Biological Forum – An International Journal **14(1): 136-142(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Golden Mosaic Virus Disease of Cowpea in Rajasthan: Survey, Occurrence and Yield Loss

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(Received 08 October 2021, Accepted 07 December, 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Cowpea (*Vigna unguiculata* L.) is a major pulse crop in India's arid and semi-arid regions. Based on a field survey conducted in four tehsils of Jhunjhunu district of Rajasthan, we can conclude that MYMIV is the most prevalent pathogen responsible for yellow mosaic disease of cowpea in the Jhunjhunu district during the months of August to September 2020-2021, during rainy season MYMIV is became a very serious problem in late sown crop. The survey provided baseline information on the distribution and occurrence of cowpea golden mosaic disease, incidence and severity in the major cowpea growing area of Jhunjhunu district in Rajasthan state. During the survey, discussions were held with the farmers concerned, regarding occurrence, incidence and yield losses due to this disease. In four tehsils of Jhunjhunu district, disease intensity ranged from 29.31 to 60.95 per cent. Jhunjhunu tehsil has the highest disease intensity (54.12 per cent), followed by Khetri tehsil (52.50 per cent). Plants show yellow mosaic patches on their leaves as a result of disease, which then spread to other parts of the plant. Plants having yellow mosaic spots on their leaves develop chlorosis and shortening of internodes, and produce undersized, immature, and shrivelled seeds as a result of the disease. Grain yield losses ranged from 11.55 to 58.38 percent. When disease developed 21-30 days after planting, the highest percent disease intensity (54.45%) was reported, while the highest yield loss (58.38%) was recorded when disease appeared 20 days after sowing. According to the findings, there is a progressive decrease in yield as the percent disease intensity increases.

Keywords: Cowpea, survey, golden mosaic virus disease, disease severity, yield loss.

INTRODUCTION

Cowpea (*Vigna unguiculata* Linn. 2n = 22) is a tropical and subtropical plant that is widely cultivated in Asia, Africa, Central and South America, and parts of southern Europe and the United States. It's a popular grain legume that's grown all over India and is a good source of protein and carbohydrates. It is native to central Africa, where nearly all wild variants can be found. Cowpea, also known as “lobia”, is utilized as a pulse, animal fodder, and a soil-improvement green manure crop. It's referred to as "vegetable meat". Cowpea seeds content nutrients as Protein (22-24%), Carbohydrate (55-66%), Fat (1.8%), Fiber (6.3%), Iron (0.005%), Calcium (0.08 – 0.11%), Vitamin A (I.U.) 60mg, Thiamine 0.5 mg, Riboflavin 0.48 mg, Nicotinic acid 1.3 mg, Biotin 202 mg, Niacin 0.28 mg, and Essential amino acids lysine, tryptophan, leucine, and phenylalanine (Source – Singh *et al.*, 2010 and Pulses Revolution from food to Nutritional Security, Min. Agri. & FW, GOI, 2018-19).

Cowpea is an important crop in cropping systems because it fixes atmospheric nitrogen and improves soil fertility, especially in small-scale farming systems when fertilizer is used rarely (Kyei-Boahen *et al.*, 2017). Drought-tolerant and stress-tolerant, this crop thrives in a variety of conditions. Golden mosaic disease (CGMD) and severe leaf curl disease, both caused by the *Mungbean yellow mosaic India virus*, are quite common in India (John *et al.*, 2008; Malathi *et al.*, 2005). Cowpea golden mosaic disease (CGMD) in southern Asia is thought to be caused by a *Begomovirus* that is different from those that cause disease in other legumes. In western India, the components of the Begomovirus that causes CGMD (John *et al*., 2008).

In comparison to other crop species, cowpea is well suited to high temperatures, drought, and poor soils. Cowpea, despite its importance, is subject to a number of production restrictions. Cowpea production is hampered by low yields of older types and expensive costs, vulnerability to viral, fungal, and insect infection Virus infection is responsible for a significant amount

of losses, which ranges from 10% to 100% (Kareem and Taiwo, 2007), depending on virus-host vector connections and other epidemiological parameters. The most important biotic limitations of this crop are diseases produced by fungus, viruses, and bacteria.

It was first reported by Nariani (1960) who named the putative causal agent MYMV at IARI, New Delhi with 20-30 per cent incidence at institutional areas. This disease is a major threat to cowpea cultivation in different countries (Honda *et al.*, 1983; Chenulu and Verma, 1988). The disease is causing complete losses *Vigna radiate* (up to 100%) depending on the genotypes and age of the plant (Yadav and Brar, 2005). According to Rathi (2002) yield losses due to this disease varied from 5-100 per cent depending upon crop age, disease severity, and susceptibility of cultivars and population of white fly.

Cowpea is highly susceptible to golden mosaic disease (Varma and Reddy, 1984). CGMD was earlier confined only to northern India (Varma and Malathi, 2003) and was believed to be caused by a whitefly-transmitted *Gemini virus* distinct from the YMVs infecting mungbean and blackgram, MYMV and MYMIV (Varma and Reddy, 1984) in India. Mungbean yellow mosaic India virus (MYMIV) is the most devastating among the all viruses. Cowpea plants are frequently affected by several viruses, resulting in significant economic losses in the crop's yield (Byoung-Cheorl *et al.*, 2005).

Yellow mosaic disease (YMD) was first reported from western India in the late 1940 in Lima bean and later in mungbean in northern India (Capoor and Varma; 1948; Nariani, 1960). Similarly, in the regions of the subcontinent now forming part of Pakistan, YMD was first reported in cowpea in the vicinity of Lyllpur (now known as Faisalabad; Vasudeva, 1942). Across the subcontinent, including India, Bangladesh, Pakistan and Sri Lanka, YMD is a major constraint to the production of most of the major legume crops (Qazi *et al.*, 2007).

Mungbean yellow mosaic India virus infects mung bean, soybean, moth bean, cowpea, urd bean and some other leguminous hosts (Dhingra and Chenulu, 1985; Qazi *et al.* 2007). Yellow mosaic is reported to be the most destructive viral disease not only in India, but also in Pakistan, Bangladesh, Sri Lanka and contagious areas of South East Asia (Bakar, 1981; Malik 1991; Biswas *et al.*, 2008).

The goal of this study was to determine the prevalence of distinctive viral symptoms, their incidence, and severity on cowpea in Rajasthan, India.

MATERIALS AND METHODS

Survey of affected field. The disease intensity of Golden mosaic virus of cowpea was assessed by using a roving survey method. During the *Kharif* of 2020, a survey was conducted in major cowpea growing four tehsils of the Jhunjhunu district. Two villages were chosen at random from each tehsil, and two cowpea holdings (fields) were observed in each village. To determine the disease intensity, a total of 16 holdings (fields) were examined. By scoring 100 plants at each location randomly selected, the per cent of disease index in each field was calculated, and observations were taken accordingly.

Assessment of disease on infected plant in the field. The severity of viral symptoms in cowpea was assessed based on their occurrence. The severity of disease was assessed visually on cowpea leaves with the incidence of viral symptoms, using following standard rating scale: 1 = 0% (absence of viral disease symptoms) and whenever the index 5 ≥ 60% (very severe symptoms leads to death of the plants). Infected plants with stunted growth, acute leaf curling, smaller leaves, yellow spots, and leaf lamina distortion were chosen for disease assessment.

The percent disease index was calculated by scoring diseases on a 0–5 disease rating scale suggested by Mc Kinney (1923).

$$\text{PDI} = \frac{\text{Sum of all numerical ratings}}{\text{No. of plants assessed} \times \text{Max. disease rating}} \times 100$$

Site of experimentation. The current research work was conducted at the Agronomy Farm, S.K.N. College of Agriculture, Jobner, and the Department of Plant Pathology, S.K.N. College of Agriculture (Sri Karan Narendra Agriculture University), Jobner, Rajasthan, during the *Kharif* 2020-2021. Jobner is located at latitude 26 5′N, longitude 752′E, with an elevation of 427 meters above mean sea level (MSL) (mean sea level). This region falls under semi-arid eastern plain (Agro Climatic Zone-ll A) of Rajasthan.

Raising of Crop. Before sowing, the field was prepped by cross ploughing with a tractor-drawn disc harrow and planking. The field research trial was carried out on the susceptible Cowpea variety RC-19. Different field experiments were lay out in Randomized block designs with three replication for treatment application. Except for the date of the sowing experiment, the crop was planted in the second week of July. The crop was grown in 3 × 2 m plots with a row-to-row and plant-to-plant spacing of 40 × 15 cm. Irrigation, weeding, and hoeing were done according to package of practices recommended for the crop in this zone. Thinning was done to maintain the ideal plant numbers (Plate-I).

Plate 1: Field experiment overview during *Kharif* 2020.

Estimation of cowpea yield reduction due to Golden mosaic. Plants with yellow mosaic symptoms were

tagged after 20 days of planting and then every 10 days intervals until harvesting, subsequently plants include in different disease intensity groups. At the time of crop harvest, tagged plants from each category were chosen at random. Data on yield contributing features such as number of pods, seeds per pod, 1000 grain weight (test weight), and grain yield were recorded, and the yield loss was estimated by the following formula given by Nene (1972).

$$Q = \frac{a - b}{a} \times 100$$

Where, Q = Per cent yield loss
a = Average yield from a healthy plant
b = Average yield from a diseased plant

Experiments were carried out at Agronomy Research Farm, Jobner. The commonly grown susceptible cowpea variety RC-19 was sown in 3 × 2 m plots with three replications in each category in the *kharif* season of 2020. Plants with yellow mosaic symptoms were first tagged after 20 days of seeding, and then every 10 days until the crop was ready to be harvested.

Plants were split into six groups in order to distinguish disease signs at different phases of disease development:

Category	Description
Category A	Plants that show no signs of disease until they are harvested.
Category B	Plants that show disease symptoms within 20 days of sowing.
Category C	Plants that show disease symptoms between 21 and 30 days after sowing.
Category D	Plants that show disease symptoms between 31 and 40 days after sowing.
Category E	Plants that show disease symptoms between 41 and 50 days after sowing.
Category F	Plants that show disease symptoms between 51 and 60 days after sowing.

At the time of harvesting, three tagged plants were chosen at random from each replication in each category. The number of pods, seeds per pod, 1000 grain weight (test weight), and grain yield of the plants were measured. The information was collected in order to do statistical analysis.

RESULTS

Survey of golden mosaic of cowpea at Jhunjhunu district. During *Kharif* 2020, a roving survey was undertaken in Jhunjhunu, Khetri, Chirawa, and Udaipurwati, four cowpea-growing tehsils in Jhunjhunu district. A survey was conducted in two villages in a single tehsil. During the survey, the farmers involved were interviewed about the disease's occurrence and incidence. The intensity of cowpea golden mosaic disease was more severe in cowpea cultivating tehsils of Jhunjhunu district, according to the results reported in Table 1 (Fig. 1 and Plate-2). In all investigated regions of Jhunjhunu district, the disease intensity of cowpea golden mosaic ranged from 29.31 to 60.95 per cent. In the Jhunjhunu tehsil's Khajpur Purana village, the disease intensity peaked at 60.95 per cent, followed by Khetri tehsil's Nagli Saledi Singh village (58.15 per cent). Natash village in Udaipurwati tehsil has the lowest disease intensity (29.31 per cent).

Table 1: Survey of golden mosaic of cowpea at Jhunjhunu district.

Sr. No.	Village	Tehsil	District	Per cent disease intensity (%)
1.	Nagli	Khetari	Jhunjhunu	58.15
2.	Charawas	Khetari	Jhunjhunu	46.85
			Mean	52.50
3.	Natash	Udaipurwati	Jhunjhunu	29.31
4.	Bhorki	Udaipurwati	Jhunjhunu	41.65
			Mean	35.48
5.	Chanana	Chirawa	Jhunjhunu	45.71
6.	Solana	Chirawa	Jhunjhunu	36.85
			Mean	41.28
7.	Khajpur	Jhunjhunu	Jhunjhunu	60.95
8.	Bharunda	Jhunjhunu	Jhunjhunu	47.28
			Mean	54.12

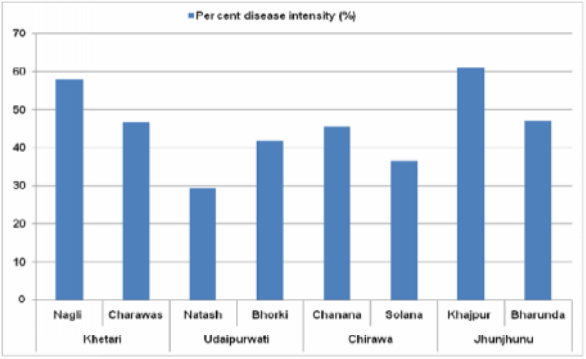

Fig. 1. Survey of golden mosaic of cowpea at Jhunjhunu district.

Plate 2: Fields of cowpea crop visited during survey.

Symptoms of Yellow Mosaic Disease on the Cowpea Crop in Surveyed Fields. The results of the field survey study revealed that the cowpea crop in the assessed field exhibited varying degrees of symptoms. During the survey, there were significant differences in the intensity of viral symptoms on the cowpea crop. This disease begins as little yellow spots along the veins of immature leaves, and then spreads to neighboring leaves. During the survey, the entire leaf can display yellowing or chlorosis on the whole plant, followed by necrosis, internode shortening, severe stunting of plants with no yield or few deformities flowers, and malformed pods yielding small, immature, and shriveled seeds. Plants were exhibited distinguish disease development signs grouped in five categories using by standard scale (Plate 3).

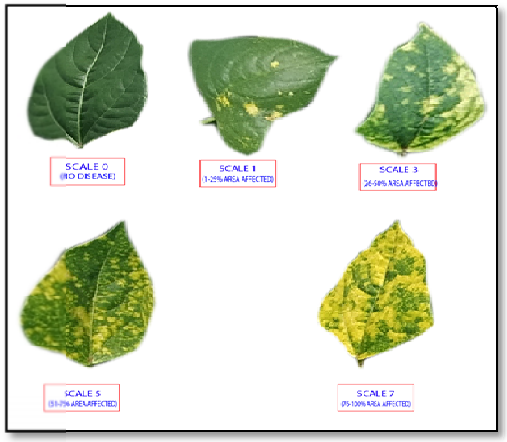

Plate 3: Golden mosaic disease rating scale.

Estimation of cowpea production decrease due to golden mosaic. At Agronomy farm, SKNCOA, Jobner, conducted an experiment during Kharif 2020. According to the findings, there was a steady decline in yield as the percent disease intensity increased (Table 2 and Fig. 2). Grain yield losses varied from 11.55 percent to 58.38 percent. With no disease, the highest grain yield was reported (7.81 q/ha). When disease occurred 20 days after planting, it had a maximum percent disease intensity of 54.45% and a maximum yield loss of 58.38 percent.

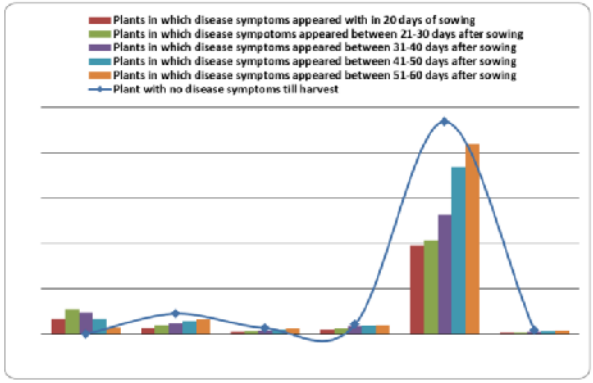

Fig. 2. Estimation of yield losses due to golden mosaic of cowpea.

Table 2: Estimation of yield losses due to golden mosaic of cowpea.

Category	Symptoms appeared days after sowing	*PDI	Number of pods /plant	Number of seeds /pod	Test weight	Yield (g/plot)	Yield (q/ha)	Per cent yield loss
A	Plant with no disease symptoms till harvest	0.00	44.16	12.80	20.31	468.85	7.81	-
		(0.00)	(41.65)	(20.96)	(26.79)		(16.23)	
B.	Plants in which disease symptoms appeared within 20 days of sowing	33.45	13.53	5.25	9.89	195.25	3.25	58.38
		(35.34)	(21.58)	(13.25)	(18.33)		(10.39)	
C	Plants in which disease sympotoms appeared between 21-30 days after sowing	54.45	18.56	6.10	11.93	206.20	3.43	56.08
		(47.55)	(25.52)	(14.30)	(20.21)		(10.67)	
D	Plants in which disease symptoms appeared between 31-40 days after sowing	45.86	22.70	7.35	16.34	262.63	4.37	44.04
		(42.63)	(28.45)	(15.73)	(23.84)		(12.07)	
E	Plants in which disease symptoms appeared between 41-50 days after sowing	33.60	28.45	9.75	18.16	368.90	6.14	21.38
		(35.43)	(32.23)	(18.19)	(25.22)		(14.35)	
F	Plants in which disease symptoms appeared between 51-60 days after sowing	14.25	32.25	11.50	19.06	419.35	6.98	11.55
		(22.18)	(34.60)	(19.82)	(25.89)		(15.32)	
	SEm±	1.36	1.14	0.66	0.89	11.90	0.54	
	CD (P=0.05)	4.11	3.44	1.99	2.68	35.86	1.62	
	CV (%)	8.94	7.45	7.74	7.60	7.43	8.18	

* Average of four replications; Angular transformed value given in parenthesis

DISCUSSION

Virus symptoms observed in the field on cowpea. Preliminary disease diagnoses were made only on the basis of visual symptom manifestation during the survey. The study determined the prevalence and severity of the cowpea virus, which is very important in the cowpea-growing region of Rajasthan, India. The findings of this study revealed that there was a significant outbreak of Golden mosaic virus in the years 2020-2021. There were significant differences in the severity of viral symptoms in cowpea among the surveyed fields. Small yellow spots on young leaves, yellowing or chlorosis of leaves, internode shortening, stunting of plants, and deformed flowers and pods (mosaic, leaf mottling, vein clearing, and necrotic lesion) were observed in the field and were similar to symptoms reported elsewhere on legumes affected by the disease. Symptoms of virus-infected legumes have been documented elsewhere (Qazi *et al.,* 2007; Kumar *et al.,* 2016; Kumar *et al.,* 2017; Jat, 2018; Bediako *et al.,* 2018).

Initially, this disease appears as yellow spots on young leaves along the veins and then spread to the other leaves. Under severe infection, the entire leaf can show yellowing or chlorosis on the whole plant followed by necrosis, shortening of internode, severe stunting of plants with no yield or few flowers and deformed pods producing small, immature and shriveled seeds (Akhtar and Haq, 2003; Bashir *et al.,* 2006). In India, cowpea is highly susceptible to golden mosaic disease (CGMD) and severe leaf curl disease which are caused by Mungbean yellow mosaic India virus (John *et al.,* 2008; Malathi *et al.,* 2005; Verma and Reddy, 1984).

Golden mosaic virus severity on cowpea crop. A survey was conducted to systematically examine the level of golden mosaic in four tehsils of Jhunjhunu district, namely Jhunjhunu, Khetri, Chirawa, and Udaipurwati, which are key cowpea production areas. The disease was discovered in none of the four tehsils that were surveyed. In all surveyed regions of Jhunjhunu district, the disease intensity of cowpea ranged from 29.31 to 60.95 percent. Jhunjhunu tehsil in Jhunjhunu district has the highest disease intensity of 60.95 per cent, followed by Khetri tehsil (58.15 per cent). This result is supported with the study of Panduranga *et al.*, (2011); Kumar *et al.,* (2016); Kumar *et al.,* (2017); Jat (2018). Similar results have been reported in case of soya bean yellow mosaic (Dhingra and Chenulu, 1985).

Cowpea yield reduction due to golden mosaic virus. The survey result provided for the first time at first hand, baseline information on the distribution and prevalence of cowpea golden mosaic disease, incidence and severity in the major cowpea growing area of Jhunjhunu district in Rajasthan. It was attempted to calculate the losses caused by golden mosaic disease. Golden mosaic disease in cowpea caused productivity losses ranging from 11.55 per cent to 58.38 per cent. With no disease, the highest grain yield was reported (7.81 q/ha). When disease occurred 20 days after planting, data revealed a maximum per cent disease intensity of 54.45 per cent and a maximum yield loss of 58.38 per cent. When disease struck 51-60 days after sowing, a minimum seed yield loss of 11.55 per cent was found. The decline in the number of pods, the number of seeds per pod, and the thousand grain weight appeared to be the most important component that caused the yield to drop. The results also showed that as the proportion of yellow mosaic infection increased, the yield decreased. These data support the fact that the disease is extremely devastating when it is caught early on. Similar findings on grain yield losses in legumes impacted by viral infections have been published elsewhere (Dhingra and Chenulu, 1985; Rathi, 2002; Yadav and Brar, 2005; Kareem and Taiwo, 2007; Karthikeyan *et al.,* 2014; Jat, 2018). This could explain the differences in yield losses reported in previous

research. The study established the widespread distribution and occurrence of virus infection on cowpea at various locations in the growing area of Jhunjhunu district and causes huge economical yield losses to cowpea. The results obtained in this study demonstrated that there was a substantial occurrence of virus during *kharif* 2020 cropping season. The severest crop loss of (18-87%) reported in Iran, and a probable (100%) loss reported in Nigeria (Thottappilly and Rossel, 1992). Karthikeyan *et al.*, (2014) reported economic losses due to this mung bean yellow mosaic disease up to 85 per cent.

CONCLUSION

We can conclude that MYMIV is the most prevalent pathogen responsible for yellow mosaic disease of cowpea across the Jhunjhunu district in Rajasthan based on a field survey conducted in four tehsils of the Jhunjhunu district. Due to the rainy season, MYMIV is a serious problem in this crop during the months of August and September. According to a survey of cowpea-growing tehsils in the Jhunjhunu region, none of the locations were found to be free of the disease. Jhunjhunu tehsil (54.12 per cent) had the highest golden mosaic disease intensity, while Udaipurwati tehsil had the lowest (35.48 per cent. The disease starts out as small yellow spots on young leaves, then spreads to the rest of the leaves. Shortening of internodes, necrotic spots on leaves, and stunting of plants occur as a result of severe infection, with few blooms and malformed pods yielding small, immature, and shriveled seeds. Maximum yield losses of (58.38 per cent) were discovered during yield loss calculation when disease appeared 20 days after sowing, followed by 21-30 days (56.08 per cent). As a result, cowpea fields must be constantly monitored through routine disease surveys in order to detect new and developing viruses.

FUTURE SCOPE

The present investigation has opened up new information and given rise to new ideas on cowpea golden mosaic virus. Hence the future lines of work are needed with there is a need to undertake an intensive survey for cowpea golden mosaic virus disease of cowpea in all major growing areas of Rajasthan and quantify the loss caused by pathogen. To identify the molecular variability in cowpea golden mosaic virus to know the different strains of these virus prevalent in different agro-climatic zone of Rajasthan.

Acknowledgments. The authors are grateful to Head, Department of Plant Pathology and Dean SKN Agriculture University, Jobner, Jaipur, Rajasthan 303329, India for valuable guidance, support and facilities provided to conduct this research experiment successfully.

Conflict of Interest. None.

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How to cite this article: Kumar, A.; Rathore, G. S.; Kumar, S.; Singh, M.; Maurya, S.; Kumari, P.; Kiran ; Kumari, N. and Lakharan, L. (2022). Golden Mosaic Virus Disease of Cowpea in Rajasthan: Survey, Occurrence and Yield Loss. *Biological Forum – An International Journal, 14*(1): 136-142.