SOYBEAN VIRUS INFECTION: A THREAT TO FOOD SECURITY IN BARUTEN LOCAL GOVERNMENT AREA OF KWARA STATE, NIGERIA

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Abstract
Food security faces challenges from a growing population, limited arable land, plant diseases, and climate change. Soybean is vital for food security and agricultural sustainability due to its nutritional benefits and is often considered a key solution to hunger. Viral diseases pose a significant risk to soybean production, affecting its growth and yields. A study was conducted to evaluate the prevalence & intensity of viruses in soybeans grown in the Baruten Local Government Area of Kwara State. Surveys at 30 soybean farms in the area identified viruses through ELISA testing. Findings showed occurrence of viruses varied from 38.1% in Ningurume to 57.9% in Okuta, while severity indices ranged from 3 in Boriya to 5 in Bwereguru. The serological analysis detected CMV, SBMV, and BPMV occurring alone or in combinations, while TRSV was not found. The study highlighted a significant prevalence of viral pathogens in soybeans and recommends the introduction of improved varieties to ensure food security and enhance the livelihoods of farmers in Baruten LGA of Kwara State.

Keywords: Virus occurrence; Soybean, Global food security; Survey; Improved varieties

Introduction

Soybean (*Glycine max* L. Merrill) is a leguminous plant from the Leguminosae family and the Papilionaceae sub-family. Native to East Asia, it is better classified as an oilseed crop (Riya Mishra et al., 2024). Today, soybean is regarded as one of the most important agricultural crops, being a major source of protein derived from plants

and oil, and is increasingly recognized as a valuable supplementary source of nutritious food (Tripathi et al., 2022). Soybean protein is considered complete because it provides The body needs all of the necessary amino acids for tissue growth and repair. (Kohli and Singha, 2024). However, the health of soybean plants is significantly threatened by two main types of organisms: plant pathogenic fungi and viruses. Pathogenic fungi can alter the composition of seeds, reduce yields, and decrease overall production (Hosseini et al., 2023). Among the most destructive and widespread diseases of soybean is soybean mosaic disease (SMD). Infected plants can sometimes die, with symptoms ranging from leaf mottling and necrosis to general stunting (Zečević et al., 2023). Soybean mosaic virus (SMV), which spreads through seeds, has varying rate of seed transfer, ranging from 0% to 64%, depending on the virus genotype and soybean variety (Li et al., 2020). Planting SMV- resistant cultivars is regarded the most effective and environmentally beneficial control approach for the disease. However, no soybean cultivars resistant to SMV currently exist (Eid et al., 2023). In Nigeria, soybean is cultivated across nearly all states, with higher concentrations in the northern regions, particularly the north-central area. The average yield per hectare is below 1,000 kg, highlighting the need to identify factors that could improve production and productivity. This study aims to assess the occurrence of viral infections in soybean fields in Baruten Local Government Area (LGA) of Kwara State and to serologically characterize the viruses infecting the crops. The findings could provide solutions to production challenges caused by pathogenic viruses, thereby improving food security and enhancing economic returns for soybean farmers in Baruten LGA, Kwara State.

Materials and methods

To assess the presence of viruses, A survey was carried out to ascertain the prevalence and seriousness of viral infections.

in soybean across 30 farm locations within Baruten Local Government Area (LGA). These locations were purposively chosen from a list of soybean-producing areas in Baruten LGA, which was provided by the Kwara State Ministry of

Agriculture in Sango-Ilorin. The survey methodology for identifying virus symptoms involved randomly tagging twenty plants per farm locationBy traversing the field in a "W" shape,

path in the field, with five plants spaced evenly on each side (Aliyu, 2019). The incidence of the disease was determined by looking at

the symptoms of infected plants in each field, and the proportion of infected plants was estimated based on these observations by:

$$IC = \frac{n \times 100}{N}$$

IC = incidence; n = number of diseased plants; N = total number of plants assessed

The virus severity index, which quantifies the damage caused by the disease on plant leaves, was determined using a modified visual scale from Ogunsola et al. (2020). The scale ranges from 0 to 5, with the following descriptions:

0: No disease symptoms

In the beginning 10% of the leaf area has mild mottling.

2: Light downward cupping or mottling on 50% of the leaf surface

3. Chlorosis, noticeable upward or downward leaf cupping, or 75–100% leaf mottling

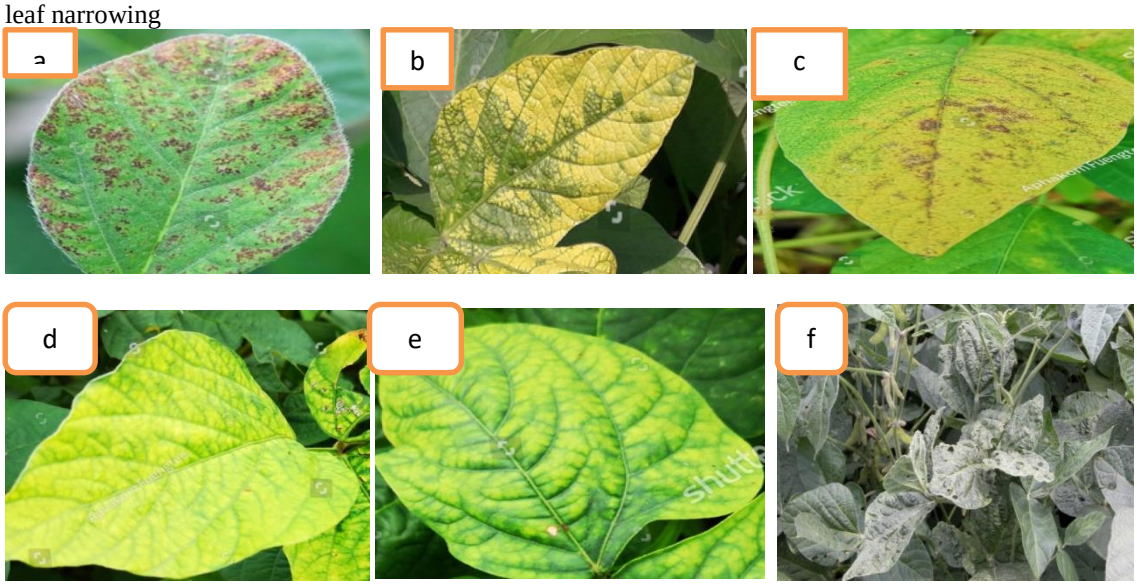
4. extreme mosaic, leaf bunching, crinkled leaves, extreme leaf deformation, or plant stunting 5. Severe leaf deformity, necrosis, or shoestring-like leaf narrowing

Serological protocol for virus indexing

A total of 150 soybean leaf samples variously collected from the locations were kept desiccated on calcium chloride and stored at 4 °C. The samples were indexed for 4 viruses namely (Bean pod mottle virus (BPMV), Southern bean mosaic virus (SBMV), Cucumber mosaic virus (CMV), and Tobacco ringspot mosaic virus (TRSV). The Antigen coated plate Enzyme Linked Immunosorbent Assay (ACP-ELISA) was deployed for the process (Aliyu *et al*, 2022).

Results and discussion

The virus symptoms observed during the survey included a mosaic, rugose leaves, leaf curl, chlorosis, stunting, leaf distortion, mottling, reduced pod numbers, and seed discoloration (Figure 1). The symptoms are virus infection related, although some can be caused by nutritional imbalances. The differences in varieties sown and variations in plant age during infection can result in symptom variation and this is consistent with Hill and Whitham (2014) which reported that virus infected soybean plants exhibited foliar symptoms of shrinkage, yellow spots, chlorotic, mottling and leaf distortions



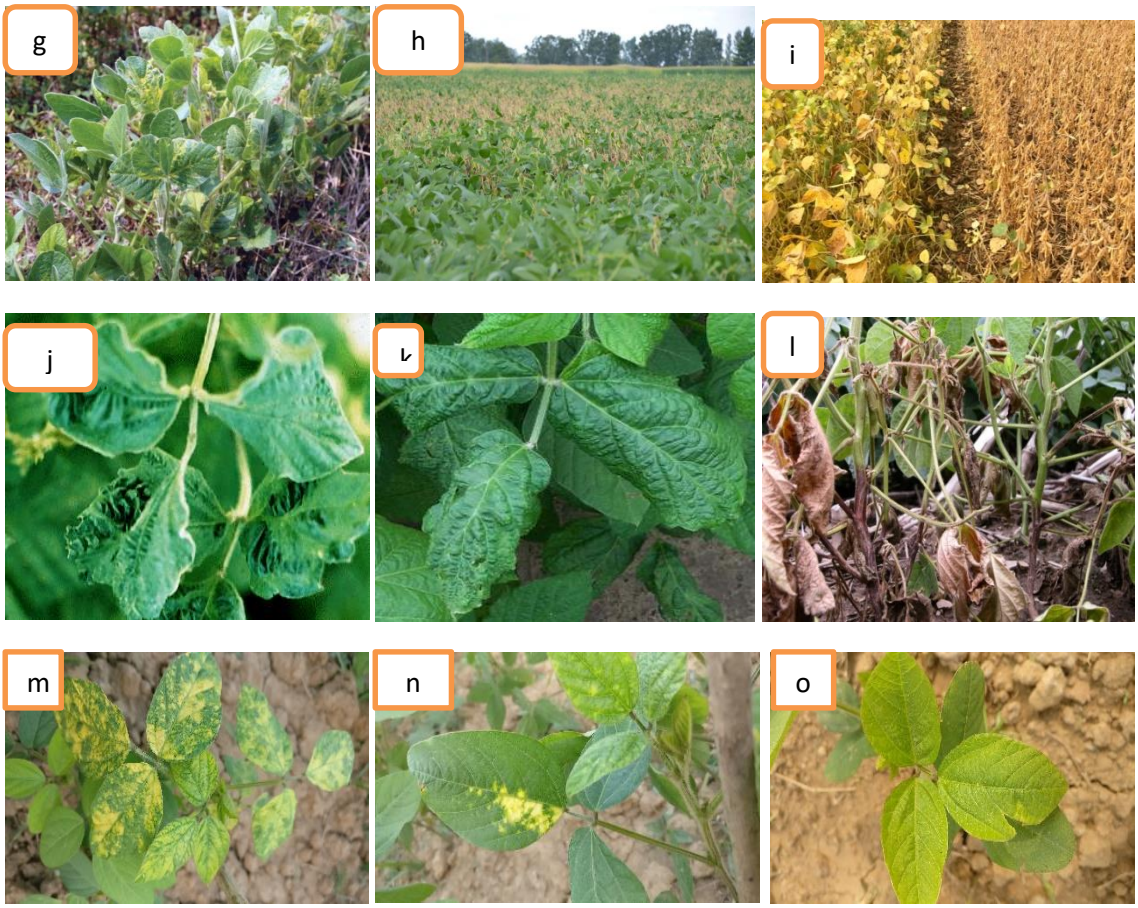


Figure 1: Virus symptoms observed during the survey: (a) necrotic ring spots in Boriya (b) mosaic pattern in Waguru (c) irregular leaf shaped and leaf necrosis in Gure (d) leaf mosaic in Gwasoro (e) yellow mosaic in Babane (f) chlorotic and necrotic lesions in Kenu (g) leaf wilting in Ilesha (h) shoe string in Kosubosu (i) puckering in Gwanara (j) Rugose leaf in Gobbe (k) leaf mottling in Yawadi (l) reduced pod numbers, and seed discoloration in Kosomono (m) yellow mosaic in Bwen (n) Stunting in Okuta (o) chlorosis in Yawadi

The frequency and intensity of viral infections
The incidence and severity of virus infection during the survey were from 3.8% and 1 in Yashikira to 35.8% and 5 in Ningurume respectively (Table 1). The locations with high virus incidence and severity were: Yakiru (23.4% and 4); Kosubosu (22.4% and 4); Kenu (22.1% and 4); and Bwereguru (20.9% and 4). On the other, Faberu, Yawadi and Gobbo had low virus occurrence. The result indicated that higher virus incidence corresponded to higher severity in most of the fields. This may be due to soybean viruses being seed transmissible and these might emerge as the field's primary inoculum, since most farmers do not get access to virus-free soybean seeds. Additionally, the host range of Soybean virus diseases is quite extensive and this may cause other plants to become reservoirs of viruses when the main host is not available in the field. This assertion is also confirmed by Burrows *et al*, (2005).

Serological examination
The serological assay by ELISA confirmed and identified presence of 3 viruses on the samples (Table 2). The result detected CMV, SBMV and BPMV in the samples. CMV was however the most prominent with its detection in all of the samples tested. A further analysis of the result indicated that BPMV was positive in 63.3% of samples (19 locations) and SBMV in 60% of the samples (18 locations). The 3 viruses were found occurring in combination of two or three in the locations with the exception of TRSV which was not detected in the study.
The outcome showed that soybean varieties grown in the study area were susceptible to CMV, SBMV and BPMV infections. This confirms the view of Tolin and Lacy (2004) that viruses could be found infecting soybean in all growing areas of the world. On the contrary, Maroof *et al*, (2009) described SMV to be the most prevalent virus found in a study. Arogundade *et al.*, (2009) had previously reported TRSV to be a major virus infecting

soybean in Nigeria, however TRSV was not detected in the present study. Link and Fuchs (2005) had asserted that nematodes are mostly vectors of TRSV transmission in soybean. The non-detection of TRSV in the study could therefore be due to low population of nematodes in the soils of the study area.

Conclusion and Recommendation

The study provides an important step towards understanding the interactions among the viruses infecting soybean. The diversity in type and distribution of the viruses as well as the dynamics of occurrence has significant implication for sustainable soybean production. Further and frequent surveys aimed at identifying other viruses implicated in soybean losses is advocated as a panacea to food insecurity and enhanced livelihood for farmers in Baruten LGA of Kwara State, Nigeria

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Table 1: Incidence and Severity of viruses infecting Soybean in Baruten LGA

S/No	Location	Incidence (%)	Severity
1	Taberu	12.3	2
2	Boriya	14.8	3
3	Gure	11.2	2
4	Shiya	10.9	2
5	Yashikira	3.8	1
6	Shinawu	13.7	3
7	Tunbuyan	16.2	3
8	Okuta	14.1	3
9	Kiyoru	11.1	2
10	Kpaura	12.7	2
11	Yakiru	23.5	4
12	Kenu	22.1	4
13	Faberu	4.5	1
14	Ilesha	17.6	3
15	Gwanara	16.4	2
16	Gwedebereru	12.2	2
17	Babane	11.8	2
18	Gure	14.6	2
19	Gwasoro	13.8	2
20	Monre	15.6	2
21	Bwereguru	20.9	4
22	Kosubosu	22.4	4
23	Waguru	17.7	3
24	Yawadi	5.4	1
25	Gobbo	6.6	1
26	Ningurume	35.8	5
27	Kosomono	11.8	2
28	Baah	10.6	2
29	Bwen	12.2	2
30	Wodora	10.4	2

Table 2: Virus indexing on Soybean in Baruten LGA of Kwara State-Nigeria

		VIRUSES			
S/No	**Location**	**CMV**	**TRSV**	**SBMV**	**BPMV**
1	Taberu	++	--	++	--
2	Boriya	++	--	++	++
3	Gure	++	--	--	++
4	Shiya	++	--	--	++
5	Yashikira	++	--	--	++
6	Shinawu	++	--	++	++
7	Tunbuyan	++	--	++	++
8	Okuta	++	--	++	++
9	Kiyoru	++	--	--	++
10	Kpaura	++	--	++	--
11	Yakiru	++	--	++	++
12	Kenu	++	--	++	++
13	Faberu	++	--	--	--
14	Ilesha	++	--	++	++
15	Gwanara	++	--	++	--
16	Gwedebereru	++	--	++	--
17	Babane	++	--	++	--
18	Gure	++	--	--	++
19	Gwasoro	++	--	--	++
20	Monre	++	--	++	--
21	Bwereguru	++	--	++	++
22	Kosubosu	++	--	++	++
23	Waguru	++	--	--	++
24	Yawadi	++	--	--	--
25	Gobbo	++	--	--	--
26	Ningurume	++	--	++	++
27	Kosomono	++	--	++	--
28	Baah	++	--	--	++
29	Bwen	++	--	--	++
30	Wodora	++	--	++	--

Key: CMV = Cucumber mosaic virus, TRSV = Tobacco ringspot mosaic virus, SBMV = Southern bean mosaic virus, BPMV = Bean pod mottle virus.
++ connotes presence of virus.
– connotes absence of virus

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