop	0.25	Severe mosaic, mottling and puckering	32.25
Vijayapur	Indi	Halagunaki	C-152	Vegetative	Sole crop	0.25	Severe mosaic and mottling	33.00
Vijayapur	Indi	Tadavalaga	DC-15	Vegetative	Sole crop	2.00	Mosaic and vein banding	25.70
Vijayapur	Indi	Alura	DC-15	Vegetative	Sole crop	0.50	Severe mosaic and mottling	26.70
Vijayapur	Indi	Chikkabevanu ra	DC-15	Vegetative	Sole crop	1.00	Severe mosaic and mottling	28.32
Vijayapur	Muddebihal	Madikeshvara	C-152	Flowering	Sole crop	1.00	Severe mosaic and mottling	17.25
Vijayapur	Muddebihal	Taranala	C-152	Vegetative	Sole crop	1.25	Mosaic and puckering	24.75
Vijayapur	Nidagundi	Itagi	DC-15	Vegetative	Sole crop	0.25	Severe mosaic and mottling	25.65
Vijayapur	Nidagundi	Kodagaanura	C-152	Flowering	Sole crop	0.50	Mosaic and vein banding	14.90
Vijayapur	Nidagundi	Muddapura	C-152	Vegetative	Sole crop	2.00	Severe mosaic and mottling	25.75
Vijayapur	Sindagi	Alahalli	C-152	Flowering	Sole crop	1.50	Mosaic and vein banding	27.36
Vijayapur	Sindagi	Balaganura	C-152	Flowering	Sole crop	3.50	Severe mosaic and mottling	31.95
Vijayapur	Sindagi	Malagana	C-152	Vegetative	Sole crop	2.25	Severe mosaic and mottling	38.21
Vijayapur	Sindagi	Kannolli	C-152	Vegetative	Sole crop	1.50	Severe mosaic and mottling	30.37
Vijayapur	Talikoti	Konnura	C-152	Flowering	Sole crop	2.83	Severe mosaic and mottling	17.25
Vijayapur	Talikoti	Talikoti	C-152	Flowering	Sole crop	1.66	Mosaic and vein banding	16.89
Vijayapur	Talikoti	Tamadaddi	DC-15	Vegetative	Sole crop	1.65	Mosaic and vein banding	26.75
Vijayapur	Talikoti	Bijjaragi	DC-15	Vegetative	Sole crop	0.25	Severe mosaic and mottling	27.50
Bagalkote	Badami	Anantagiri	C-152	Vegetative	Sole crop	3.00	Severe mosaic and mottling	28.70
Bagalkote	Badami	Guddadamalla pura	C-152	Vegetative	Sole crop	1.50	Severe mosaic, mottling and puckering	32.00
Bagalkote	Badami	Hosura	DC-15	Vegetative	Sole crop	2.00	Severe mosaic and mottling	28.73
Bagalkote	Badami	Kabbalageri	C-152	Flowering	Sole crop	1.50	Severe mosaic and mottling	23.50
Bagalkote	Badami	Nasagunni	C-152	Vegetative	Sole crop	1.00	Severe mosaic, mottling and puckering	37.25
Bagalkote	Bilagi	Herakal	C-152	Vegetative	Sole crop	2.50	Mosaic and vein banding	25.75
Bagalkote	Guledagudda	Hullikeri	C-152	Flowering	Sole crop	1.50	Severe mosaic, downward curling and mottling	35.50
Bagalkote	Guledagudda	Parvati	DC- 15	Vegetative	Sole crop	2.00	Mosaic, blistering and cupping	42.76
Bagalkote	Guledagudda	Togunasi	C-152	Vegetative	Sole crop	0.75	Mosaic, blistering and cupping	39.50
Bagalkote	Hungund	Kamatagi	C-152	Flowering	Sole crop	2.00	Severe mosaic and mottling	26.00
Bagalkote	Ilkal	Budihala	C-152	Flowering	Sole crop	1.50	Severe mosaic, mottling and puckering	37.60
Bagalkote	Ilkal	Muradi	C-152	Vegetative	Sole crop	2.00	Mosaic and vein banding	14.56
Bagalkote	Ilkal	Vadageri	C-152	Vegetative	Sole crop	2.00	Severe mosaic and cupping	32.00
Dharwad	Hubli	Belagali	DC-15	Vegetative	Sole crop	0.25	Severe mosaic and mottling	24.90
Dharwad	Hubli	Chavaragudda	DC-15	Vegetative	Sole crop	2.00	Severe mosaic and mottling	23.36
Dharwad	Hubli	Gangivala	DC-15	Flowering	Sole crop	1.50	Severe mosaic and mottling	18.95
Dharwad	Hubli	Sherevada	DC-15	Flowering	Sole crop	0.25	Severe mosaic and mottling	27.45
Dharwad	Hubli	Tirumalakoppa	C-152	Vegetative	Sole crop	1.50	Mosaic, blistering and cupping	30.86
Dharwad	Hubli	Kusugalla	C-152	Flowering	Sole crop	2.00	Mosaic and vein banding	17.25
Dharwad	Kalaghatagi	G. Basanakoppa	DC-15	Vegetative	Sole crop	2.50	Severe mosaic and cupping ofleaves	31.75
Dharwad	Kalaghatagi	Linganakoppa	DC-15	Vegetative	Sole crop	1.00	Severe mosaic, mottling and puckering	30.50
Dharwad	Kalaghatagi	Mishreekoti	C-152	Flowering	Sole crop	2.00	Severe mosaic and mottling	23.58
Dharwad	Kundgol	Bilebala	C-152	Vegetative	Sole crop	0.50	Severe mosaic and mottling	26.90
Dharwad	Kundgol	Hirebudihala	C-152	Vegetative	Sole crop	3.00	Severe mosaic and cupping of leaves	29.75

Contd...

Dharwad	Kundgol	Gowdageri	DC-15	Flowering and podding	Sole crop	1.00	Mosaic, blistering and cupping	31.90
Dharwad	Kundgol	Konkanakurahatti	C-152	Vegetative	Sole crop	0.50	Severe mosaic and mottling	27.00
Dharwad	Navalgund	Arekurahatti	C-152	Vegetative	Sole crop	2.00	Mosaic and puckering	12.45
Dharwad	Navalgund	Gudisagara	C-152	Vegetative	Sole crop	1.50	Severe mosaic and cupping of leaves	25.86
Dharwad	Navalgund	Gummagola	C-152	Vegetative	Sole crop	1.00	Severe mosaic and mottling	27.25
Dharwad	Navalgund	Moraba	DC-15	Vegetative	Sole crop	2.00	Mosaic and puckering	16.75
Belagavi	Athani	Hanamapura	C-152	Vegetative	Sole crop	0.25	Severe mosaic and mottling	19.69
Belagavi	Athani	Kiranagi	C-152	Flowering	Sole crop	0.50	Severe mosaic and mottling	24.56
Belagavi	Athani	Tanvashi	DC-15	Vegetative	Sole crop	1.50	Severe mosaic, mottling and puckering	26.35
Belagavi	Bailhongal	Bailhongala	DC-15	Vegetative	Sole crop	1.50	Severe mosaic and mottling	23.10
Belagavi	Bailhongal	Kadasagatti	C-152	Vegetative	Sole crop	1.00	Mosaic and puckering	16.75
Belagavi	Bailhongal	Mugabasava	C-152	Flowering	Sole crop	2.00	Mosaic and puckering	11.15
Belagavi	Chikkodi	Hirekodi	C-152	Vegetative	Sole crop	2.00	Severe mosaic and mottling	23.73
Belagavi	Chikkodi	Kadapura	C-152	Vegetative	Sole crop	0.50	Severe mosaic and mottling	20.00
Belagavi	Chikkodi	Kerur	DC-15	Flowering	Sole crop	1.50	Severe mosaic and mottling	9.40
Belagavi	Chikkodi	Kamatenahatti	C-152	Vegetative	Sole crop	0.50	Mosaic, blistering and cupping	27.18
Belagavi	Gokak	Makkalageri	C-152	Flowering	Sole crop	3.00	Mosaic and puckering	6.25
Belagavi	Gokak	Panchanakyanah atti	DC-15	Vegetative	Sole crop	0.50	Severe mosaic and mottling	20.35
Belagavi	Gokak	Tavaga	DC-15	Vegetative	Sole crop	2.00	Mosaic and puckering	15.68
Belagavi	Hukkeri	Belavi	C-152	Vegetative	Sole crop	2.00	Mosaic and puckering	18.46
Belagavi	Hukkeri	Bassapura	C-152	Vegetative	Sole crop	1.00	Severe mosaic and mottling	21.50
Belagavi	Hukkeri	Hagedala	C-152	Vegetative	Sole crop	2.00	Severe mosaic, mottling andpuckering	27.59
Belagavi	Ramdurg	Chilamura	DC-15	Flowering	Sole crop	2.00	Mosaic and puckering	3.25
Belagavi	Ramdurg	Totagatti	DC-15	Vegetative	Sole crop	1.75	Severe mosaic and mottling	22.62
Belagavi	Savadatti	Rudrapura	C-152	Vegetative	Sole crop	1.50	Severe mosaic and mottling	26.13
Belagavi	Savadatti	Tadasalura	C-152	Vegetative	Sole crop	2.00	Mosaic and puckering	18.06

followed by Badami (30.04%), Ilkal (28.05%), Hungund (26.00%) and lowest average per cent disease incidence was observed in Bilagi (25.75%) (Fig. 2).

Among 4 taluks of Dharwad district, highest average per cent disease incidence was observed in Kundgol (28.89%) followed by Kalaghatagi (28.61%), Hubli (23.80%) and lowest average per cent disease incidence was observed in Navalgund (20.58%) (Fig. 3).

Among 7 taluks of Belagavi district, highest average per cent disease incidence was observed in Athani (23.53%)

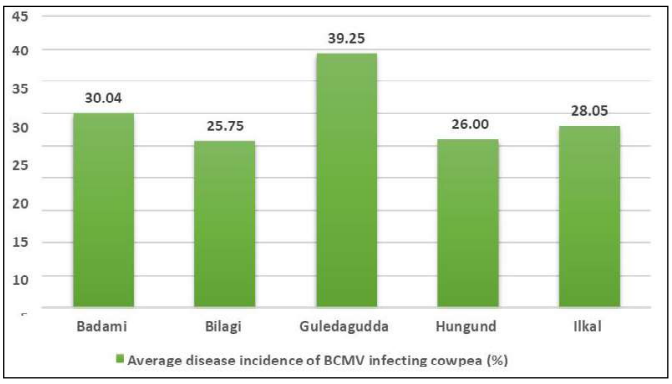


Fig. 2 Average incidence of BCMV infecting cowpea in different taluks of Bagalkote district

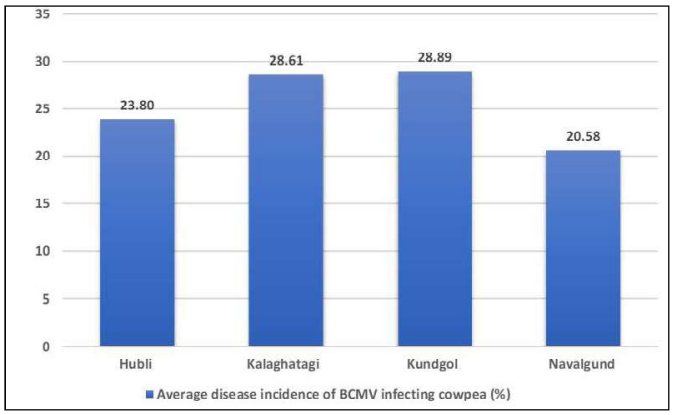


Fig. 3 Average incidence of BCMV infecting cowpea in different taluks of Dharwad district

followed by Hukkeri (22.52%), Savadatti (22.10%), Chikkodi (20.08%), Gokak (14.09%), Bailhongal (17.00%) and lowest average per cent disease incidence was observed in Ramdurg (12.94%) (Fig. 4).

In all the cowpea fields surveyed, BCMV infected plants exhibited symptoms like systemic mosaic with dark and light green patches, slight puckering and dark green vein banding with downward curling of the leaves which was in accordance with the studies by Aliyu *et al.* (2012). Aphids (*Aphis craccivora*) were invariably found in every infected field

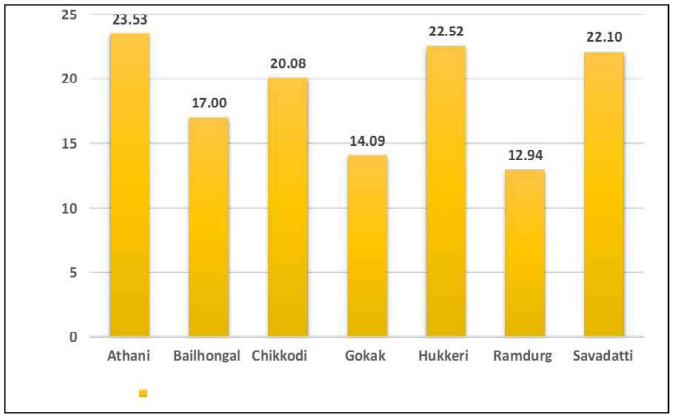


Fig. 4 Average incidence of BCMV infecting cowpea in different taluks of Belagavi district

surveyed. The difference in disease incidence in different fields might be because of the prevalence of different weather factors that favoured multiplication and migration of the vector responsible for the spread of the disease and availability of infected seeds of previous season.

Pavithra (2013) conducted a survey during 2012-13 in eight districts of southern Karnataka to assess the incidence of mosaic disease of cowpea which revealed the occurrence of disease in the range of 11.66 to 36.66 per cent. Highest disease incidence was recorded in Bengaluru urban (36.66%) and least disease incidence in Ramanagar district (11.66%).

A diagnostic survey in 6 clusters (Bujumba, Alupe, Madola, Kimaeti, Ndareti and Chebich) of Busia and Bungoma counties, Kenya in the long and short rain seasons of 2017. The occurrence of BCMD in all the clusters varied, with an incidence of 36.58 per cent in Bujumba, 29.40 per cent in Alupe, 34.33 per cent in Madole, 37.95 per cent in Kimaeti, 42.78 per cent in Ndareti and 39.45 per cent in Chebich, respectively (Murere *et al*., 2018).

Transmission studies revealed that BCMV infecting cowpea was readily transmissible by sap, the inoculated plants exhibited symptoms of vein banding and mosaic mottling on first trifoliate leaves within twelve to fifteen days after inoculation. The mechanical transmission per cent was 71.43 (Table 3 and Plate 1). The insect transmissibility of the BCMV infecting cowpea was carried out with the aphid species *Aphis craccivora*. The aphid was found transmitting the virus to an extent of 54.42 per cent (Table 3). The inoculated plants exhibited symptoms such as mosaic mottling on the trifoliate leaves from seven to fifteen days after inoculation (Plate 2). In seed transmission, germination per cent of seeds was 100 per cent. The plants developed symptoms from ten to fifteen days after sowing in the form of vein banding, mosaic mottling and leaf distortion. The per cent seed transmission of BCMV infecting cowpea was 64.00 per cent (Table 3). This indicated the seed transmissible nature of the BCMV infecting cowpea (Plate 3). Similar results were also reported by Pavithra (2013).

Pavithra (2013) studied that Cowpea Mosaic Virus was readily transmitted through sap and also by aphid *Aphis*

Table 2. Average per cent incidence of BCMV infecting cowpea in Vijayapur, Bagalkote, Dharwad and Belagavi districts of northern Karnataka

Districts	Taluks	Average disease incidence of taluk(%)	Average disease incidence of districts (%)
Vijayapur	Babaleshwar	28.80	27.41
	Basavana Bagewadi	19.34	
	Vijayapur	44.80	
	Indi	29.19	
	Muddebihal	21.00	
	Nidagundi	22.10	
	Sindagi	31.97	
	Talikoti	22.10	
Bagalkote	Badami	30.04	29.82
	Bilagi	25.75	
	Guledagudda	39.25	
	Hungund	26.00	
	Ilkal	28.05	
Dharwad	Hubli	23.80	25.47
	Kalaghatagi	28.61	
	Kundgol	28.89	
	Navalgund	20.58	
Belagavi	Athani	23.53	18.89
	Bailhongal	17.00	
	Chikkodi	20.08	
	Gokak	14.09	
	Hukkeri	22.52	
	Ramdurg	12.94	
	Savadatti	22.10	

Table 3. Transmissibility of BCMV infecting cowpea

Transmission method	No.of plants inoculated	No.of plants showing symptoms	Percent transmission
Sap	9+1*	7	77.78
Aphid	9+1*	5	55.55
Seed	25*	16	64.00

*Not inoculated

Plate 1. Vein banding and puckering symptoms observed on sap transmitted cowpea plant

Plate 2. Mosaic and puckering symptoms observed on aphid transmitted cowpea plant

Table 4. Host range studies of BCMV infecting cowpea on different leguminous hosts

Botanical name of host	No. of plants inoculated	No. of plants showing symptoms	Type of symptoms
Cajanus cajan (Pigeon pea)	9	0	-
Vigna radiata (Green gram)	9	0	-
Vigna mungo (Black gram)	9	2	Puckering and distortion of leaves
Glycine max (Soybean)	9	4	Chlorotic lesions
Dolichos lablab (Field bean)	9	0	-
Macrotyloma uniflorum (Horse gram)	9	0	-

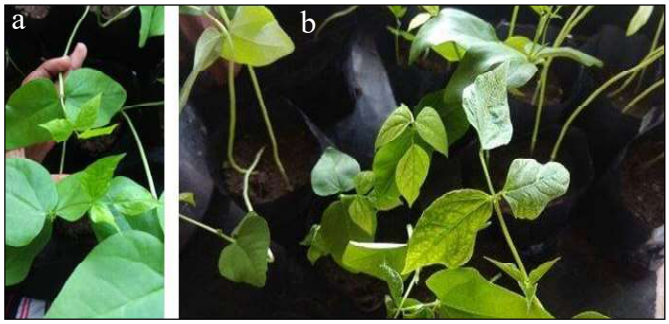
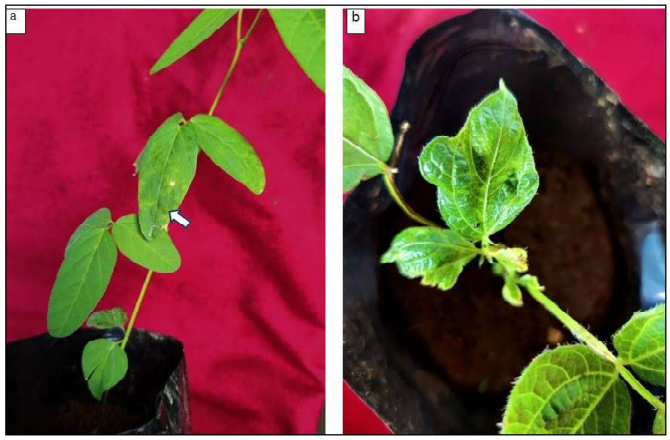


Plate 3 (a and b): Mosaic and vein banding symptoms observed on seed transmitted cowpea plant at 15 and 21 days after sowing



Chlorotic lesions on sap inoculated soybean

Puckering and leaf distortion of sap inoculated black gram leaves

Plate 4 (a and b): Symptoms observed on soybean and black gram in host range studies of BCMV infecting cowpea

craccivora. The sap transmission varied from 88.00 to 96.00 per cent. The transmission of the virus through aphids varied between 44.00 to 64.00 per cent. The per cent seed transmission of the virus varied from 33.33 to 47.07.

The susceptibility of BCMV infecting cowpea was conducted on different *Leguminous* hosts. Black gram and soybean were found susceptible for BCMV infecting cowpea and produced symptoms like puckering, leaf distortion and chlorotic lesions (Table 4 and Plate 4).

In population dynamics study, aphid species observed during the research period was *Aphis craccivora*. The mean population of aphid varied from 0.00 to 92.70 (Table 5 and Fig. 5). The population of aphid (*Aphis craccivora*) was maximum during the 38th and 39th Standard Meteorological Weeks (SMWs) with the mean value of 92.70 and 81.20, respectively and minimum during the 31st SMW with the mean value of 0.00. The population of aphids (*Aphis craccivora*) was highest during the 38th Standard Meteorological Week (SMW), when the minimum temperature, maximum temperature, morning relative humidity, evening relative humidity and rainfall were 18.9 °C, 29.5 °C, 90 per cent, 56 per cent, 3.4 hrs and 0.00 mm, respectively.

Aphid population gradually increased from vegetative phase, flowering and podding stage. Aphid population was less in vegetative stage, more in flowering and podding stages. Aphids preferred flowers and pods rather than the stem portion in this stage, may be due to release of volatiles from flowers and aphid population was observed upto harvest. There was a sudden decline in aphid population during 35th, 36th, 40th and 41st SMWs because of rainfall received which was of about 44.20, 63.10 mm, 37.20 and 68.20 mm, respectively.

Aphid population build up showed strong significant negative correlation with rainfall (r= -0.64**). There was significant negative correlation with minimum temperature (r= -0.53*) and morning RH (r= -0.60 *). There was non-significant negative correlation with maximum temperature (r= -0.13 ^{NS}) and evening RH (r= -0.50 ^{NS}) and non-significant positive correlation with sunshine duration (r = 0.43^{NS}) showed in Table 6.

These results were corroborated with Borad *et al*. (2020) who observed that the population of aphid first appeared during the 4th week of August and gradually increased up to the 3rd week of October and then disappeared from the 1st week of November. Its peak level (30.10/3 cm twig) was found in the 1st

Table 5. Population of *Aphis craccivora* transmitting BCMV at different Standard Meteorological Weeks (SMWs) along with weather parameters during *kharif* 2022

Standard Meteorological Week No.	Air Temperature		Relative humidity		Sunshine Duration (hr)	Rainfall (mm)	Mean population of *Aphis craccivora*
	Max.(ºC)	Min.(ºC)	I(%)	II(%)			
30	30.1	20.9	91	61	2.7	4.8	0.9
31	30.6	20.6	96	73	4.3	202.8	0
32	28.1	20.7	89	68	3.2	7.8	39.4
33	29.3	20.3	88	61	4.4	0.5	51.5
34	30.9	20.4	89	55	5.7	2.6	70.3
35	31.1	20.9	92	64	3.9	44.2	36.6
36	30.8	21	96	62	4.9	63.1	21.2
37	29.1	20.4	92	70	3.6	22.4	56.8
38	29.5	18.9	90	56	3.4	0	92.7
39	30.3	19.6	91	67	4.9	9.5	81.2
40	31.3	20	90	58	5.1	37.2	45.6
41	29.3	20.1	96	70	4.3	68.2	16.2
42	29.5	19.8	96	68	4.1	25.5	51.7
43	29.8	14.4	84	34	8.1	0	67.8
44	29.8	15	82	37	8.7	0	78.2

Table 6. Correlation of *Aphis craccivora* population with major environmental factors during *kharif* 2022

Aphis craccivora population	Air Temperature		Relative humidity		Sunshine (hr)	Rainfall (mm)
	Max. (°C)	Min. (°C)	I (%)	II (%)		
r	-0.13 ^{NS}	-0.53 ^{S*}	-0.60 ^{S*}	-0.50 ^{NS}	0.43 ^{NS}	-0.64^{S**}

r- Correlation co- efficient, NS- Not significant, S- Significant

* : @ 5% level of significance

** : @ 1% level of significance

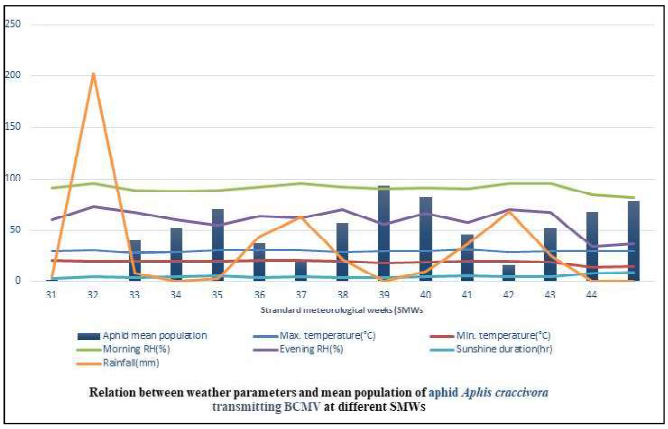


Fig. 5 Relation between weather parameters and mean population of aphid *Aphis craccivora* transmitting BCMV at different SMWs

week of October which coincided with the flowering to pod developing stage of the crop.

Conclusion

The disease incidence of BCMV infecting cowpea ranged from 3.25 per cent to 69.59 per cent in Vijayapur, Bagalkote, Dharwad and Belagavi districts of northern Karnataka. The Bean Common Mosaic Virus (BCMV) infecting cowpea was readily transmissible by sap, aphids and through seeds. In host range studies, black gram and soybean showed severe symptoms of BCMV infection, such as puckering, leaf distortion and chlorotic lesions. The population of aphid (*Aphis craccivora*) was maximum during the 38th and 39th Standard Meteorological Weeks (SMWs) with the mean value of 92.70 and 81.20, respectively.

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