Original Research Article

Screening of solanaceous plants for resistance and tolerance to widespread begomoviruses in Burkina Faso

ABSTRACT

Solanaceous fruits are economically important and contribute to food security worldwide. Despite this importance, solanaceous crops are confronted with constraints, including begomoviruses. In Burkina Faso, the pepper yellow vein Mali virus (PepYVMLV) and the tomato leaf curl Mali virus (ToLCMLV) have been reported to be the most widespread begomoviruses. They are responsible for leaf deformation and yellowing in Solanaceae crops. The use of resistant/tolerant accessions would be of help in finding suitable solutions. This study aims to contribute to the appropriate and effective management of solanaceous diseases due to begomoviruses. To achieve this objective, an inventory of solanaceous accessions sold and produced in the western region of Burkina Faso and a screening of the preferred accessions were conducted in semi controlled conditions. Our results showed that twenty-seven accessions, including two newly introduced ones, were identified, with *Mongal F1*, *Jaune du Burkina*, and *Simbad F1* being the most preferred. Preferred solanaceous plants were monitored for 39 days after whitefly-mediated transmission. The hot pepper *Jaune du Burkina* exhibited mild symptoms with an infection rate of 66%, while the tomato *Mongal F1* and the sweet pepper *Simbad F1* showed disease with severe symptoms with infection rates ranging from 33% to 100%. When the behaviors of newly introduced accessions were compared to most preferred accessions, the results indicated that the newly introduced accessions (*Mona F1* and *Ganga*) showed mild symptoms, suggesting potential tolerance despite high infection rates. Howerever, it is suitable to access the impact of viruses on the productivity of these accessions.

Keywords: preferred accessions,DNA-A, DNA-B, PCR, symptoms, disease

1. INTRODUCTION

"Solanaceous crops represent important food crops in the word. The most economically important genera of these corps are *Solanum*, which contains the tomato (*S. lycopersicum*) and *Capsicum*, including hot and sweet peppers (*C. frutescens* and *C. annuum*). These crops are grown almost throughout the world, including tropical, sub-tropical, and temperate regions. They are consumed fresh in salad, fried in culinary preparations, and processed in various forms viz., ketchup, sauce, puree, etc." [1]. "In 2022, worldwide estimated values of production of tomato and green peppers were 186.11 million and 36.97 million tons [2]. For the same year, in Africa, the total production was estimated at 22.92 million tons with 15.66 tons per hectare and 3.51 million tons with 10.55 tons per hectare for tomato and peppers, respectively" [2]. "However, in Burkina Faso, total production of tomato was around 313

thousand tons with 17 tons per hectare while the estimated value of the pepper production was height thousand tons with five tons per hectare" [2]. "At the socioeconomic level, solanaceous crops generate financial income for rural and peri-urban communities" [3]. "In addition, these solanaceous crops contribute to the dietary balance of the population through their high intake of nutrients such as carbohydrates, vitamins (A, B3, B5, and B9, C), antioxidants, and minerals" [1,4]. "However, despite their potential, these crops are confronted with numerous constraints, including viral diseases" [3,5–7]. These diseases are most devastating, with the resurgence of leaf deformation diseases in recent decades. Viruses responsible for solanaceous plant leaf deformation diseases have been reported to be members of the family *Geminivirideae*, which consists of 15 genera, of which the genus *Begomovirus* is the most widely described [8,9]. Transmitted to plants by the whitefly *Bemisia tabaci* [10], begomoviruses cause symptoms such as leaf curling, leaf yellowing, and stunted growth with yield losses of up to 100% when infection occurs early [11]. In Burkina Faso, solanaceous crops have been reported to be highly impacted by begomovirus infections with a complex of at least five species of virus [5]. Furthermore, among these begomoviruses, the pepper yellow vein Mali virus (PepYVMLV) was recognized as the most widespread virus [5,12] with its associated DNA-B component [5,12]. Infecting a large host range [5,6,13,14] , it is followed by the tomato leaf curl Mali virus, which is mainly reported in the western of Burkina Faso [5]. Given the socioeconomic importance of solanaceous crops, it is necessary to develop control methods and strategies based on research on varieties that are resistant/tolerant to begomovirus. Admittedly, plant breeding efforts have allowed the marketing of improved accessions, but the appreciation of these accessions by farmers and their resistance to begomoviruses remains unclear. To contribute to the appropriate and effective management, this study aimed to assess the accessions of solanaceous preferred by farmers and to identify resistant or tolerant solanaceous accessions for improved management of begomoviruses in semi-controlled conditions (temperature: 20 to 37 °C; a photoperiod of 12 h:12 h) in the central region of Burkina Faso. The availability of such information should play a more critical role in making decisions on the necessity of controlling tomato diseases.

2. MATERIAL AND METHODS

2.1 Surveys and accession inventory

In August – October 2022, surveys were carried out in the localities around Bobo-dioulasso, located in the humid Sudan zone (annual rainfall between 900 and 1100 mm) of Burkina Faso. Fifteen seed sellers and 50 farmers were randomly interviewed. All of seeds sellers were from Bobo-Dioulasso (11° 11′ 00″ N, 4° 17′ 00″ W). The 50 farmers were located in four sites in the province of Houet. This included the localities of Leguema (n = 20), Sakabi (n = 10), Kiri (n = 10), and Diarradougou (n = 10). The interview mainly focused on the accessions of solanaceous available in Burkina Faso, the choice of accessions used by farmers, the favorable periods of production, and the life cycle of available accessions and the production company.

2.2 Survey and collection of infected entire plants

In March 2023, a second survey was conducted in fields around Ouagadougou (12° 21′ 58″ N, 1° 31′ 05″ W). Entire solanaceous plants with typical symptoms of begomovirus infection were identified in the fields and then pictured, collected, and moved into pots for the whitefly-mediated transmission assay described below [3]. First, pots were filled with potting soil. Then symptomatic plants were carefully dug from the ground (not pulled out), so the root

systems remained relatively intact. These plants were then transferred into the pots without damaging the roots. This collection process was done before the flowering stage of plants, as described by Ouattara *et al*. [3].

2.3 Nursery of tomato accessions

The most preferred accession of each solanaceous species, identified based on the seller and farmer interviews, was used for the widespread begomovirus (ToLMLV and PepYVMLV) resistance test. Seeds of the three accessions of solanaceous (tomato, hot pepper, and sweet pepper) were sown in a growing medium consisting of a mixture of commercial substrate (2/3, Jardinova, Longué- Jumelles, France) and homemade compost (1/3) in 96-cell seedling starter trays to raise seedlings for transplanting in pots as described elsewhere [3]. The cell seedling starter trays were maintained in an insect-proof cage (semi-controlled condition : temperature: 20 to 37 °C; a photoperiod of 12 h:12 h). At the one-leaf growth stage, half of them remained in the insect-proof cage as controls, while the other half was transferred to the cage containing the symptomatic plants for the whitefly-mediated inoculation experiments described below [3]. Two accessions newly introduced in Burkina Faso, the Mona F1 (tomato) and Ganga (sweet pepper), were also used in this study.

2.4 Whitefly-mediated assay

Whitefly-mediated assay was conducted as described by Ouattara et al. [3]. In practice, a non-viruliferous *B. tabaci* colony was first fed on symptomatic solanaceous plants collected as described above. Second, the cell seedling starter trays containing healthy solanaceous seedlings (at the one-leaf growth stage) were transferred into the cage containing viruliferous whiteflies obtained after a 72-hour acquisition access period to induce the inoculation. Inoculated solanaceous plants were transplanted seven days post-inoculation (dpi) into 20-cm-diameter pots containing the growing medium. Three plants per pot and three pots per accession were used. The pots were then arranged in three insect-proof cages (three replicates) based on a complete random block design. Each cage (replicate) contained three plants per solanaceous accession. Negative controls were healthy tomato plants maintained in insect-proof cages [3].

2.5 Symptom monitoring leaf samples collection

Weeks after inoculation processing, symptoms were scored twice a week until 39 dpi. The symptom severity scale ranged from 1 (no symptom) to 10 (plant death), with grades 1-9 corresponding to the scale described elsewhere [3,12,15]. This activity of monitoring and noting symptoms made it possible to assess the kinetics of progression of the disease of the different solanaceous accessions.

At 39 dpi, apical leaves were collected regardless of the symptomatology for the detection of begomoviruses. All collected samples were first placed in envelopes and then oven-dried at 50°C for 48 hours before molecular analysis described below.

2.6 Molecular analysis of collected samples

Total DNA was extracted from 20 mg of leaves of all collected samples using the adapted cetyl trimethylammonium bromide method [16], as described elsewhere [3,17]. The resulting DNA was stored at -20 °C before use. Sets of primer pairs were used for the specific detection of DNA-A-like (PepYVMLV-A-F 5'-GCTCTTGAGTGCGTAATTC-3'; PepYVMLV- A-R 5'-ATGCAGATTCCGCTGAAG-3') and DNA-B (PepYVMLV-B-F 5'-GAGATCCAGACAGGTACTG-3'; PepYVMLV-B-R 5'-GTCG ACCTTCACTACTTCTC-3')

components of PepYVMLV and the DNA-A-like (ToLCMLV_F 5'-TGTCATGTTCTACTTGGTC-3'; ToLCMLV_R 5'-GAACCACGACATGATATCAG-3') component of ToLCMLV in collected samples [5]. Polymerization chain reaction (PCR) was carried out in 25 µL volumes containing 5 µL of 5× buffer, 2.5 µL of deoxynucleotide triphosphates (2 mM), 1.5 µL of $MgCl_2$ (25 mM), 1 µL of forward and reverse primers (10 mM), and 1 U of GoTaq Flexi DNA polymerase (Promega) as described by Ouattara *et al*., [3]. After an initial denaturation of 5 minutes at 94°C, 30 cycles consisting of 30 seconds at 94°C, 30 seconds at 55°C (primers PepYVMLV-A_F / PepYVMLV-A_R), 57°C (primers PepYVMLV-B_F / PepYVMLV-B_R) or 62°C (primers ToLCMLV_F / ToLCMLV_R), and 1 minute at 72°C were conducted, followed by a final elongation step for 5 minutes at 72°C. Amplicons were checked by electrophoresis on 1% agarose gels [3].

2.7 Statistical analysis of the data

The Excel spreadsheet from the Microsoft Office 2016 suite was used to enter all the data. Analyses of these data were carried out using the R v.4.6.2 (R Core Team, 2023) statistical software. Nonlinear regression analyses between preferred solanaceous accessions on the one hand and between preferred and newly introduced accessions on the other hand were carried out. Different functions (Cauchy, cloglog, logistic, logit, loglog, and probit) were tested to adjust disease severity progression with the *gnls* function using the nmle package [18]. Based on likelihood and using the Akaike Information Criterion (AIC), the logit function was selected as the best model. In this model, denoted $y \sim 1 + C/ (1 + \exp (- A * (x - B)))$, the severity of the disease (y) depends on the JAI (x) and three biologically relevant parameters, where A is the slope of the linear phase at the inflection point, 1 + C is the disease severity at the plateau phase, and B is the time to reach 50% of the disease severity at the plateau phase as described by ouattara et al. [3,12]. Based on survey data, the citation rates were calculated as the percentage of accessions cited by a subject among all citations of accessions for each solanaceous speculation. The prevalence of disease and that of virus infection were calculated as the percentage of solanaceous plants with symptoms of solanaceous plant leaf curl and/or yellow leaf curl disease and with positive PCR results, respectively, among all inoculated plants of each solanaceous accession from each cage of the experiment. The citation frequency and prevalence differences were examined using the chi-square test based on the contingency table containing the collected data [3].

3. RESULTS AND DISCUSSION

3.1 Average participation of respondents and appreciated solanaceous accessions

3.1.1. Average participation of respondents

Out of a total of 50 farmers interviewed in the sub-humid Sudan-Sahel zone of Burkina Faso, 32 agreed to answer the questionnaire, representing a participation rate of 64%. However, 17 out of the 20 targeted seed sellers participated in the interview (46.67%). The low participation rate of seed sellers and the non-participation of certain farmers could be explained by the lack of financial support during the surveys. Indeed, some people criticized the lack of payment for the service provided and the fact that they were interviewed by several research teams, resulting in a waste of time for them.

3.1.2. Tomato accessions appreciated

The surveys allowed the identification of seventeen tomato accessions, including nine accessions cited by both farmers and seed sellers (Table 1). Analysis of citation rates obtained from interviews of farmers showed that the tomato accessions most cultivated by farmers were *Mongal F1* (28%) and *Cobra 26 F1* (23%), compared to *Diva F1* (13%), *Mona* F1 (13%), *Petomech St* (5%), *Tropimech St* (5%), *Assila F1* (3%), *Fortune* (3%), *Roma St* (3%), and *Rossol* (3%) with a significant difference ($p \leq 0.02$) excepted *Petomech St* (5%), *Tropimech St* ($p \geq 0.2$). Similarly, data collected from tomato seed shops showed that both *Mongal F1* and *Cobra 26 F1* were the most sold accessions, with citation rates equal to 12% (Table 1). Interestingly, a very strong positive correlation was observed between citation rates and preference scores according to both farmers and seed sellers, with a correlation coefficient $r \geq 0.89$. The high citation rates obtained with these accessions could be explained by the fact that they have a greater market value. In fact, the tomato *Mongal F1* and *Cobra 26 F1* were much appreciated by consumers and adapted to all seasons. This was reported elsewhere [3].

Table 1: Tomato accessions mainly used by farmers and sold in seed shops in the central region of Burkina Faso.

			Data from farmers		Data from seed sellers	
Speculations	**Company**	**Accessions**	**Citation rates [n/N]**	**Score***	**Citation rates [n/N]**	**Score***
Tomato	Sakata	*Admiral F1*	0% [0/39]	-	5% [2/41]	2
Tomato	Seminis	*Assila F1*	3% [1/39]	1	0% [0/41]	-
Tomato	Technisem	*Cobra 26 F1*	23% [9/39]	4	12% [5/41]	4
Tomato	East West Seed	*Diva F1*	13% [5/39]	3	10% [4/41]	3
Tomato	Sakata	*Emerald F1*	0% [0/39]	-	5% [2/41]	2
Tomato	Technisem	*Fortune*	3% [1/39]	1	0% [0/41]	-
Tomato	Technisem	*Mona F1*	13% [5/39]	3	7% [3/41]	3
Tomato	Technisem	*Mongal F1*	28% [11/39]	4	12% [5/41]	4
Tomato	East West Seed	*Padma F1*	3% [1/39]	1	2% [1/41]	2
Tomato	Technisem	*Petomech St*	5% [2/39]	2	10% [4/41]	2
Tomato	East West Seed	*Platinum F1*	0% [0/39]	-	2% [1/41]	1
Tomato	East West Seed	*Rio Grande*	0% [0/39]	-	7% [3/41]	2
Tomato	Technisem	*Roma St*	3% [1/39]	2	7% [3/41]	2
Tomato	Les doigts verts	*Rossol*	3% [1/39]	2	5% [2/41]	1
Tomato	East West Seed	*Tandi F1*	0% [0/39]	-	2% [1/41]	1
Tomato	Technisem	*Tropimech St*	5% [2/39]	2	5% [2/41]	2
Tomato	Technisem	*UC 82 B*	0% [0/39]	-	7% [3/41]	2
correlation coefficient			**0.89**		**0.90**	
Hot pepper	Technisem	*Big Sun*	38% [3/8]	4	36% [4/11]	4
Hot pepper	Technisem	*Estrella F1*	12% [1/8]	3	9% [1/11]	2
Hot pepper	Technisem	*Jaune du Burkina*	50% [4/8]	4	36% [4/11]	4
Hot pepper	Green Seeds	*Jaune Fort*	0% [0/8]	-	9% [1/11]	2
Hot pepper	Green Seeds	*Yellow Teresa*	0% [0/8]	-	9% [1/11]	2
correlation coefficient			**0.89**		**1**	

Sweet pepper	East West Seed	*Ganga*	8% [2/25]	3	19% [3/16]	3
Sweet pepper	Technisem	*Goliath F1*	8% [2/25]	2	6% [1/16]	2
Sweet pepper	Technisem	*Nikita F1*	8% [2/25]	3	19% [3/16]	3
Sweet pepper	Technisem	*Simbad F1*	60% [15/25]		31% [5/16]	4
Sweet pepper	Technisem	*Yolo wonder St*	16% [4/25]		25% [4/16]	3
correlation coefficient			**0.81**		**0.95**	

**appreciation of the accessions according to the scale ranging from 1 to 4 with 1 for not preferred, 2 for little preferred, 3 for preferred, and 4 for very preferred.*

3.1.3. Pepper accessions appreciated

Considering the both hot and sweet peppers, five accessions were inventoried per speculation (Table 1). Based on data collected from farmers, the *Jaune du Burkina* and the *Big Sun* were the most cultivated hot peppers in Burkina Faso, with citation rates of 50% and 38%, respectively (Table 1). The observation is the same with the data collected from sellers, notably with rates of 31% and 36% for the *Jaune du Burkina* and the *Big Sun*. Analysis of citation rates showed that there is no difference between citation rates when considering both *Jaune du Burkina* and *Big Sun* regardless of the data (Table 1). Moreover, the sweet pepper *Simbad F1* was the most appreciated by farmers, with a citation rate of 60%. It is followed by the sweet pepper *Yolo wonder* St with 16% as citation rate. This was confirmed by data obtained from seed sellers (Table 1). Here, a very strong positive correlation was also observed between citation rates and preference scores according to both farmers and seed sellers, with a correlation coefficient $r \geq 0.81$.

Taken together, the top accessions were the tomato *Mongal F1*, the hot pepper *Jaune du Burkina,* and the sweet pepper *Simbad F1.* The fact that these accessions are cultivated mainly by farmers could be explained by consumers appreciation. In fact, the hot pepper *Jaune du Burkina* is known as an accession with an extremely hot taste. All of these accessions have a life cycle up to 70 days, with the exception for the hot pepper *Jaune du Burkina,* which has a long life cycle (120 days) (Table 2). The tomato Mona F1 and the sweet pepper Ganga produced by Technisem and East West Seed societies were identified as accessions, which were newly introduced in Burkina Faso. This can explain the lowest citation rates obtained with these accessions. They were associated with the top three solanaceous accessions for the screening test, with results presented in the next section.

Table 2: Information about the top and the newly introduced solanaceous accessions cultivated in Burkina Faso

Speculations	Company	Accession	Life cycle (days)	Production periods
Tomato	Technisem	Mongal F1	65-70	Dry season
Tomato	Technisem	Mona F1	65-70	Dry and rainy seasons
Hot pepper	Technisem	Jaune du Burkina	120	Dry and rainy seasons
Sweet pepper	Technisem	Simbad F1	55-60	Dry and rainy seasons
Sweet pepper	East West Seed	Ganga	75	Dry and rainy seasons

3.2 Kinetics of estimated symptom severity on top one solanaceous accessions

Whitefly-mediated inoculation tests were successfully carried out for the most cited accessions of solanaceous. All accessions developed distinct symptoms of leaf crumpling

with yellowing and stunting (Figure 1). At 39 dpi, the tomato *Mongal F1* (100%) and the sweet pepper *Simbad F1* (89%) showed the highest prevalence of symptoms in inoculated plants. However, the pepper *Jaune du Burkina* showed symptoms in 56% of inoculated plants (Table 2). Based on comparison analysis, a significant difference was observed for the pepper *Jaune du Burkina* compared to both tomato *Mongal F1* ($p=0.01$) and sweet pepper *Simbad F1* ($p=0.2$). In contrast, no significant differences were observed between the tomato *Mongal F1* and the sweet pepper *Simbad F1* ($p=0.2$). The kinetics of symptom severity were compared using the three accessions of solanaceous. Thirteen dpi, the tomato *Mongal F1* and the sweet pepper *Simbad F1* showed the first symptoms of crumpling, yellowing, and stunting. In contrast, the hot pepper *Jaune du Burkina F1* exhibited its first symptoms after 30 dpi (Figure 2). The tomato *Mongal F1* and the sweet pepper *Simbad F1* accessions showed quick development of disease with a severity score of eight and nine at 30 dpi, while the severity score for the hot pepper *Jaune du Burkina F1* was three at 40 dpi. Interestingly, logistic growth models of the progression of disease symptom severity in the three solanaceous accessions show significant differences ($p<0.001$) (Table 4). These results could be explained by the whitefly feeding preference and the existence of coinfection cases. Another study stated that both plants and whiteflies mediate their host selection, oviposition, development, and survival [19]. In the same study, certain tomato varieties were the most suitable hosts for *B. tabaci* Q compared to the other tomato varieties or other plant species. However, *B. tabaci* Q is reported to be the most widespread in the central region of Burkina Faso [20]. This may then confirm the previous hypothesis of feeding affinity of whiteflies.

Figure 1: Disease symptoms in (A) tomato (*Solanum lycopersicum*) and (B) pepper (*Capsicum* Sp.) plants inoculated by whitefly-mediation method.

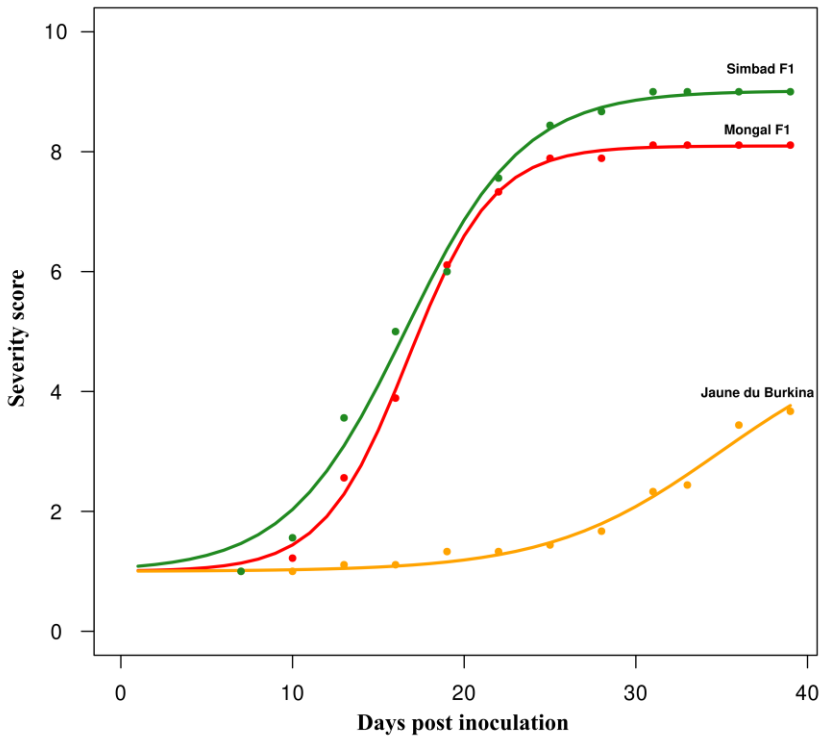

Figure 2: Kinetics of estimated symptom severity of begomovirus induced disease following whitefly-mediated inoculation of solanaceous accessions. Each point represents the average for one experiment. The symptom severity scale (y axis) ranges from 1 (no symptoms) to 9 (Severe symptoms)

Table 3: Disease prevalence of the top and the newly introduced solanaceous accessions cultivated in Burkina Faso

Speculations	Accessions	Prevalence [number of diseased plants/total of inoculated plants]
Sweet pepper	Simbad F1	100 % [18/18]
Tomato	Mongal F1	88,89 % [16/18]
Hot pepper	Jaune du Burkina	55,56 % [10/18]
Sweet pepper*	Ganga	44,44 % [8/18]
Tomato*	Mona F1	38,89 % [7/18]

** Accessions newly introduced in Burkina Faso*

Table 4: Estimated parameters [95% confidence intervals] of the logistic growth model of the progression of disease symptom severity in plants of solanaceous accessions inoculated by whitefly-mediated transmission of the begomovirus from infected plants.

Speculations	Accessions	Parameter estimates for the logit model		
		A	B	1+C

Hot pepper	Jaune du Burkina	0.2	[0.14 - 0.27]	34.89	[30.48 - 39.31]	3.98	[2.4 - 5.55]
Tomato	Mongal F1	0.4	[0.36 - 0.44]	16.73	[16.46 - 17.01]	7.1	[6.98 - 7.21]
Sweet pepper	Simbad F1	0.29	[0.24 - 0.34]	16.57	[15.87 - 17.27]	8.02	[7.72 - 8.31]

3.3. Detection of begomovirus in inoculated plants

PCR diagnosis with primers specific to PepYVMLV and ToLCMLV allowed the detection of these viruses in leaf samples collected from inoculated solanaceous plants. The sweet pepper *Simbad F1* accession recorded the highest prevalence of PepYVML (100%), while the highest infection (100%) was recorded in the case of the tomato *Mongal F1* . However, the hot pepper *Jaune du Burkina* occupied the second and last place when considering the PepYVMLV and ToLCMLV infections, respectively (table 5). PepYVMLV was widely detected in samples for all solanaceous accessions. This highlights the very aggressive nature of PepYVMLV [3] that can be due to the presence of the second DNA-B molecule of PepYVMLV characterized previously [5]. In addition, these results confirm the presence and maintenance of PepYMLV [6,7,14] and ToLCMLV [3,5,7,14] in Burkina Faso.

Table 5: Transmission rates of the widespread begomoviruses on solanaceous accessions using whitefly-mediated transmission 39 days after inoculation.

		Virus prevalence [positives samples / tested samples]	
Speculations	**Accessions**	**PepYVMLV**	**ToLCMLV**
Sweet pepper	Simbad F1	100 % [18/18]	33,33 % [6/18]
Tomato	Mongal F1	33,33 % [6/18]	100 % [18/18]
Hot pepper	Jaune du Burkina	66,67 % [12/18]	0 % [0/18]
Sweet pepper*	Ganga	100 % [18/18]	0 % [0/18]
Tomato*	Mona F1	0 % [0/18]	100 % [18/18]

* *Accessions newly introduced in Burkina Faso*

3.4 Behavior of Solanaceous accessions introduced into Burkina Faso compared to those preferred

The surveys made it possible to note the presence of the tomato Mona F1 and hot pepper *Ganga* as new accessions used by producers. The behavior of these varieties was evaluated and compared to farmers' preferred accessions. The curve of the kinetics of appearance of leaf deformation disease shows that the tomato *Mona F1* only presented the first typical symptoms on the 38th dpi (Figure 3A). And the symptoms were less severe than those observed in the tomato *Mongal F1* ($p<0.001$, Figure 3). However, ToLCMLV viruses were detected in 100% of the samples collected from the tomato *Mona F1* (Table 5). Likewise, the sweet pepper *Ganga F1* presented mild symptoms late (Figure 3B). Analysis based on the curve of the kinetics of appearance of disease showed that typical symptoms of begomovirus infection appeared early and were more severe in the sweet pepper *Simbad F1* than *Ganga*, significantly ($p<0.001$). In contrast, only PepYVMLV was detected in the samples collected in this accession, with a prevalence of 100%. The sweet pepper *Ganga* and the tomato *Mona F1* showed mild symptoms during the screening. This could be explained by a tolerance capacity of these accessions, probably linked to a tolerant gene or

the fact that these accessions have been improved according to the respondents. Previous work has demonstrated that varieties with less severe symptoms would be tolerant [12,15]. These accessions must therefore be tested for production under infection conditions.

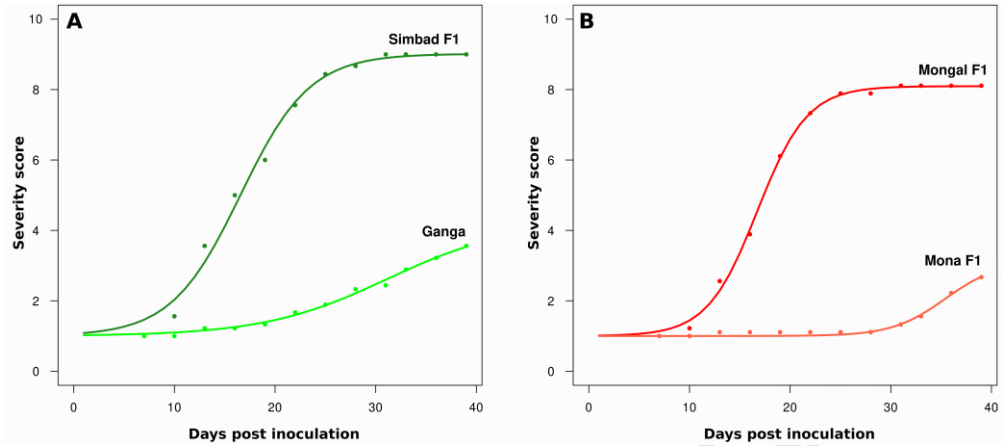

Figure 3: Kinetics of estimated symptom severity of begomovirus induced disease following whitefly-mediated inoculation of (A) preferred and (B) newly introduced solanaceous accessions. Each point represents the average for one experiment. The symptom severity scale (y axis) ranges from 1 (no symptoms) to 9 (Severe symptoms)

4. CONCLUSION

To contribute to the determination of solanaceous' accessions resistant/tolerant to begomoviruses, surveys made it possible to list more than fifteen Solanaceae accessions in western Burkina Faso with two newly introduced accessions. The transmission test carried out via the whitefly on the most preferred accession of each of the three speculations made it possible to reproduce typical symptoms of begomovirus infection with the detection of PepYVMLV and/or ToLCMLV. This made it possible to confirm that begomoviruses are responsible for these symptoms observed in the field. The evaluation of the preferred accessions with regard to begomovirus made it possible to retain the tomato *Mona F1*, the pepper *Ganga,* and hot pepper *Jaune du Burkina* as less sensible accessions to begomovirus. These accessions could be used in varietal improvement programs in Burkina Faso. In perspective, the impact of begomoviruses on the productivity of these potential tolerant accessions could also be evaluated.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

REFERENCES

1. Dhaliwal, M. S. (2007). Solanaceous vegetables. In *Handbook of Vegetable Crops* (3rd ed., pp. 34–76). Kalyani Publishers.

2. Nations Food and Agriculture Organization of the United. (2024). FAOSTAT statistical database. [Rome] : FAO. Retrieved from https://www.fao.org/faostat/en/#data/QCL

3. Ouattara, A., Kaboré, I., Zombré, C., Sogoba, K. H., Badiel, B., Traoré, E. V., … Traoré, O. (2023). Screening of widely used accessions of tomato for resistance / tolerance to the Pepper yellow vein Mali virus in the central region of Burkina Faso. *Italian Journal of Agronomy*, *18*(2202), 3–8. https://doi.org/10.4081/ija.2023.2202

4. Dembélé, S., Koffi, N. E., Cissé, I., Adima, A. A., Yao, K., & Louise, A. A. A. (2019). Nutritional composition and antioxidant capacity of four tomato varieties cultivated in Cote d'Ivoire. *International Journal of Innovation and Applied Studies*, *26*(4), 915–925. Retrieved from http://www.ijias.issr-journals.org/abstract.php?article=IJIAS-19-006-03

5. Ouattara, A., Tiendrébéogo, F., Lefeuvre, P., Hoareau, M., Claverie, S., Allibert, A., … Lett, J.-M. (2019). Diversity , distribution and prevalence of vegetable-infecting geminiviruses in Burkina Faso. *Plant Pathology*, *69*, 379–392. https://doi.org/10.1111/ppa.13120

6. Ouattara, A., Nana, T. A., Sogoba, K. H., Koïta, K., Lefeuvre, P., & Lett, J. M. (2023). First report of a naturally occurring isolate of Pepper yellow vein Mali virus causing tobacco yellow leaf curl disease in Burkina Faso. *New Disease Reports*, *48*(September), 3–5. https://doi.org/10.1002/ndr2.12217

7. Ouattara, A., Ouologueme, M. Y., Neya, B. F., Sogoba, K. H., & Sanon, E. (2024). Impact of the Seasons on the Evolution of Tomato-infecting Geminivirus and Identification of Plant Reservoirs Harboring Geminivirus in Burkina Faso. *International Journal of Plant & Soil Science*, *36*(11), 345–355. Retrieved from https://doi.org/10.9734/ijpss/2024/v36i115151

8. Fiallo-Olivé, E., Lett, J. M., Martin, D. P., Roumagnac, P., Varsani, A., Zerbini, F. M., & Navas-Castillo, J. (2021). ICTV Virus Taxonomy Profile: Geminiviridae 2021. *Journal of General Virology*, *102*(12), 1–2. https://doi.org/10.1099/jgv.0.001696

9. Roumagnac, P., Lett, J. M., Fiallo-Olivé, E., Navas-Castillo, J., Zerbini, F. M., Martin, D. P., & Varsani, A. (2022). Establishment of five new genera in the family Geminiviridae: Citlodavirus, Maldovirus, Mulcrilevirus, Opunvirus, and Topilevirus. *Archives of Virology*, *167*(2), 695–710. https://doi.org/10.1007/s00705-021-05309-2

10. Dogra, S., Eini, O., Rezaian, M., & Randles, J. (2009). A novel shaggy-like kinase interacts with the Tomato leaf curl virus pathogenicity determinant C4 protein. *Plant Molecular Biology*, *71*, 25–38. https://doi.org/10.1007/s11103-009-9506-x

11. Zhou, Y.-C., Noussourou, M., Kon, T., Rojas, M. R., Jiang, H., Chen, L.-F., … Gilbertson, R. L. (2008). Evidence of local evolution of tomato-infecting begomovirus species in West Africa: characterization of tomato leaf curl Mali virus and tomato yellow leaf crumple virus from Mali. *Archives of Virology*, *153*(4), 693–706. https://doi.org/10.1007/s00705-008-0042-9

12. Ouattara, A., Tiendrébéogo, F., Becker, N., Urbino, C., Thébaud, G., Hoareau, M., … Lett, J. M. (2022). Synergy between an emerging monopartite begomovirus and a DNA-B component. *Scientific Reports*, *12*(1), 1–11. https://doi.org/10.1038/s41598-021-03957-7

13. Ouattara, A., Kéré, D., Hoareau, M., Koïta, K., Lefeuvre, P., & Michel, J. (2024). A new monopartite begomovirus infecting Melochia tomentosa in Burkina Faso. *Archives of Virology*, *169*(240), 3–5. https://doi.org/10.1007/s00705-024-06167-4

14. Ouattara, A., Seka, K., Elisabeth, A., Alice, S., Kere, D., Ouattara, Y. S. R., … Traoré, O. (2024). Role of Medicinal Herbs in Sustaining Begomovirus Populations in Burkina Faso : Therapeutic Implications and Ecological Insights. *Journal of Experimental Agriculture International*, *46*(11), 508–520. Retrieved from https://doi.org/10.9734/jeai/2024/v46i113072

15. Lapidot, M., Cohen, L., Machbash, Z., & Levy, D. (2006). Development of a Scale for Evaluation of Tomato yellow leaf curl virus Resistance Level in Tomato Plants. *Phytopathology*, *96*(12), 1404–1408. https://doi.org/10.1094 /PHYTO-96-1404

16. Doyle, J. J., & Doyle, J. L. (1987). A rapid DNA isolation procedure for small quantities of fresh leaf tissue. *Phytochem. Bull.*, *19*, 11–15. Retrieved from https://worldveg.tind.io/record/33886/

17. Séka, K., N'cho, J. A., Assiri, K. P., Yao, K. F., & Diallo, H. A. (2018). Medicinal plants of Côte d ' Ivoire and viral infections : Diagnosis of Begomovirus. *International Journal of Agronomy and Agricultural Research*, *12*(2), 78–86. Retrieved from https://innspub.net/wp-content/uploads/2018/02/IJAAR-V12-No2-p77-85.pdf

18. Pinheiro, J. C., Bates, D. M., DebRoy, S., Sarkar, D., & Team, R. C. (2016). nlme: Linear and Nonlinear Mixed Effects Models. Retrieved from http://cran.r-project.org/package=nlme

19. Rahman Shah, M. M., Zhang, Z., Hu, J., Gaber, A., & Hossain, A. (2023). Impact of leaf trichomes of tomatoes and weeds on the host selection and developmental bioassays of Bemisia tabaci Q and A cryptic species. *Heliyon*, *9*(9), e20077. https://doi.org/10.1016/j.heliyon.2023.e20077

20. Gnankiné, O., Mouton, L., Henri, H., Terraz, G., Houndeté, T., Martin, T., … Fleury, F. (2013). Distribution of Bemisia tabaci (Homoptera: Aleyrodidae) biotypes and their associated symbiotic bacteria on host plants in West Africa. *Insect Conservation and Diversity*, *6*, 411–421. https://doi.org/10.1111/j.1752-4598.2012.00206.x