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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 10 (24): 4365-4374, 2007
ISSN 1028-8880

Effect of Cowpea Seeds Contamination Rate by the *Cowpea aphid borne mosaic virus* on Epidemics Development

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Abstract: *Cowpea aphid borne mosaic virus* (CABMV) diseased seeds provide at seedling, virus infected plants which are the only source of primary inoculum. Secondary infections are bequeathed by aphids. The objective of this research is to study the development of the secondary infection in field. Therefore, eight cowpea varieties with different seed contamination rate (0, 0.05, 0.25, 0.5, 1, 5%) were used over consecutive four years. The infected plants were recorded every week from the tenth day after sowing and over seven weeks. In the same way, aphids' population were evaluated in plots 30 days after sowing. There was no difference for the incidence rate between the average of plots sown with virus free-seeds and those sown with infected seeds with a rate of 0, 5%. In any case, the disease progressed lowly leading to incidences less than 50% at the post-flowering period in spite of a relatively high initial contamination rate of seed. For this group of varieties, the low progression of the disease indicated a high level of resistance to the infection. The high levels of infection especially observed with the varieties with high level of virus transmission to seed, translated the need to reduce aphids' population density notably by the use of insecticides during cowpea growing cycle. The high number of aphids and inoculum availability in the neighbouring plots were undoubtedly at the source of this result. This situation laid out the problematic of the use of seeds then little or not contaminated by the virus.

Key words: *Cowpea aphid borne mosaic virus*, contaminated seeds, primary inoculum, aphids, epidemic

INTRODUCTION

Among virus infecting cowpea in Africa, the *Cowpea aphid borne mosaic virus* (CABMV) is the most expand (Aboul Ata *et al*., 1982). Yield losses caused by this virus are between 15 and 87% (Thottappilly and Rossell, 1992; Reeves, 1983). According to these researchers, the capacity of transmission of virus by seed is related to the cowpea cultivar. In Burkina, this virus was identified with two other viruses of minor importance (Some, 1989), which are the *Cowpea golden mosaic virus* (CGMV) and the *Cowpea mottle virus* (CmoV). All these three viruses were identified on the basis of symptom and serological analysis.

The rates of transmission of CABMV by seed on cowpea vary from 0 to 40% according to varieties (Aboul Ata *et al*., 1982; Tignegre, 2000; Neya, 2002). On the other hand, other sources or permanent reservoirs of CABMV are not known. So, the transmission of CABMV by seed remains the privileged mean of infection from one generation to another one and constitutes sources of inoculums (Konate and Neya, 1996).

The reduction of the number of contaminated seed can be considered by acting in the choice of cowpea genotype as some genotypes posse a weak level of virus transmission contrary to others (Tignegre, 2000; Neya, 2002). The aim of this study presented was to get a better knowledge of the transmission of the mosaic of cowpea by aphids in Burkina Faso, in a prospect of an integrated pest control management against this disease. It was also to study the development of CABMV epidemic by using several level (0, 0.05, 0.25, 0.5, 1, 5%) of cowpea seed contamination by CABMV in eight varieties. This research investigation has never been performed. The different levels were following the methods of Konate and Neya (1996). The development of CABMV epidemics caused by secondary infections of aphids on eight varieties will enable the knowledge of:

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- The role of seeds in the spread of CABMV.
- The role of the vector in the propagation of CABMV.
- The creation of an integrated pest management in response to CABMV epidemic.

MATERIALS AND METHODS

During four consecutive years (2001-2004), shares of seeds contaminated by the CABMV at rate of 0, 0.05, 0.25 and 0.5% were built up for the following cowpea varieties: Kvx30-309-6G, Kvx414-22-72, Gorom local and Moussa local. These varieties transmit the virus by seeds at variable rate ranging between 20 and 40% (Tignegre, 2000; Neya, 2002). Other shares of contaminated seeds at 0, 0.25, 1 and 5% have also been built up for four other varieties: Kvx61-1, Kvx396-4-5-2D, KN1 and Tvx3236. They transmit virus by seeds at a low rate (1 to 2%) (Tignegre, 2000; Neya, 2002).

The research of contaminated seeds has been achieved using the method of (Konate and Neya, 1996). Thus, the seeds whose fragments were tested positively were gathered. By a rule of three, a combination has been made with virus free seeds to get the expected contamination rates. For each level of contamination, the seeds were sown on 200 m^2 plots. They were previously ploughed and ridged after mineral fertilization of 100 kg ha^{-1} in three replications that makes 96 elementary plots. The density was of two seeds by hall with 0, 40 m between hall and 0, 80 m between ridges. For each replication, the plots were ordered in the increasing sense of the contamination rate.

The diseased plants were recorded every week from the tenth day after sowing until 59 days. Thirty days after sowing, aphids' population were scored on each plot and per plant, using the entomologists scale that is as follows: 0 = no aphid; 1 = 1 to 4 aphids per cowpea plant; 2 = 5 to 20 aphids by cowpea plant; 3 = 20 to 100 aphids by cowpea plant; 4 = 100 to 500 aphids by cowpea plant; 5 = more than 500 aphids cowpea plant. No insecticide treatment was applied during the whole length of the observations.

The analytical and statistical procedures were used according to Stanton (1996).

RESULTS

Plants stand one week after sowing: On each plot of the three replications, at one week after sowing, the number of plants was counted. The averages of plant numbers within the three replications per variety and initial contamination rate are consigned in Table 1.

The assessment of aphid's population 30 days after sowing: The number of aphids in the plots corresponding to each initial contamination rate of the seeds was recorded according to the entomologists scale in order to evaluate the infestation of the plots one in relation to the other (Table 2). The notes assigned in each of the two tested cowpea variety groups were varied between 2 and 4. Within each year, the analysis of variance showed that there was no significant difference between the average number of insects per plot and per share of varieties. In 2001, for the first share of varieties, $F = 1.21$; $p = 0.349$ while for the second group $F = 2.81$; $p = 0.085$. In 2002, $F = 0.2$; $p = 0.94$ for the first group and $F = 1.84$; $p = 0.193$ for the second group. In 2003, for the first group, $F = 1.43$; $p = 2.85$ while for the second group $F = 0.85$ and $p = 0.495$. Last, in 2004, the first group had $F = 1.20$ and $p = 0.352$ and for the second group $F = 1.30$; $p = 0.321$. Therefore, we noticed a non significant difference infected plants at 5% level according to Newman-Keuls' test between 2001 and 2004. Similarly significant difference was noted between 2002 and 2003. This difference is significant at 5% level of the same test between the two groups of years.

The effect of seed contamination rate on the disease incidence 31 and 59 days after sowing: In 2001, 31 days after sowing, the disease incidence was generally superior to 60% with the varieties of high ability of virus

Table 1: Mean total number of plants per variety and per initial contamination rate

Varieties	2001				2002				2003				2004			
ICR (%)	0	0.05	0.25	0.5	0	0.05	0.25	0.5	0	0.05	0.25	0.5	0	0.05	0.25	0.5
Gorom local	674	678	670	678	645	599	673	547	700	678	597	669	675	723	723	728
Kvx414-22-72	682	677	675	709	634	607	680	675	678	657	608	643	680	687	740	725
Kvx30-309-6G	653	604	685	647	658	611	653	600	657	674	624	639	653	645	685	713
Moussa local	675	640	657	688	657	641	677	603	689	697	652	656	632	639	726	724
	0	0.25	1	5	0	0.25	1	5	0	0.25	1	5	0	0.25	1	5
Kvx61-1	656	673	671	695	673	681	686	617	707	679	651	678	653	736	697	699
KN1	696	656	714	639	681	689	698	692	735	689	667	687	696	659	712	738
Tvx3236	597	700	741	641	684	701	704	697	732	712	694	653	722	726	734	714
Kvx396-4-5-2D	619	655	619	613	662	672	657	651	698	653	634	659	609	729	681	722

ICR = Initial Contamination Rate

Table 2: Assessment of aphids on the plots 30 days after sowing from 2001 to 2004

	Initial contamination rate															
	2001				2002				2003				2004			
Varieties	0	0.05	0.25	0.5	0	0.05	0.25	0.5	0	0.05	0.25	0.5	0	0.05	0.25	0.5
Gorom local	3	3	3	2	2	3	3	2	4	2	3	3	3	2	3	3
Kvx414-22-72	2	3	2	4	3	2	3	2	4	3	4	3	3	2	4	2
Kvx30-309-6G	3	3	2	4	3	3	3	2	3	4	3	4	3	3	2	3
Moussa local	3	2	2	3	2	2	3	3	2	3	3	3	3	2	2	4
Average	2.75 (ns)[#]	2.5 (ns)	2.25 (ns)	3.25 (ns)	2.5 (ns)	2.5 (ns)	3 (ns)	2.25 (ns)	3.25 (ns)	3 (ns)	3.25 (ns)	3.25 (ns)	3 (ns)	1.75 (ns)	2.75 (ns)	3 (ns)
	0	0.25	1	5	0	0.25	1	5	0	0.25	1	5	0	0.25	1	5
Kvx61-1	3	3	2	4	4	3	3	2	4	3	4	3	3	3	2	4
KN1	2	3	2	3	2	3	3	2	3	4	4	4	2	3	3	2
Tvx3236	4	3	3	4	3	3	3	4	4	4	3	4	3	4	3	4
Kvx396-4-5-2D	4	2	3	4	3	4	4	3	3	3	4	3	4	4	2	3
Average	3.25 (ns)[#]	2.75 (ns)	2.5 (ns)	3.75 (ns)	3 (ns)	3.25 (ns)	3.25 (ns)	2.75 (ns)	3.5 (ns)	3.5 (ns)	3.75 (ns)	3.5 (ns)	3 (ns)	3.5 (ns)	2.5 (ns)	3.25 (ns)

#: Non significant at 5% level according to Newman Keuls' test; *: The number of aphids was estimated while using the following scale: 0 = no aphid; 1 = 1 to 4 aphids per cowpea plant; 2 = 5 to 20 aphids per cowpea plant; 3 = 20 to 100 aphids per cowpea plant; 4 = 100 to 500 aphids by cowpea plant; 5 = More than 500 aphids per cowpea plant

Table 3a: Incidence of CABMV on cowpea varieties 31 days after sowing according to the seed initial contamination rates.

	Initial contamination rate															
	2001				2002				2003				2004			
Varieties	0	0.05	0.25	0.5	0	0.05	0.25	0.5	0	0.05	0.25	0.5	0	0.05	0.25	0.5
Gorom local	67.12	77.97	88.88	82.51	2.36	2.57	2.05	7.03	1.65	1.82	1.47	3.15	47.12	59.71	68.98	70.11
Kvx414-22-72	68.60	56.98	67.21	56.56	1.39	3.13	1.25	2.05	1.90	1.94	4.96	6.96	50.23	52.18	56.46	57.14
Kvx30-309-6G	54.27	60.20	64.85	74.10	1.16	1.73	1.21	2.11	1.38	1.52	2.29	2.43	44.17	54.12	58.48	72.65
Moussa local	29.33	14.23	33.70	33.80	1.28	1.11	1.56	3.24	1.36	2.18	2.51	3.42	32.24	29.36	32.44	32.18
Average	54.83	52.35	63.66	61.73	1.55	2.14	1.47	3.61	1.57	1.87	2.81	4.00	43.44	48.84	54.09	58.02
	0	0.25	1	5	0	0.25	1	5	0	0.25	1	5	0	0.25	1	5
Kvx61-1	2.20	2.68	2.72	6.800	0.69	2.32	2.39	13.27	0.00	1.78	1.44	8.66	2.08	2.28	2.97	5.87
KN1	3.85	6.77	6.82	12.75	0.00	1.89	2.53	13.21	0.29	0.69	2.35	8.75	3.34	4.55	5.72	9.68
Tvx3236	0.39	0.34	2.71	5.030	0.00	0.42	2.07	13.18	0.00	0.81	1.83	6.87	0.61	0.71	1.98	9.06
Kvx396-4-5-2D	4.41	5.93	5.63	8.550	0.44	0.77	2.26	13.55	1.41	1.25	1.54	6.90	4.11	4.21	5.63	7.65
Average	2.71	3.93	4.47	8.280	0.28	1.35	2.31	13.30	0.42	1.13	1.79	7.80	2.53	2.94	4.08	8.07

transmission by seeds with the variety Moussa local (Table 3a). The analysis of variance did not show any significant difference between the various initial seed contamination rates, F = 0. 23; p = 0.874. With the four varieties of a low ability of virus transmission by seed, the diseased plants rate remained below 15% even with seed initial contamination rates of 5%. The differences observed at the level of the incidences corresponding with the contamination rates of 0-1% were not significant. On the other hand, the corresponding impact at the contamination rate of 5% was significantly different from those corresponding with the other rates. Incidences increases were very low comparatively to the varieties with high ability of virus transmission by seed.

As at 31 days after sowing, the features of infection at 59 days after planting were similar with varieties having high ability of virus transmission to the seed. No difference was been shown between the incidences corresponding to the various contamination rates. On the other hand, incidences greatly increased, reaching 95% to 100% (Table 3b). A lower increase was observed with varieties of low powers of virus transmission by seeds. Incidences reached this way 49% in some cases even if no difference was observed whatever the seed initial contamination rate.

In 2002 as in 2003, at 31 days after planting, the disease incidence was less than 10% with all the varieties with high ability of virus transmission by seeds. The analysis of variance did not show significant difference between the various initial seed contamination rates, F = 4.23; p = 0.74. With the four varieties of low ability of virus transmission by seed, the rate of diseased plants remained below 9% even with seed initial contamination rates of 5%. The differences observed at the level of incidences corresponding to the contamination rates of 0-1% were not significant. On the other hand, the

Table 3b: Incidence of CABMV on cowpea varieties 59 days after planting according to the seed initial contamination rates

	Initial contamination rate															
	2001				2002				2003				2004			
Varieties	0	0.05	0.25	0.5	0	0.05	0.25	0.5	0	0.05	0.25	0.5	0	0.05	0.25	0.5
Gorom local	99.37	100.00	100.00	99.7	48.24	44.29	45.35	55.68	15.05	19.35	21.54	38.97	98.76	100.00	100	100.00
Kvx414-22-72	99.36	98.92	100.00	99.4	76.94	61.74	76.56	65.00	13.00	14.60	18.76	25.95	99.21	99.40	100	100.00
Kvx30-309-6G	98.98	100.00	99.40	100.0	31.94	40.07	42.62	45.91	17.02	16.47	21.64	36.37	98.87	99.12	100	99.33
Moussa local	97.67	95.22	100.00	96.8	58.01	70.8	80.45	82.64	15.10	25.60	31.43	36.37	98.76	97.89	100	100.00
Average	98.85	98.55	99.85	99.0	53.78	54.23	61.25	62.31	15.04	19.01	23.34	34.42	98.90	99.10	100	99.83
	0	0.25	1	5	0	0.25	1	5	0	0.25	1	5	0	0.25	1	5
Kvx61-1	11.66	12.71	13.13	22.38	6.06	8.30	21.86	28.89	1.12	2.03	2.13	17.30	12.61	14.87	17.77	20.39
KN1	19.35	34.66	38.01	49.03	4.86	6.88	20.87	27.78	0.70	0.96	6.07	16.72	20.20	21.43	29.89	51.15
Tvx3236	1.130	2.41	7.91	27.75	1.64	7.00	6.89	9.45	0.87	1.23	1.93	8.170	2.100	2.43	5.56	29.14
Kvx396-4-5-2D	15.40	18.67	34.52	36.15	2.54	4.26	17.53	20.90	3.06	3.15	12.62	15.76	14.67	17.00	31.32	36.70
Average	11.89	17.11	23.39	33.83	3.76	6.61	16.79	21.76	1.44	1.84	5.69	14.99	12.40	13.93	21.14	34.35

incidence corresponding to the contamination rate of 5% was significantly different from those corresponding to the other rates. The increase of incidences was very low compared to the case of the varieties with high ability of virus transmission by seed (Table 3a).

As at 31 days after sowing, the levels of infection at 59 days after sowing were low in comparison to those got in 2001 with the varieties having high ability of virus transmission to seed. No difference was shown between incidences corresponding with the various contamination rates. The incidences increased progressively to reach 80% in 2002 against 40% in 2003. A lower increase was observed with varieties of low ability of virus transmission by seed. The incidences reached 28% in 2002 against 17% in 2003 in some cases though no difference was observed whatever the seed initial contamination rate. Final incidences indicated that the disease evolution was very low in 2003 (Table 3b).

In 2004, 31 days after planting, the disease incidence was greater than 50% with varieties of high ability of virus transmission by seed with variety Moussa local as in 2001 (Table 3a). The analysis of variance did not show a significant difference between the various seed initial contamination rates, F = 0. 77; p = 0.53. With the four varieties of low ability of virus transmission by seed, the rate of diseased plants remained below 10% even with seed initial contamination rates of 5%. The differences observed at the level of the incidences corresponding to the contamination rates of 0-5% were not significant. The increase of incidences was very low compared to the case of the varieties of high ability of virus transmission by seed.

The levels of infection at 59 days after sowing were similar with varieties having high ability of virus transmission to the seed. No difference was shown between the incidences corresponding to the various contamination rates. Therefore, the levels of incidences had greatly increased in all cases, reaching 95 to 100% Table 3b. A lower increase was observed with varieties of low ability of virus transmission by seed. The incidences reached that way 50% in only one case though no difference was observed whatever the seed initial contamination rate.

Evolution of CABMV incidence: The number of diseased plants was scored every week from 10 days after sowing until 59 days in each seed levels of initial contamination within three replications. The averages of diseased plants were achieved every week and the incidences curves in percent were drawn according to the number of days after planting. The obtained curves were those of polycyclic epidemics where the inoculum increases with time. This situation meets the theoretical model of (Van Der Plank, 1963; Lepoivre, 1989). According to which the growth of the disease at the time t is proportional to the level of diseased plants at this moment. The number of diseased plants according to the time showed that the early infected plants became themselves infectious and contributed therefore to the inoculum growth. The speed of spreading increased with the growth of diseased plant number.

Kinetic of the CABMV spreading at field level from 0% level of initial contamination rate 2001 to 2004: The evolution of the average number of diseased plants in the plots sown with virus-free seed, during the four years differed from one year to the other with therefore some likenesses.

With the varieties of high ability of virus transmission by seed, the obtained curves were of sigmoid shape, indicating a very fast spreading speed resulting in some cases infection rates of 100% between 31 and 38 days after sowing (2001 and 2004). At these same dates, the rate of diseased plants remained lower than 30% with the same varieties in 2002 and 2003.

With the varieties of low ability of virus transmission by seed, the obtained curves showed that the speed of the disease spreading was low and also similar in evens. The results of 2001 were similar to those of 2004 and those of 2002 to 2003. For these varieties, the speed of the disease due to secondary infections between 31 and 38 days after sowing hardly passed 10%. Up to the maturity, the disease incidence was of 20% in 2001 and 2004 against 6% in 2002 and 2003 (Fig. 1a, b).

Kinetic of the CABMV spreading at field level from an initial contamination rate of 0.25% from 2001 to 2004 with the eight varieties: From an initial contamination rate of 0, 25%, the varieties of high ability of virus transmission by seed had incidences higher than 60% 31 days after planting in 2001 and 2004, except the variety Moussa local, whose incidence was of 33 and 31%. At the same dates, the same varieties had incidences lower than 5% in 2002 and 2003. The obtained curves looked like the previous, except that the 100% incidence is reached around 38 days after planting in 2001 and 2004 as to say one week earlier. In 2002 and in 2003, at the same date, these incidences remained under the standard of 50%. With the varieties of the second group, the incidence of the disease was around 40% at maturity in 2001 and 2004 against 10% in 2002 and 2003 where secondary infections were very low (Fig. 2a, b).

Kinetic of the CABMV spreading at field level from an initial contamination rate of 0. 05% from 2001 to 2004 with the sensitive varieties: The initial contamination rate of 0, 05% was only been used withvarieties of the first group. This rate tallies in other words to 5 contaminated plants in a share of 10000 plants. The obtained curves from the incidences reached the 100% over the standard of infection rate around 45 days after planting in 2001 and 2004. In 2002 and 2003, the secondary infections began 31 days practically after the planting. They progressed to reach 70% of diseased plants in spite of the lateness of the secondary infections starting in 2002 against 30% in 2003 at the maturity (Fig. 3a, b).

Kinetic of the CABMV spreading at field level from an initial contamination rate of 0.5% of 2001 to 2004 with the sensitive varieties: Still with varieties of high ability of virus transmission by seed, the obtained curves from a initial contamination rate of 0. 5% which means 5 plants contaminated in a share of 1000 plants were as sigmoid and comparable in evens. Therefore, the spreading speed was greater and located between 17 and 38 days after sowing. 100% incidence was quickly reached before the maturity in 2001 and 2004. At the same period, it was of 85 and 40%, respectively in 2002 and in 2003 (Fig. 4a, b).

Kinetic of the CABMV spreading at field level from an initial contamination rate of 1% from 2001 to 2004 with tolerable varieties: With the varieties of the group two, with an initial contamination rate of 1%, the secondary infections, intervened practically 31 days after planting. They slowly progressed to reach 40% of infection rate in 2001 and 2004, these rates were between 15 and 25% in 2002 and 2003. During these four years, the varieties KN1 and KVX396-4-5-2D had always the highest incidence rates and KVX61-1 and TVX3236 had the lowest rates (Fig. 5a, b).

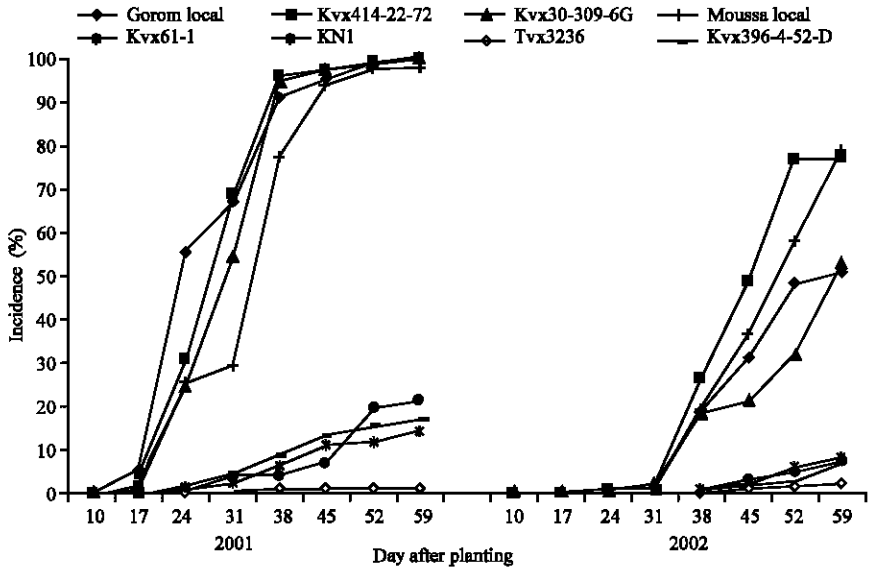

Fig. 1a: Kinetic of the CABMV spreading from an initial contamination rate of 0% of 2001 and 2002 with eight varieties

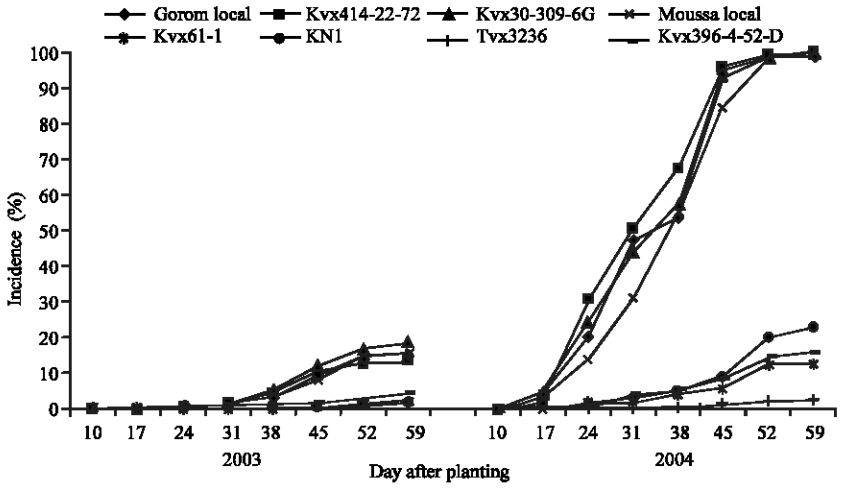

Fig. 1b: Kinetic of the CABMV spreading from an initial contamination rate of 0% of 2003 and 2004 with eight varieties.

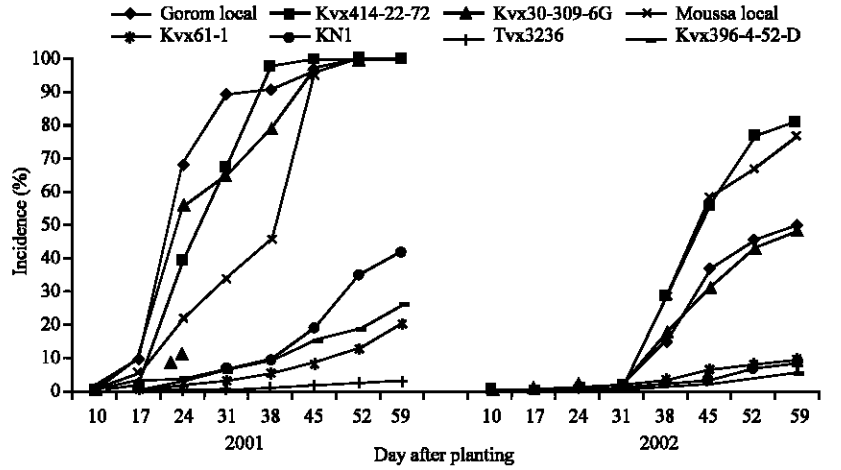

Fig. 2a: Kinetic of the CABMV spreading from an initial contamination rate of 0, 25% of 2001 and 2002 with eight varieties

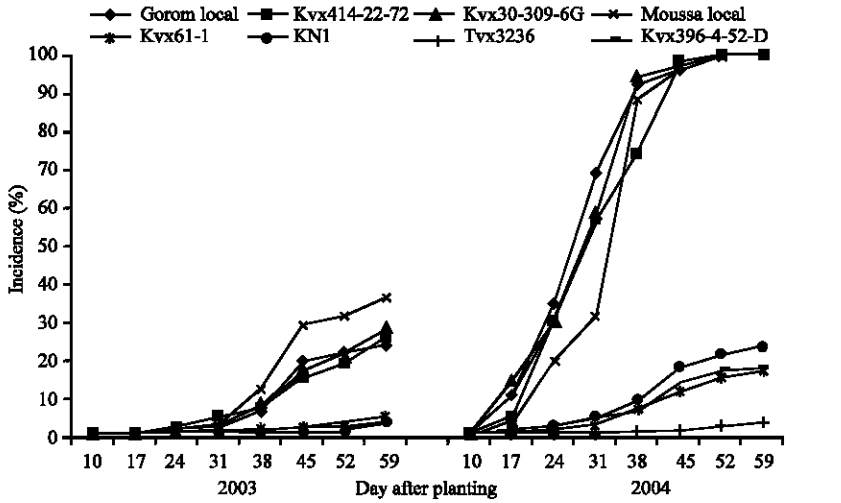

Fig. 2b: Kinetic of the CABMV spreading from an initial contamination rate of 0, 25% of 2003 and 2004 with eight varieties

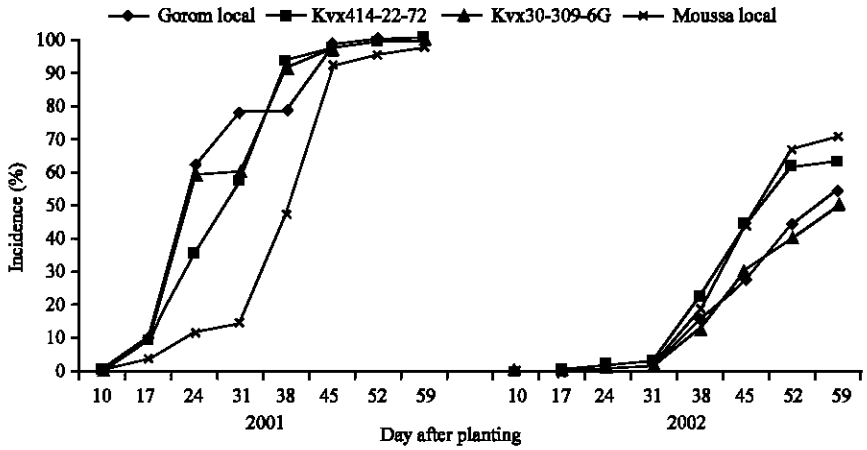

Fig. 3a: Kinetic of the CABMV spreading from an initial contamination rate of 0, 05% of 2001 and 2002 with the sensitive varieties

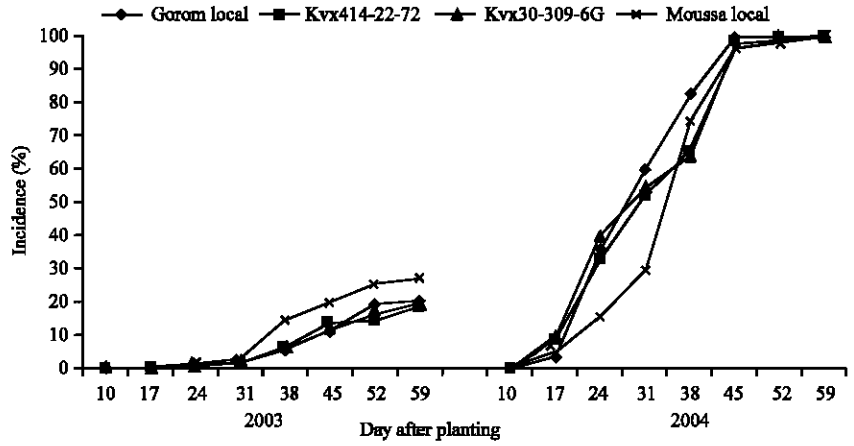

Fig. 3b: Kinetic of the CABMV spreading from an initial contamination rate of 0, 05% of 2003 and 2004 with the sensitive varieties

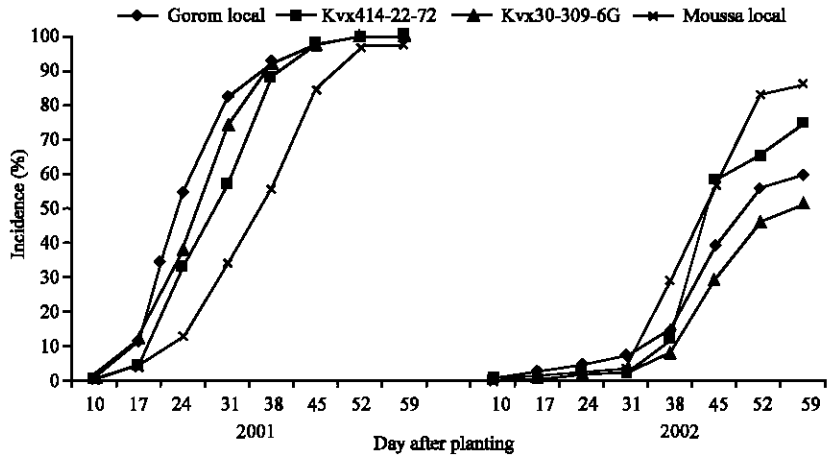

Fig. 4a: Kinetic of the CABMV spreading from an initial contamination rate of 0, 5% of 2001 and 2002 with the sensitive varieties

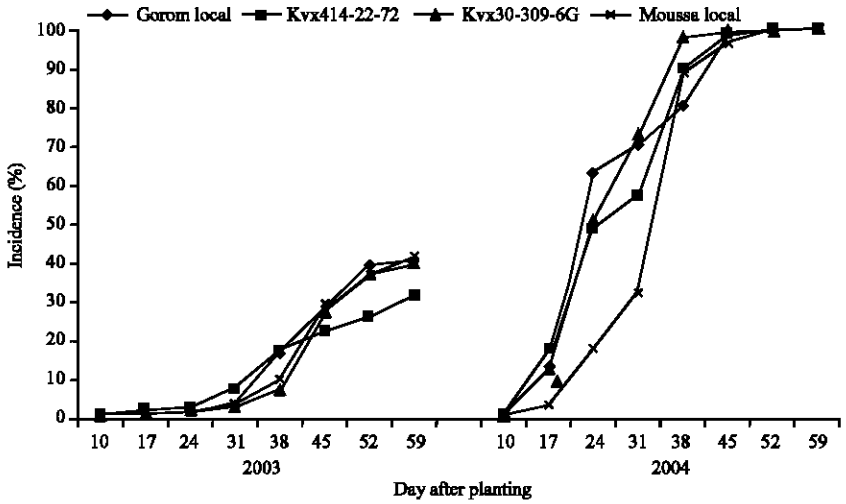

Fig. 4b: Kinetic of the CABMV spreading from an initial contamination rate of 0, 5% of 2003 and 2004 with the sensitive varieties

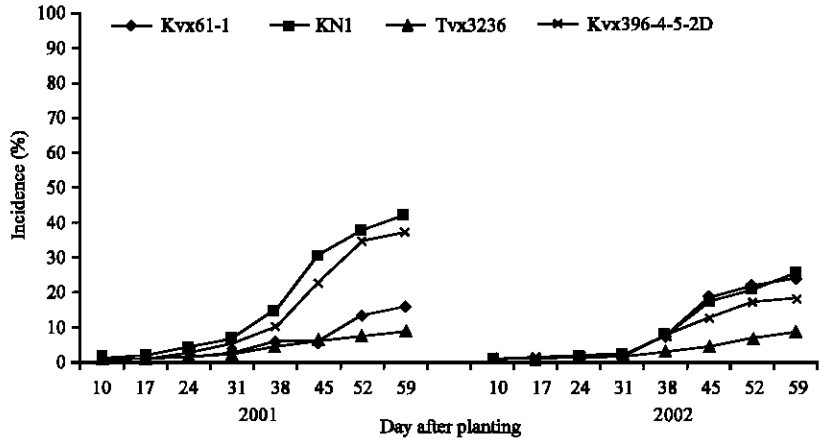

Fig. 5a: Kinetic of the CABMV spreading from an initial contamination rate of 1% of 2001 and 2002 with the tolerant varieties

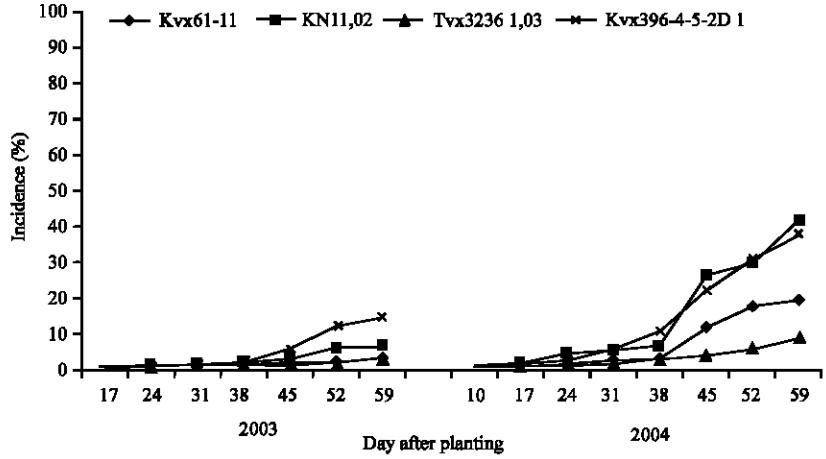

Fig. 5b: Kinetic of the CABMV spreading from an initial contamination rate of 1% of 2003 and 2004 with the tolerant varieties

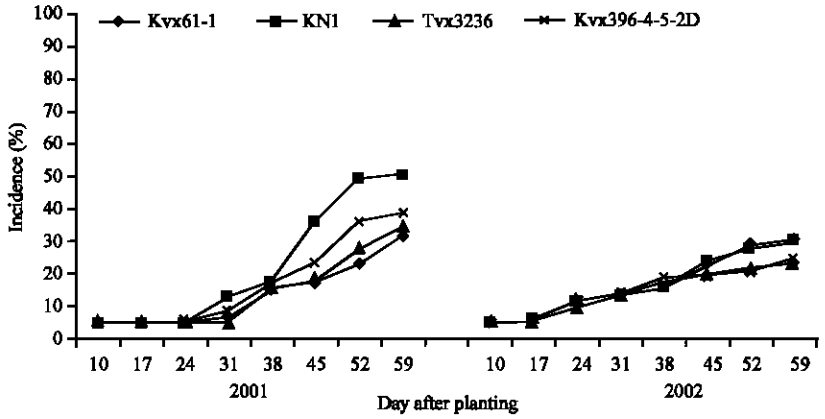

Fig. 6a: Kinetic of the CABMV spreading from an initial contamination rate of 5% of 2001 and 2002 with the tolerant varieties

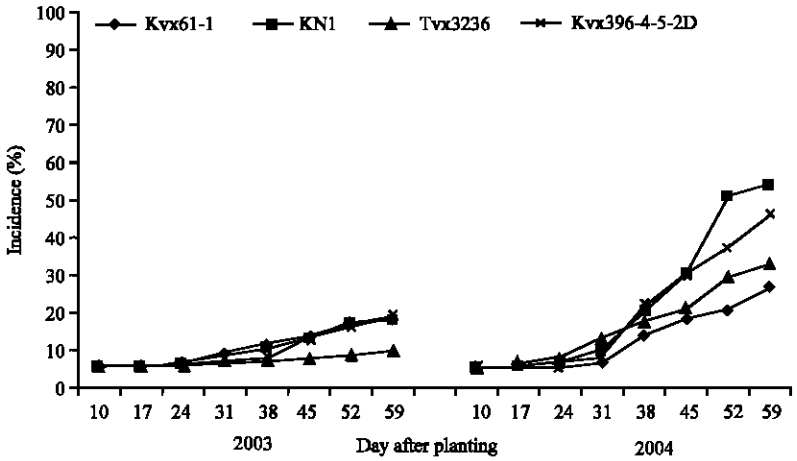

Fig. 6b: Kinetic of the CABMV spreading from an initial contamination rate of 5% of 2003 and 2004 with the tolerant varieties

Kinetic of the CABMV spreading at field level from an initial contamination rate of 5% of 2001 to 2004 with tolerable varieties: Starting from an initial contamination rate of 5%, the varieties of low ability of virus transmission by seed gave disease progression curves which were not so different from those obtained with an initial contamination rate of 1%. The starting of the secondary infections was also low as well as its progression. The greatest incidences have been observed in 2001 and in 2004. Varieties KN1 and KVX396-4-5-2D also had the highest incidence rates (50%) at 59 days after planting and KVX61-1 and TVX3236 had the lowest infection rates at the same date (Fig. 6a, b).

DISCUSSION

The results showed that the development of the CABMV epidemic depends on the various and initial seed contamination rates. For varieties with high power to transmit virus by seeds, the curves had a sigmoid pattern whatever the initial contamination rate. The secondary infections have especially been observed from the seventeenth day after sowing. They also marked the beginning of the logarithmic phase that ended since the 45th DAS because most plants had been infected, then giving impact rates of 100%. There was no impact rate difference between the average of plots sowed with virus-free seeds and those sowed with seeds with an initial rate of 0.5%. This could be due to the effect of the secondary contaminations assured by aphids (Frison, 1988) between plots corresponding to the various initial seed contamination rates. Aphid's high number and inoculum availability in the neighbouring plots were undoubtedly at the origin of this result. The impact rates of 100% have been reached in the last two weeks of the study in years with high epidemics even with virus-free seeds.

In the case of the varieties with a low faculty of the CABMV transmission by seeds such as the variety Kvx61-1, the secondary infections have been observed between 31 and 38 DAS. In any case, the disease had progressed slowly with a constant speed leading to impacts lower than 50% at the post-flowering period in spite of a relatively high and initial seed contamination rates. With Kvx61-1 variety, the CABMV propagation was low, thus giving some low impact rates even with seeds with contamination rate of 5%. For those varieties, the disease progression curves indicate a high resistance level to the infection (Tignegre, 2000; Neya, 2002). The use of seeds with low or not virus contamination can be appropriate to face the CABMV.

The high levels of infection especially observed with the variety local Gorom which represents the varieties with a high faculty of virus transmission to seed (Tignegre, 2000; Neya, 2002) suggest the necessity to reduce aphids' populations' density notably by the use of insecticides during cowpea vegetative phase. Insecticides application should be made in the third week after the sowing, most infections occurring between 17 and 24 days.

The achievement of impact rates of 100% from virus-free seeds with *Gorom local* settles the problematic of using such seeds. In that the solution would consist of setting an integrated biological control measure such as isolating the fields from important and external inoculum sources and applying suitable treatment against aphids. This research investigation has never been performed in the past.

The quality of seeds and especially the resistance of the cowpea varieties play an important role in the development and the propagation of the CABMV in the field.

REFERENCES

Aboul Ata, A.E., D.J. Allen, G. Thottappilly and H.G. Rossel, 1982. Variation in the rate of seed transmission of *Cowpea aphid borne mosaic virus* in cowpea. Tropical Grain Legume Bull., 25: 2-7.

Frison, E.A., 1988. Cowpea viruses in the sahel. FAO Plant Protection Bull., 36: 9-18.

Konate, G. and B.J. Neya, 1996. Rapid detection of *Cowpea aphid borne mosaic virus* in cowpea seeds. Annal. Applied Biol., 129: 261-266.

Lepoivre, P., 1989. Epidemiology of Plants Parasites Diseases. In: Treaty Plant Pathology. Gembloux Agron. Press, pp: 621.

Neya, B.J., 2002. Epidemiologic aspects and serology variability of *Cowpea aphid borne mosaic virus* transmitted by aphid in Burkina Faso. M.Sc. Thesis, University of Ouagadougou, pp: 46.

Reeves, W.H., 1983. The Cowpea. Int. Inst. Trop. Agric. Ibadan Nig., pp: 170.

Some, K.K.J., 1989. Epidemiology of *Cowpea aphid borne mosaic virus* transmitted by aphids in Burkina Faso. M.Sc. Thesis, University of Ouagadougou, pp: 46.

Stanton, A.G., 1996. Introduction to Bio Statistical Scientific. Scientific Revision of French. Michel, T. (Ed.). 4th Edn. McGraw-Hill, New York, pp: 456.

Thottappilly, G. and H.W. Rossel, 1992. Virus diseases of cowpea in tropical Africa. Trop. Pest Manage., 38: 337-348.

Tignegre, J.B., 2000. Cowpea aphid-borne mosaic virus (CABMV) transmission to cowpea (*Vigna unguiculata* (L.) Walp). M.Sc. Thesis, University of Ouagadougou.

Van der Plank, J., 1963. Plant Diseases. Epidemics and Control. Academic Press, New-York and London, pp: 349.