



## Effects of Two Unrelated Viruses on Growth and Yield of Some Cowpea (*Vigna unguiculata* L. Walp.) Cultivars in Mokwa, Southern Guinea Savannah

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### Abstract

Twenty five cowpea cultivars were evaluated for their reaction to *Blackeye cowpea mosaic virus* (BICMV) and *Cowpea mottle virus* (CPMoV) singly and the mixture of BICMV + CPMoV under field conditions at Mokwa, Southern Guinea agro-ecological zone in the 2017 wet season. The trial was laid out using randomized complete block design with three replications. For the single virus inoculation, seedlings of the twenty five cultivars were mechanically inoculated singly with BICMV or CPMoV at 10 days after sowing, while for the mixed virus inoculation, cowpea seedlings were mechanically inoculated with double virus mixture; that is BICMV at 10 days after sowing (DAS) and CPMoV at 17 DAS. Symptom expression such as bright yellowing, mosaic and mottling started one week after inoculation (WAI) from all treatments, while at 2 WAI, 50.0–84.3 % infection was observed among the viruses and cowpea cultivars. The plants showed typical symptoms of both viruses but at varying levels. The rating done on a scale of 1 - 5 with respect to symptomatology indicated that the viruses had significant ( $p < 0.05$ ) severe effects on the crops. The severity of the viruses on symptom rating indicated that BICMV caused the highest severity effects in Ife Brown, IT99K-316-2 and IT07K-211-1-8 which rated 4.3, CPMoV induced the highest severity effects in Ife brown, IT99K-316-2 and IT06K-137-1 with ratings of 4.3, while disease severity rating of the co-infections of BICMV + CPMoV did not differ from those of BICMV alone. However, BICMV disease severity was significantly lowest (1.6) in cultivars IT97K-568-18 and IT03K-337-6. Cultivars IT90K-277-2, IT96D-610, IT99K-316-2, IT04K-267-8, IT04K-332-1 and IT07K-243-1-10 exhibited significantly low disease severity of 1.8 on CPMoV infection, while cultivars IT96D-610, IT97K-499-35, IT97K-573-2-1 and IT04K-332-1 show the lowest disease severity score of 1.6 in the mixed virus infections. Generally, cowpea cultivar IT07K-292-1-10 consistently gave significantly ( $p < 0.05$ ) highest seed weight per plant irrespective of the virus treatments. The results indicate the potentials of cultivar IT07K-292-1-10 as source of resistance gene (s) for breeding cowpea against BICMV and CPMoV disease to enhance productivity and food security.

**Keywords:** *Blackeye cowpea mosaic virus*, *Cowpea*, *Cowpea mottle virus*, *disease incidence and severity*

### Introduction

Cowpea, [*Vigna unguiculata*, (L.) Walp] is one of the annual leguminous food crops grown in many parts of the tropics. The genus *Vigna* is pan-tropical and highly variable with several species, whose exact number varies (Ayenlere *et al.*, 2012). Cowpea has a wide variety of uses. It is a primary source of plant proteins in human and animal feeds. The percentage nutritional value of cowpea indicates its protein content to be 23%, fats 1.3%, fibre 1.8%, carbohydrate, 67% and water 8 – 9% (Shiringani and Shimele, 2011). Majority of people in the developing countries including Nigeria are engaged in cowpea production, the crop has the potential to produce reasonably well under conditions

that may render other crops unproductive, but productivity has been very low, less than 200 kg ha<sup>-1</sup> (Ayenlere *et al.*, 2012). This has been attributed to several biotic and abiotic factors (Muoneke *et al.*, 2012). The biotic factors that cause yield reduction include insect pests, parasitic weeds as well as virus, fungi and bacterial diseases (Agbogidi and Okonmah, 2012). The abiotic factors include poor soil fertility, drought, heat, acidity and stress due to intercropping with cereals (Shiringani and Shimele, 2011).

There have been reports of *Cowpea mottle virus* (CPMoV), genus *Carmovirus*, and *Blackeye cowpea mosaic virus* (BICMV), genus *Potyvirus* (Aliyu *et al.*,

2012) existing on cowpea in Nigeria. Symptoms due to infection by BICMV include severe mosaic. The severity depends on host cultivar and virus strain (Salaudeen *et al.*, 2016). Diseased cowpea plants show variable amount of dark green vein-banding or inter-veinal chlorosis, leaf distortion, blistering and stunting (Arogundade *et al.*, 2010). *Cowpea mottle virus* belongs to the Carmovirus group (Agrios, 2005) and infection is often manifested as bright yellowing (Alegbejo, 2015). In tolerant varieties, symptoms usually consist of mottling only. The virus also induces distortion and reduction in leaf size and witches broom syndrome in cowpea. Virus diseases of cowpea impact more deleterious effects on cowpea production compared to diseases due to fungi, bacteria and nematodes (Agrios, 2005). This study was carried out to investigate the severity of two unrelated viruses on symptoms induced in cowpea and to assess their effects on growth and yield attributes on their hosts.

## Materials and methods

### *Description of the study location*

The experiment was conducted at the Teaching and Research farm of the Faculty of Agriculture, Ahmadu Bello University (ABU) Mokwa Station (09°18'N and 05°50'E) in the Southern Guinea Savannah agro-ecological zone of Nigeria during the 2017 cropping season. Mokwa has a mean annual rainfall of 1200mm, which normally begins in April and ends in the first week of October. The temperature ranges between 35 and 37.5°C, with relative humidity between 40 and 80%.

### *Source of cowpea seeds*

Twenty five cowpea cultivars (Ife Brown, IT90K – 277 – 2, IT96D – 610, IT97K – 499 – 35, IT97K – 568 – 18, IT97K – 573 – 2 – 1, IT98K – 205 – M8, IT98KD – 288, IT99K – 316 – 2, IT99K – 377 – 1, IT00K – 901 – 5, IT03K – 337 – 6, IT04K – 267 – 8, IT04K – 291 – 2, IT04K – 321 – 2, IT04K – 332 – 1, IT06K – 124, IT06K – 137 – 1, IT07K – 211 – 1 – 8, IT07K – 222 – 2, IT07K – 243 – 1 – 10, IT07K – 251 – 3 – 3, IT07K – 292 – 1 – 10, IT07K – 299 – 6, IT07K – 318 – 33) were sourced from the cowpea germplasm, International Institute of Tropical Agriculture (IITA), Ibadan, Oyo State, for the study. The evaluated cultivars were selected from the cowpea germplasm commonly grown in the Guinea Savanna of Nigeria.

### *Treatments and experimental design*

The twenty five cowpea cultivars (treatments) were arranged in a randomised complete block design with three replications. The gross plot for the trial was 12.5m × 17.25m (216m<sup>2</sup>) and the net plot measurement was 3m × 15.75m (48m<sup>2</sup>).

### *Source of virus inoculum, multiplication and inoculation*

The BICMV and CPMoV isolates used were obtained from the Department of Crop Production, Federal University of Technology, Minna. Virus extract was extracted for inoculation by grinding (1g/1mL) the source in extraction buffer containing 0.1M sodium

phosphate dibasic, 0.1M potassium phosphate monobasic, 0.01M ethylene diamine tetra acetic acid and 0.001M L-cystine per litre of distilled water, using pre-cooled sterilized mortars and pestles. Two microlitres of β- mercapto-ethanol were added to the extract just before used. For the single virus inoculation, seedlings of the twenty five cultivars were mechanically inoculated singly with BICMV or CPMoV at 10 days after sowing, while for the mixed virus inoculation, cowpea seedlings were mechanically inoculated with double virus mixtures i.e BICMV at 10 days after sowing (DAS) and CPMoV at 17 DAS by rubbing the virus extract on the upper surface of the leaves dusted with carborundum powder (600-mesh). The inoculated plants were rinsed with sterile distilled water and monitored for symptom expression. Symptomatic leaves were collected from the infected plant at 3 weeks after inoculation (WAI) for inoculation during the main experiment. Infected leaves were preserved at room temperature, in airtight vial bottles on silica gels covered with a thin layer of non-absorbent cotton wool.

### *Crop establishment and management*

The study site was manually cleared of the previous plant remains and ridged in the second week of August, 2017. Cowpea seeds were sown one week after the land preparation. Three cowpea seeds were sown after dressing with Apron – star (methylthiuram + metalaxyl + carboxin) at the rate 3kg per 10kg seeds, in inter- and intra- row spacing of 0.75 and 0.30m, respectively. Seedlings were thinned to one per stand at 8 days after sowing. Weeds were manually controlled through hand weeding at 3 and 6 weeks after sowing. Insect pests were controlled by spraying D-D force (Cypermethrin plus Dimethoate) and pods were harvested at physiological maturity.

### *Data collection and statistical analysis*

Data were collected on BICMV and CPMoV disease incidence and severity, plant height, number of branches per plant, days to 50% flowering, number of pods per plant, number of seeds per plant and seed weight per plant. Disease severity was based on a visual scale (1 – 5) of Nsa and Kareem (2015). On the scale, 1 = no symptoms, 2 = slight mosaic; 3 = moderate mosaic, 4 = severe mosaic, leaf distortion and stunting, 5 = severe mosaic, stunting and plant death. Data were subjected to analysis of variance (ANOVA) using Statistical Analysis System (SAS, 2008) to verify if there were significant differences among the cultivars. Significance was determined at 5 % level of probability. Where the *F*-test ratio was significant, means were separated using Student-Newman-Keuls (SNK) test.

## Results and Discussion

### *Results*

#### *Disease incidence and severity*

Disease symptoms were first observed at 10 days after inoculation (DAI). Typical mosaic symptoms of BICMV infection began with intermingled patches of normal and light green colour on the leaves, these symptoms were observed on the third and fourth leaves,

while the leaves below were symptomless. On the other hand, those inoculated with CPMoV showed formation of irregular pattern of indistinct light and dark spots on leaves which were more pronounced on younger leaves. However, symptoms observed on mixed infection of BICMV + CPMoV did not differ from those of the BICMV infected crops. At 2 WAI, disease incidence was significantly ( $p < 0.05$ ) highest in BICMV infected Ife Brown cultivar with 82.3%. This was followed by IT06K-137-1, IT07K-243-1-10 and IT07K-299-6 which had 63.3% disease incidence. Cultivars IT96D-610, IT97K-499-35, IT99K-316-2, IT99-377-1, IT00K-901-5, IT04-291-2, IT04K-332-1, IT07K-222-2 and IT07K-251-3-3 showed disease incidence of 56.6% and IT07K-292-1-10 had 53.3% incidence, whereas, IT97K-568-18 and IT06K-124 exhibited the lowest disease incidence of 50 % (Table 1). Percentage of infection also varied between 84.3% in Ife Brown and 70.0% in IT07K-318-33 in CPMoV infected cowpea cultivars. Next in high disease incidence were IT07K-299-6 with 63.4%, IT04K-321-2 with 63.2% and IT98KD-288 61.6% which were not significantly ( $p > 0.05$ ) different. Cultivars IT97K-499-35, IT99-377-1, IT00K-901-5 and IT06K-124 exhibited 57% level of infection and IT07K-292-1-10 had the lowest incidence of 50%. Similarly, in cowpea cultivars co-infected with BICMV + CPMoV, the highest disease incidence 78.3% was observed in Ife Brown, followed by IT07K-318-33 (73.5 %). IT07K-251-3-3 and IT98K-205-M8 had 73.3%, whereas, IT98D-610, IT97K-499-35, IT97K-573-2-1 and IT99K-377-1 exhibited the lowest disease incidence of 53.3% (Table 1). Disease severity differed significantly ( $p < 0.05$ ) amongst the 25 cowpea cultivars investigated irrespective of the three virus treatments. This increased progressively after inoculation (Table 2). At 2 WAI, disease severity was significantly ( $p < 0.05$ ) highest in Ife brown with 3.6 score, IT97K-568-18, IT06K-124 and IT07K-292-1-10 had a symptom score of 2 in BICMV infected cowpea plants, IT03K-337-6 exhibited a mean severity score of 1.0 and moderate level of severity symptom score of 3.0 was observed in the other cultivars. In CPMoV infected cowpea plants, disease severity ranged between 1 and 3.6. The lowest symptom score of 1 was observed in IT90K-277-2, IT96D-610, IT04K-332-1 and IT07K-243-1-10. Disease severity was mild in IT07K-222-2 and IT07K-292-1-10 with a score of 2, while IT03K-337-6, IT04K-291-2, IT04K-321-2, IT06K-124, IT06K-137-1, IT07K-211-1-8, IT07K-251-3-3 and IT07K-299-6 exhibited a mean severity score of 3. The other cultivars: Ife brown, IT97K-573-2-1 and IT07K-318-33 had a mean symptom score of 3.6. Generally, disease severity in the mixture of BICMV + CPMoV infected cowpea cultivars did not differ significantly ( $p > 0.05$ ) from those of BICMV infected cowpea cultivars alone (Table 2).

#### ***Effect of single and mixed infections with Blackeye cowpea mosaic and Cowpea mottle on growth parameters***

Plant growth parameters were impaired by the viruses and the magnitude of effects varied with cultivars. The

variation in this parameter with respect to BICMV infections at 6 WAI is presented in Table 3. Cowpea plants varied in heights from 20 to 27.1cm for the BICMV infected plants, 20 to 26.7cm for CPMoV infected plants, and 20 to 27.9cm for BICMV + CPMoV infected plants. Plant height was highest in BICMV infected IT0K-337-6 cowpea cultivar with 27.1cm, followed by IT07K-292-1-10 (27.0cm), IT97K-568-18 (26.1cm) and IT06K-124 (25.6cm), whereas, the lowest value was found in IT96D-610 with 20 cm (Table 3). In the plants infected with CPMoV; IT07K-292-1-10 was the only cultivar which produced significantly ( $p < 0.05$ ) tallest plants (26.7cm), followed by IT04K-332-1 (26.3cm) and IT07K-222-2 (26cm). Cultivars; IT99K-316-2, IT07K-243-1-10, IT90K-277-2, IT04K-267-8 and IT06K-124 had mean plant heights of 25.7, 25.5, 25.3, 25.2 and 25cm respectively. No significance ( $p > 0.05$ ) height difference was observed in cultivars IT99K-377-1 (23.4cm) and IT07K-251-3-3 (23.4cm) whereas, the lowest mean value of 20 cm was found in IT07K-318-33 (Table 3). In BICMV + CPMoV inoculated cowpea plants, significantly ( $p < 0.05$ ) tallest plants were found in IT98KD-288 (27.9cm) followed by IT97K-568-18 (26.3cm). Cultivars IT06K-124 and IT07K-299-6 had same mean values of 25.6cm in height. Cultivars IT97k-573-2-1 and IT07K-251-3-3 also exhibited statistically similar mean height of 25.3 and 25cm respectively, whereas, the shortest plants were found in IT96D-610 with 20 cm (Table 3). The twenty five cowpea cultivars exhibited a slight variation in crop branch development. Substantial differences were found within the cowpea cultivars with the various virus treatments. The number of branches of the crops irrespective of all the virus treatments ranged significantly ( $p < 0.05$ ) from 0 to 5 (Table 3). Cultivar IT97K-568-18 infected with BICMV had the highest number of branches of 5 per plant followed by IT07K-292-1-10 with 4 branches. Ife Brown, IT90K-277-2, IT96D-610, IT96K-499-35, IT98K-205-M8, IT04K-291-2 and IT07K-318-33 equally produced similar branch numbers of 2 each, whereas, IT99K-377-1, IT00K-901-5, IT04K-267-8, IT04K-332-1, IT06K-137-1, IT07K-211-1-18 and IT07k-243-1-10 had no branches at all. Similarly, cultivar IT07K-292-1-10 produced the highest number of branches of 5 per plant followed by IT90K-277-2 and IT99K-316-2, which had 4 each, while IT06K-137-1 produced no branch in the CPMoV infected plants (Table 3). Also, cowpea cultivar IT97K-568-18 in the BICMV + CPMoV infection produced significantly ( $p < 0.05$ ) highest number of branches (5) followed by IT06K-124 and IT07K-292-1-10 with 3 branches each, which was not statistically different from one another. The lowest value of 1 branch was found in Ife Brown, IT96D-610, IT97K-573-2-1, IT98K-205-M8, IT98KD-288, IT99K316-2 and IT07K-292-1-10, whereas, IT90K-277-2, IT00K-901-5, IT04K-267-8, IT04K-291-2, and IT07K-251-3-3 produced no branch (Table 3).



### ***Effect of single and mixed infections with Blackeye cowpea mosaic and Cowpea mottle on yield and yield components***

The number of days to 50% flowering in the cowpea plants varied significantly ( $p < 0.05$ ) from 56 to 73 days in BICMV, 53 to 73 days in CPMoV and 56 to 73 days in BICMV + CPMoV. Number of days to 50% flowering was most prolonged in BICMV infected IT98K-205-M8 plants with 73 days, followed by IT04K-321-2 (70 days), while, IT97k-568-18 and IT04K-291-2 flowered earlier at 56 days each. Also, in CPMoV infected plants, days to 50% flowering were earliest in IT04K-267-8 (53 days). The cultivars; IT90K-277-2, IT96D-610 and IT96K-124 had similar days to flowering of 56 days, while days to 50% flowering were delayed in IT98K-205-M8 plants to 73 days. On the other hand, co-infections of cowpea cultivars with BICMV + CPMoV delayed days to 50% flowering till 73 days after sowing in IT98K-205-M8, which was the same trend as observed with same cultivar infected with BICMV alone. Also, IT04K-321-2 had 70 days to 50% flowering, whereas, days to 50% flowering was earliest in IT98KD-288 and IT04K-321-2, which averaged 56 days after sowing (Table 4). The difference in number of pods per plant were significantly ( $p < 0.05$ ) different and ranged from 1 to 9 (BICMV), 1 to 8 (CPMoV) and 1 – 11 (BICMV + CPMoV). In the BICMV infected plants, IT03K-337-6 produced the highest number of pods per plant (9), followed by IT06K-124 and IT07K-292-1-10 which produced 8 pods per plant, whereas, the remaining cultivars produced between 1 and 4 pods per plant (Table 4). Cultivar IT96D-610 infected with CPMoV produced the highest number of pods per plant (9), while cultivars IT04K-267-8, IT04K-332-1, IT06K-124 and IT07K-292-1-10 produced 8 pods per plant. Cultivars IT04K-321-2 and IT07K-251-3-3 gave the least pod per plant of 1. On the other hand, BICMV + CPMoV infected IT98KD-288 produced the highest number of pods per plant (11). Cowpea cultivars IT97K-568-18 and IT06k-124 produced 7 pods per plant and IT07K-299-6 had 6 pods per plant. Ife Brown, IT90K-277-2, IT96D-610, IT97K-499-35, IT98K-205-M8, IT99K-377-1, IT00K-901-5, IT04K-332-1, IT07K-211-1-8 and IT07K-292-1-10 produced an average of 1 pod per plant (Table 4). Cowpea cultivar IT98K-288 and IT07K-292-1-10 infected with BICMV produced the highest number of seeds of 6 per pod, followed by IT97K-568-18, IT04K-267-8 and IT06K-124 which gave 5 seeds per pod. The remaining cultivars produced number of seeds which did not differ significantly ( $p > 0.05$ ) from one another. Also, CPMoV infection on IT96D-610 gave the highest number of seeds per pod of 4. Ife Brown gave 1 seed per pod, whereas, the remaining cultivars produced number of seeds which did not differ significantly from one another (Table 4). Also, cowpea cultivar IT98KD-288 produced the highest number of seeds per pod (6) in BICMV + CPMoV infected plants, whereas, the remaining cowpea cultivars gave a minimum number of seeds which ranged from 1-4 per pod and did not differ significantly ( $p > 0.05$ ) from one another (Table 5). The seed weight per plant differed significantly ( $p < 0.05$ ) and ranged

from 1.4 to 18.6g for BICMV infected plants, 1.6 to 18.1g for CPMoV infected plants and 1.2 to 12.5g for BICMV + CPMoV infected plants. Seed weight per plant of 18.6g was significantly ( $p < 0.05$ ) heaviest with BICMV infection in IT07K-292-1-10 cultivar. Cultivar IT97K-568-18 gave seed weight of 11.7g, followed by cowpea cultivar IT06K-124 (7.8g) and IT03K-337-6 (7.6g). The difference in seed weight among the remaining cowpea cultivars did not differ from one another (Table 5). Similarly, IT07K-292-1-10 infected with CPMoV had the highest seed weight of 18.1g per plant. Seed weight per plant observed in IT04K-267-8 of 11.4g and IT07k-243-1-10 of 11g were next, followed by IT96D-610 (10.8g), IT06K-124 (10.5g) and IT04K-332-1 (10.2g) (Table 4). On the other hand, seeds from BICMV + CPMoV infected IT98KD-288 cultivar had the highest seed weight of 12.5g, followed by IT07K-292-1-10 (12.2g). The least seed weight per plant (1.2g) was found in IT97K-499-35 (Table 4). Generally, cowpea cultivar IT07K-292-1-10 consistently gave significantly ( $p < 0.05$ ) highest seed weight per plant irrespective of the virus treatments (Table 5).

### ***Discussion***

Screening of cowpea cultivars for sources of resistant genes has gained importance because of the severe losses caused by legume viruses (Arogundade *et al.*, 2010). The significant differences observed among the tested cultivars in response to BICMV and CPMoV inoculations indicate their genetic diversity. The differences in susceptibility of many cultivated varieties have been attributed to different factors and, perhaps, the different number of resistant genes they possess. In this study, the result which showed that disease symptoms appeared on the leaves soon after inoculation is consistent with the findings of Aliyu *et al.* (2012) who noted that CPMoV induced mosaic symptom on legume crops in not more than one week when plants were inoculated at the early 10 days post-planting growth stage. Mosaic, mottling, vein banding and chlorosis symptoms were observed first on the topmost leaves, because they served as infection points. IT97K-568-18, IT04K-321-2, IT07K-292-1-10, IT90K-277-2, IT96D-610, IT99K-316-2 and IT06K-124 among the cowpea cultivars investigated produced moderate symptom of infection at 2WAI (weeks after inoculation), suggesting the presence of BICMV and CPMoV-tolerant genes. The fact that complete infection was observed at 2WAI across the cultivar implies that none of the cowpea cultivars was immune to the two viruses. Immunity is the highest level of resistance and is partly exhibited as absence of visible symptoms in inoculated plants (Salaudeen *et al.*, 2016). The differences exhibited with respect to symptom severity could also be attributed to varied inherent genetic constitution of the evaluated cultivars. Height impairment was high in some cultivars because the virus was more pathogenic on them, unlike their moderately tolerant counterparts. Plant height impairment was highest in the BICMV infected Ife Brown and IT07K-318-33 infected with CPMoV probably because of their poor BICMV and CPMoV tolerance constitution. Furthermore, it could be that trait

for shortness was inherited along with resistance genes from the breeding process, as evidenced from their heights. There are several reports of genetic linkage where two or more genes are located on the same chromosome, and they tend to move together (Agrios, 2005). Seed numbers and seed weights are important attributes for genotype selection in cowpea. Highly susceptible cowpea cultivars in the present study produced small and shriveled seeds and this resulted in lower seed weight compared to their tolerant counterparts. The impact of the virus arose from the negative effects associated with infection. Similar to the results of this study, Adamu *et al.* (2015) found lower pod and seed yield in *Cucumber mosaic virus* infected soybean. Generally, in this study, the growth and subsequent yield of some cultivars can be likened to both single and double infections suggesting that the response of some of these cultivars to double infections was stronger than the sum of the effects caused by each of the virus in single infection. This concurs with the opinion of Taiwo and Akinjogunla (2006) who reported that double virus infections resulted in greater reduction in the growth and yield of cowpea cultivars. Several studies involving mixed virus infections have demonstrated synergistic interactions in mixed virus infections using growth parameters such as plant height, weight, yield and effect on seeds in cowpea (Mamman *et al.*, 2017). The present study support the hypothesis that

sequence of infection has marked effect on the virus accumulation dynamics in mixed infection and the eventual synergistic disease development in cowpea pathosystem.

### Conclusion

The study had demonstrated that variability existed among the twenty-five cowpea cultivars investigated. Complete infection was obtained in the field experiment. Response of these cultivars to single and mixed infections was influenced by their genetic constitution or make-up. Also, the yield and agronomic traits of the cultivars were largely determined by their genetic architecture. Although, there was no immunity to these virus diseases among the populations evaluated, some cowpea cultivars showed appreciable level of tolerance and desirable yield. The benefits of increased cowpea production include; improved nutrition for humans and livestock, improved soil properties, and substantial opportunities for greater income. Generally, cowpea cultivar IT07K-292-1-10 consistently gave significantly ( $p < 0.05$ ) highest seed weight per plant irrespective of the virus treatments. The present results indicated the potentials of cultivar IT07K-292-1-10 as source of resistance gene (s) for breeding cowpea against BICMV and CPMoV disease to enhance productivity and food security.

**Table 1: Incidence of single and mixed infection of *Blackeye cowpea mosaic virus* (BICMV) and *Cowpea mottle virus* (CPMoV) on cowpea plants at Mokwa in 2017**

Cultivar	1 Week after inoculation			2 Weeks after inoculation		
	BICMV	CPMoV	BI + CP	BICMV	CPMoV	BI + CP
Ife brown	46.0 <sup>a</sup>	46.0 <sup>a</sup>	43.0 <sup>a</sup>	82.3 <sup>a</sup>	84.3 <sup>a</sup>	78.3 <sup>a</sup>
IT90K-277-2	31.6 <sup>cde</sup>	31.6 <sup>cde</sup>	36.6 <sup>cde</sup>	61.6 <sup>b</sup>	53.3 <sup>c</sup>	70.0 <sup>abc</sup>
IT96D-610	42.3 <sup>ab</sup>	42.3 <sup>ab</sup>	42.2 <sup>ab</sup>	56.6 <sup>b</sup>	53.3 <sup>c</sup>	53.3 <sup>c</sup>
IT97K-499-35	35.3 <sup>a-e</sup>	38.3 <sup>a-e</sup>	35.3 <sup>a-e</sup>	56.6 <sup>b</sup>	56.6 <sup>c</sup>	53.3 <sup>c</sup>
IT97K-568-18	41.3 <sup>abc</sup>	41.3 <sup>abc</sup>	41.3 <sup>abc</sup>	50.0 <sup>b</sup>	50.0 <sup>c</sup>	66.6 <sup>abc</sup>
IT97K-573-2-1	35.0 <sup>a-e</sup>	35.0 <sup>a-e</sup>	35.0 <sup>a-e</sup>	60.0 <sup>b</sup>	60.0 <sup>bc</sup>	53.3 <sup>bc</sup>
IT98K-205-M8	41.6 <sup>abc</sup>	41.6 <sup>a-e</sup>	41.0 <sup>abc</sup>	60.0 <sup>b</sup>	60.0 <sup>bc</sup>	73.3 <sup>ab</sup>
IT98KD-288	45.0 <sup>a</sup>	45.0 <sup>a</sup>	45.9 <sup>a</sup>	61.6 <sup>b</sup>	61.6 <sup>bc</sup>	56.3 <sup>bc</sup>
IT99K-316-2	43.0 <sup>ab</sup>	43.3 <sup>ab</sup>	43.0 <sup>ab</sup>	56.6 <sup>b</sup>	53.3 <sup>c</sup>	70.0 <sup>abc</sup>
IT99K-377-1	36.6 <sup>a-e</sup>	36.6 <sup>a-e</sup>	36.6 <sup>a-e</sup>	56.6 <sup>b</sup>	56.6 <sup>c</sup>	53.3 <sup>c</sup>
IT00K-901-5	39.0 <sup>a-d</sup>	39.0 <sup>a-d</sup>	39.0 <sup>a-d</sup>	56.6 <sup>b</sup>	56.6 <sup>c</sup>	70.1 <sup>abc</sup>
IT03K-337-6	39.3 <sup>a-d</sup>	38.3 <sup>a-d</sup>	38.3 <sup>a-d</sup>	60.0 <sup>b</sup>	60.3 <sup>bc</sup>	66.6 <sup>abc</sup>
IT04K-267-8	30.0 <sup>ed</sup>	30.0 <sup>de</sup>	30.0 <sup>de</sup>	61.6 <sup>b</sup>	53.3 <sup>c</sup>	63.6 <sup>abc</sup>
IT04K-291-2	38.3 <sup>a-d</sup>	38.3 <sup>a-d</sup>	38.3 <sup>a-e</sup>	56.6 <sup>b</sup>	56.3 <sup>c</sup>	66.6 <sup>abc</sup>
IT04K-321-2	31.3 <sup>cde</sup>	31.6 <sup>cde</sup>	31.6 <sup>cde</sup>	61.6 <sup>b</sup>	63.2 <sup>bc</sup>	56.6 <sup>bc</sup>
IT04K-332-1	41.6 <sup>abc</sup>	41.6 <sup>abc</sup>	41.6 <sup>abc</sup>	56.6 <sup>b</sup>	53.3 <sup>c</sup>	63.3 <sup>abc</sup>
IT06K-124	36.6 <sup>a-e</sup>	36.6 <sup>a-e</sup>	36.5 <sup>a-e</sup>	50.0 <sup>b</sup>	56.9 <sup>c</sup>	66.6 <sup>abc</sup>
IT06K-137-1	36.6 <sup>a-e</sup>	36.6 <sup>a-e</sup>	36.6 <sup>a-e</sup>	63.3 <sup>b</sup>	53.3 <sup>bc</sup>	63.3 <sup>abc</sup>
IT07K-211-1-8	32.3 <sup>cde</sup>	32.3 <sup>cde</sup>	32.3 <sup>cde</sup>	60.0 <sup>b</sup>	60.2 <sup>bc</sup>	66.6 <sup>abc</sup>
IT07K-222-2	36.6 <sup>a-e</sup>	35.0 <sup>a-e</sup>	35.1 <sup>a-e</sup>	56.6 <sup>b</sup>	53.3 <sup>c</sup>	60.0 <sup>abc</sup>
IT07K-243-1-10	40.0 <sup>abc</sup>	40.0 <sup>abc</sup>	40.1 <sup>abc</sup>	63.3 <sup>b</sup>	53.3 <sup>c</sup>	53.6 <sup>bc</sup>
IT07K-251-3-3	38.8 <sup>a-d</sup>	38.3 <sup>a-d</sup>	38.3 <sup>a-d</sup>	56.6 <sup>b</sup>	60.4 <sup>bc</sup>	73.3 <sup>ab</sup>
IT07K-292-1-10	28.3 <sup>c</sup>	28.3 <sup>c</sup>	28.3 <sup>c</sup>	53.3 <sup>b</sup>	50.0 <sup>c</sup>	56.6 <sup>bc</sup>
IT07K-299-6	33.3 <sup>a-e</sup>	33.3 <sup>b-e</sup>	33.3 <sup>b-e</sup>	63.3 <sup>b</sup>	63.4 <sup>bc</sup>	70.0 <sup>abc</sup>
IT07K-318-33	36.6 <sup>a-e</sup>	36.6 <sup>a-e</sup>	36.6 <sup>a-e</sup>	60.0 <sup>b</sup>	70.0 <sup>b</sup>	73.5 <sup>ab</sup>
+ SEM	2.12	0.90	2.01	1.9	2	1.9

Means with the same letter (s) within the same column are not significantly ( $p < 0.05$ ) different by student Newman-Keuls (SNK) test. BICMV: Blackeye cowpea mosaic virus; CPMoV: Cowpea mosaic virus; BI + CP: Blackeye cowpea mosaic virus + Cowpea mosaic virus

**Table 2: Severity of single and mixed infection of *Blackeye cowpea mosaic virus*(BICMV) and *Cowpea mottle virus* (CPMoV) on cowpea plants at Mokwa in 2017**

Cultivar	2 Weeks after inoculation			5 Weeks after inoculation		
	BICMV	CPMoV	BI +CP	BICMV	CPMoV	BI + CP
Ife brown	3.6 <sup>a</sup>	3.6 <sup>a</sup>	3.6 <sup>a</sup>	4.3 <sup>a</sup>	4.3 <sup>a</sup>	4.3 <sup>a</sup>
IT90K-277-2	2.6 <sup>abc</sup>	1.0 <sup>d</sup>	3.6 <sup>a</sup>	4.0 <sup>a</sup>	1.6 <sup>c</sup>	4.3 <sup>a</sup>
IT96D-610	3.0 <sup>ab</sup>	1.0 <sup>d</sup>	1.0 <sup>b</sup>	4.3 <sup>a</sup>	1.6 <sup>c</sup>	1.6 <sup>b</sup>
IT97K-499-35	3.0 <sup>ab</sup>	3.0 <sup>ab</sup>	1.0 <sup>b</sup>	4.3 <sup>a</sup>	4.3 <sup>a</sup>	1.6 <sup>b</sup>
IT97K-568-18	1.6 <sup>cd</sup>	3.0 <sup>ab</sup>	3.0 <sup>a</sup>	1.6 <sup>b</sup>	4.3 <sup>a</sup>	4.3 <sup>a</sup>
IT97K-573-2-1	2.6 <sup>abc</sup>	3.6 <sup>a</sup>	1.0 <sup>b</sup>	4.3 <sup>a</sup>	4.3 <sup>a</sup>	1.6 <sup>b</sup>
IT98K-205-M8	3.0 <sup>ab</sup>	2.6 <sup>abc</sup>	3.0 <sup>a</sup>	4.3 <sup>a</sup>	4.3 <sup>a</sup>	4.0 <sup>a</sup>
IT98KD-288	3.0 <sup>ab</sup>	3.0 <sup>ab</sup>	3.0 <sup>a</sup>	3.6 <sup>a</sup>	3.6 <sup>ab</sup>	4.3 <sup>a</sup>
IT99K-316-2	2.6 <sup>abc</sup>	1.0 <sup>d</sup>	2.6 <sup>a</sup>	4.3 <sup>a</sup>	1.6 <sup>c</sup>	4.0 <sup>a</sup>
IT99K-377-1	3.0 <sup>ab</sup>	3.0 <sup>ab</sup>	3.0 <sup>a</sup>	4.3 <sup>a</sup>	4.3 <sup>a</sup>	4.0 <sup>a</sup>
IT00K-901-5	2.6 <sup>abc</sup>	3.0 <sup>ab</sup>	2.6 <sup>a</sup>	4.0 <sup>a</sup>	4.3 <sup>a</sup>	4.3 <sup>a</sup>
IT03K-337-6	1.0 <sup>d</sup>	2.6 <sup>abc</sup>	2.6 <sup>a</sup>	1.6 <sup>b</sup>	4.3 <sup>a</sup>	4.3 <sup>a</sup>
IT04K-267-8	3.0 <sup>ab</sup>	1.0 <sup>d</sup>	2.6 <sup>a</sup>	4.3 <sup>a</sup>	1.6 <sup>c</sup>	4.3 <sup>a</sup>
IT04K-291-2	3.0 <sup>ab</sup>	3.0 <sup>ab</sup>	3.0 <sup>a</sup>	3.6 <sup>a</sup>	3.6 <sup>ab</sup>	4.0 <sup>a</sup>
IT04K-321-2	2.6 <sup>abc</sup>	2.6 <sup>abc</sup>	2.6 <sup>a</sup>	4.3 <sup>a</sup>	4.3 <sup>a</sup>	4.3 <sup>a</sup>
IT04K-332-1	3.0 <sup>ab</sup>	1.3 <sup>cd</sup>	1.0 <sup>b</sup>	4.3 <sup>a</sup>	1.6 <sup>c</sup>	1.6 <sup>b</sup>
IT06K-124	2.0 <sup>bcd</sup>	3.3 <sup>b</sup>	3.0 <sup>a</sup>	2.3 <sup>b</sup>	3.6 <sup>ab</sup>	4.3 <sup>a</sup>
IT06K-137-1	3.0 <sup>ab</sup>	3.0 <sup>ab</sup>	3.0 <sup>a</sup>	4.3 <sup>a</sup>	4.0 <sup>a</sup>	4.0 <sup>a</sup>
IT07K-211-1-8	2.6 <sup>abc</sup>	3.0 <sup>ab</sup>	2.6 <sup>b</sup>	4.3 <sup>a</sup>	4.3 <sup>a</sup>	4.3 <sup>a</sup>
IT07K-222-2	3.0 <sup>ab</sup>	2.0 <sup>bc</sup>	3.0 <sup>a</sup>	4.3 <sup>a</sup>	2.3 <sup>bc</sup>	4.2 <sup>a</sup>
IT07K-243-1-10	2.6 <sup>abc</sup>	1.0 <sup>d</sup>	2.6 <sup>a</sup>	4.0 <sup>a</sup>	1.6 <sup>c</sup>	4.3 <sup>a</sup>
IT07K-251-3-3	2.6 <sup>abc</sup>	2.6 <sup>abc</sup>	2.6 <sup>a</sup>	4.3 <sup>a</sup>	4.3 <sup>a</sup>	4.0 <sup>a</sup>
IT07K-292-1-10	2.3 <sup>bc</sup>	2.0 <sup>bc</sup>	1.0 <sup>b</sup>	2.6 <sup>b</sup>	2.6 <sup>abc</sup>	2.0 <sup>b</sup>
IT07K-299-6	3.0 <sup>ab</sup>	3.0 <sup>ab</sup>	3.0 <sup>a</sup>	4.0 <sup>a</sup>	4.3 <sup>a</sup>	4.3 <sup>a</sup>
IT07K-318-33	2.6 <sup>abc</sup>	2.6 <sup>abc</sup>	2.6 <sup>a</sup>	4.3 <sup>a</sup>	4.0 <sup>a</sup>	4.3 <sup>a</sup>
+SEM	1.9	0.2	0.21	0.32	0.37	0.34

Means with the same letter (s) within the same column are not significantly ( $p < 0.05$ ) different by Student Newman-Keuls (SNK) test. Blackeye cowpea mosaic virus; CPMoV: Cowpea mosaic virus; BI + CP: Blackeye cowpea mosaic virus + Cowpea mosaic virus

**Table 3: Height (cm) and number of branches of cowpea plants infected with single and mixture of *Blackeye cowpea mosaic virus* (BICMV) and *Cowpea mottle virus* (CPMoV) at 6 weeks after inoculation at Mokwa in 2017**

Cultivar	BICMV				Number of branches			
	CPMoV	BI + CP	CP + BI	BICMV	CPMoV	BI + CP	CP + BI	
Ife Brown	20.0 <sup>d</sup>	22.2 <sup>fg</sup>	21.0 <sup>fg</sup>	21.3 <sup>fg</sup>	2 <sup>bc</sup>	1 <sup>cde</sup>	1 <sup>c</sup>	2 <sup>a-c</sup>
IT90K – 277 – 2	20.8 <sup>cd</sup>	22.2 <sup>fg</sup>	21.0 <sup>fg</sup>	21.3 <sup>fg</sup>	2 <sup>bc</sup>	4 <sup>a</sup>	0 <sup>c</sup>	2 <sup>a-c</sup>
IT96D – 610	20.0 <sup>d</sup>	25.3 <sup>a-d</sup>	21.0 <sup>fg</sup>	23.0 <sup>def</sup>	2 <sup>bc</sup>	3 <sup>a-c</sup>	1 <sup>c</sup>	4 <sup>a</sup>
IT97K – 499 – 35	22.4 <sup>bcd</sup>	23.2 <sup>c-h</sup>	20.0 <sup>g</sup>	24.4 <sup>bcd</sup>	1 <sup>ede</sup>	4 <sup>a-c</sup>	1 <sup>c</sup>	4 <sup>a</sup>
IT97K – 568 – 18	26.1 <sup>a</sup>	22.4 <sup>c-h</sup>	22.4 <sup>def</sup>	24.9 <sup>bc</sup>	2 <sup>cd</sup>	1 <sup>ede</sup>	0 <sup>c</sup>	3 <sup>ab</sup>
IT97K – 573 – 2 – 1	23.3 <sup>b</sup>	21.2 <sup>h</sup>	26.3 <sup>b</sup>	21.2 <sup>fg</sup>	5 <sup>a</sup>	1 <sup>ede</sup>	4 <sup>b</sup>	0 <sup>c</sup>
IT98K – 205 – M8	22.2 <sup>bcd</sup>	23.5 <sup>b-h</sup>	25.3 <sup>b</sup>	27.1 <sup>a</sup>	1 <sup>ede</sup>	1 <sup>ede</sup>	1 <sup>c</sup>	3 <sup>ab</sup>
IT98KD – 288	21.2 <sup>bcd</sup>	22.3 <sup>fg</sup>	22.3 <sup>def</sup>	22.2 <sup>efg</sup>	2 <sup>cd</sup>	2 <sup>b-e</sup>	1 <sup>c</sup>	1 <sup>a-c</sup>
IT99K – 316 – 2	20.8 <sup>cd</sup>	21.2 <sup>h</sup>	27.9 <sup>a</sup>	26.1 <sup>ab</sup>	1 <sup>ede</sup>	1 <sup>ede</sup>	6 <sup>a</sup>	3 <sup>ab</sup>
IT99K – 377 – 1	22.2 <sup>bcd</sup>	25.7 <sup>abc</sup>	24.4 <sup>bcd</sup>	21.8 <sup>efg</sup>	1 <sup>ede</sup>	4 <sup>ab</sup>	1 <sup>c</sup>	2 <sup>a-c</sup>
IT00K – 901 – 5	21.2 <sup>bcd</sup>	23.4 <sup>b-h</sup>	22.4 <sup>def</sup>	26.0 <sup>ab</sup>	0 <sup>e</sup>	1 <sup>ede</sup>	1 <sup>c</sup>	3 <sup>ab</sup>
IT03K – 337 – 6	27.1 <sup>a</sup>	21.7 <sup>gh</sup>	24.4 <sup>bcd</sup>	21.2 <sup>fg</sup>	0 <sup>e</sup>	0 <sup>de</sup>	0 <sup>c</sup>	0 <sup>c</sup>
IT04K – 267 – 8	22.2 <sup>bcd</sup>	23.5 <sup>b-h</sup>	23.0 <sup>def</sup>	23.2 <sup>def</sup>	4 <sup>ab</sup>	0 <sup>de</sup>	1 <sup>c</sup>	2 <sup>a-c</sup>
IT04K – 291 – 2	21.2 <sup>bcd</sup>	25.2 <sup>a-e</sup>	23.2 <sup>c-f</sup>	22.2 <sup>efg</sup>	0 <sup>e</sup>	2 <sup>a-d</sup>	0 <sup>c</sup>	0 <sup>c</sup>
IT04K – 321 – 2	20.8 <sup>cd</sup>	21.2 <sup>h</sup>	23.3 <sup>c-f</sup>	25.7 <sup>ab</sup>	1 <sup>ede</sup>	1 <sup>ede</sup>	0 <sup>c</sup>	3 <sup>a-c</sup>
IT04K – 332 – 1	22.6 <sup>bc</sup>	24.3 <sup>a-f</sup>	24.1 <sup>b-e</sup>	21.8 <sup>efg</sup>	1 <sup>ede</sup>	1 <sup>ede</sup>	1 <sup>c</sup>	1 <sup>bc</sup>
IT06K – 124	25.6 <sup>a</sup>	26.3 <sup>ab</sup>	22.8 <sup>def</sup>	25.1 <sup>bc</sup>	0 <sup>e</sup>	3 <sup>abc</sup>	0 <sup>c</sup>	2 <sup>a-c</sup>
IT06K – 137 – 1	21.2 <sup>bcd</sup>	25.0 <sup>a-f</sup>	25.6 <sup>b</sup>	22.2 <sup>efg</sup>	2 <sup>bc</sup>	4 <sup>a</sup>	3 <sup>b</sup>	1 <sup>a-c</sup>
IT07K – 211 – 1 – 8	20.8 <sup>cd</sup>	21.8 <sup>gh</sup>	22.7 <sup>def</sup>	21.3 <sup>fg</sup>	0 <sup>e</sup>	0 <sup>e</sup>	1 <sup>c</sup>	1 <sup>a-c</sup>
IT07K – 222 – 2	22.2 <sup>bcd</sup>	22.7 <sup>ef</sup>	22.3 <sup>def</sup>	21.6 <sup>efg</sup>	0 <sup>e</sup>	0 <sup>de</sup>	1 <sup>c</sup>	1 <sup>bc</sup>
IT07K – 243 – 1 – 10	21.2 <sup>bcd</sup>	26.0 <sup>ab</sup>	20.1 <sup>def</sup>	22.7 <sup>def</sup>	1 <sup>ede</sup>	3 <sup>a-d</sup>	0 <sup>c</sup>	0 <sup>c</sup>
IT07K – 251 – 3 – 3	23.1 <sup>bc</sup>	25.5 <sup>abc</sup>	23.4 <sup>c-f</sup>	25.6 <sup>ab</sup>	0 <sup>e</sup>	2 <sup>a-e</sup>	1 <sup>c</sup>	2 <sup>a-c</sup>
IT07K – 292 – 1 – 10	27.0 <sup>a</sup>	23.4 <sup>b-h</sup>	25.0 <sup>b</sup>	23.6 <sup>bcd</sup>	1 <sup>ede</sup>	1 <sup>ede</sup>	0 <sup>c</sup>	1 <sup>bc</sup>
IT07K – 299 – 6	21.2 <sup>bcd</sup>	26.7 <sup>a</sup>	24.1 <sup>b-c</sup>	25.7 <sup>ab</sup>	4 <sup>ab</sup>	4 <sup>a</sup>	1 <sup>c</sup>	3 <sup>ab</sup>
IT07K – 318 – 33	20.8 <sup>cd</sup>	21.2 <sup>h</sup>	25.6 <sup>b</sup>	21.5 <sup>efg</sup>	1 <sup>ede</sup>	1 <sup>ede</sup>	3 <sup>b</sup>	1 <sup>bc</sup>
+ SEM	0.47	20.0 <sup>h</sup>	21.7 <sup>efg</sup>	20.8 <sup>g</sup>	1 <sup>ede</sup>	1 <sup>ede</sup>	1 <sup>c</sup>	2 <sup>a-c</sup>

Means with the same letter (s) within the same column are not significantly ( $p < 0.05$ ) different using Student-Newman-Keuls (SNK) test

**Table 4: Days to 50% flowering and number of pods of cowpea plants infected with single and mixture of *Blackeye cowpea mosaic virus* (BICMV) and *Cowpea mottle virus* (CPMoV) at Mokwa in 2017**

Cultivar	Days to 50% flowering			Number of pods per plant		
	BICMV	CPMoV	BI + CP	BICMV	CPMoV	BI + CP
Ife Brown	63 <sup>cde</sup>	63 <sup>bcg</sup>	64 <sup>c-f</sup>	3 <sup>b</sup>	4 <sup>bcd</sup>	1 <sup>c</sup>
IT90K-277-2	66 <sup>bc</sup>	56 <sup>fgh</sup>	66 <sup>bcd</sup>	3 <sup>b</sup>	7 <sup>abc</sup>	1 <sup>c</sup>
IT96D-610	65 <sup>bc</sup>	56 <sup>fgh</sup>	65 <sup>b-e</sup>	3 <sup>b</sup>	9 <sup>a</sup>	1 <sup>c</sup>
IT97K-499-35	65 <sup>bc</sup>	66 <sup>bcd</sup>	66 <sup>bcd</sup>	1 <sup>b</sup>	2 <sup>d</sup>	1 <sup>c</sup>
IT97K-568-18	56 <sup>c-g</sup>	66 <sup>bcd</sup>	59 <sup>d-h</sup>	7 <sup>a</sup>	3 <sup>d</sup>	7 <sup>b</sup>
IT97K-573-2-1	66 <sup>bc</sup>	63 <sup>bcg</sup>	64 <sup>c-f</sup>	4 <sup>b</sup>	4 <sup>bcd</sup>	3 <sup>c</sup>
IT98K-205-M8	73 <sup>a</sup>	73 <sup>a</sup>	73 <sup>a</sup>	2 <sup>b</sup>	2 <sup>d</sup>	1 <sup>c</sup>
IT98KD-288	65 <sup>bc</sup>	64 <sup>b-c</sup>	56 <sup>h</sup>	3 <sup>b</sup>	3 <sup>d</sup>	11 <sup>a</sup>
IT99K-316-2	65 <sup>bc</sup>	58 <sup>d-h</sup>	65 <sup>b-e</sup>	2 <sup>b</sup>	7 <sup>abc</sup>	2 <sup>c</sup>
IT99K-377-1	62 <sup>c-f</sup>	62 <sup>b-h</sup>	65 <sup>b-e</sup>	2 <sup>b</sup>	2 <sup>d</sup>	1 <sup>c</sup>
IT00K-901-5	60 <sup>c-f</sup>	60 <sup>b-h</sup>	62 <sup>c-g</sup>	4 <sup>b</sup>	4 <sup>bcd</sup>	1 <sup>c</sup>
IT03K-337-6	64 <sup>bcd</sup>	68 <sup>ab</sup>	60 <sup>c-h</sup>	9 <sup>a</sup>	3 <sup>d</sup>	2 <sup>c</sup>
IT04K-267-8	64 <sup>bcd</sup>	53 <sup>h</sup>	66 <sup>bcd</sup>	3 <sup>b</sup>	8 <sup>a</sup>	2 <sup>c</sup>
IT04K-291-2	56 <sup>c-g</sup>	56 <sup>fgh</sup>	64 <sup>c-f</sup>	3 <sup>b</sup>	3 <sup>d</sup>	2 <sup>c</sup>
IT04K-321-2	70 <sup>ab</sup>	70 <sup>ab</sup>	56 <sup>h</sup>	1 <sup>b</sup>	1 <sup>d</sup>	2 <sup>c</sup>
IT04K-332-1	62 <sup>c-f</sup>	56 <sup>fgh</sup>	70 <sup>ab</sup>	3 <sup>b</sup>	8 <sup>a</sup>	1 <sup>c</sup>
IT06K-124	56 <sup>c-g</sup>	56 <sup>fgh</sup>	58 <sup>fgh</sup>	8 <sup>a</sup>	8 <sup>a</sup>	7 <sup>b</sup>
IT06K-137-1	64 <sup>bcd</sup>	63 <sup>bcg</sup>	66 <sup>bcd</sup>	2 <sup>b</sup>	2 <sup>d</sup>	2 <sup>c</sup>
IT07K-211-1-8	63 <sup>cde</sup>	63 <sup>bcg</sup>	64 <sup>c-f</sup>	3 <sup>b</sup>	3 <sup>d</sup>	1 <sup>c</sup>
IT07K-222-2	64 <sup>bcd</sup>	57 <sup>fgh</sup>	64 <sup>c-f</sup>	2 <sup>b</sup>	7 <sup>abc</sup>	2 <sup>c</sup>
IT07K-243-1-10	64 <sup>bcd</sup>	59 <sup>bh</sup>	64 <sup>c-f</sup>	2 <sup>b</sup>	7 <sup>abc</sup>	2 <sup>c</sup>
IT07K-251-3-3	63 <sup>cde</sup>	63 <sup>bcg</sup>	64 <sup>c-f</sup>	1 <sup>b</sup>	1 <sup>d</sup>	2 <sup>c</sup>
IT07K-292-1-10	58 <sup>c-g</sup>	59 <sup>bh</sup>	64 <sup>c-f</sup>	8 <sup>a</sup>	8 <sup>a</sup>	1 <sup>c</sup>
IT07K-299-6	64 <sup>bcd</sup>	64 <sup>b-c</sup>	59 <sup>d-h</sup>	4 <sup>b</sup>	4 <sup>bcd</sup>	6 <sup>b</sup>
IT07K-318-33	63 <sup>cde</sup>	67 <sup>bc</sup>	63 <sup>b-f</sup>	2 <sup>b</sup>	2 <sup>d</sup>	2 <sup>c</sup>
SEM	1.41	1.56	1.54	0.75	0.76	1.15

Means with the same letter (s) within the same column are not significantly ( $p < 0.05$ ) different by Student Newman-Keuls (SNK) test. *Blackeye cowpea mosaic virus*; CPMoV: *Cowpea mosaic virus*; BI + CP: *Blackeye cowpea mosaic virus* + *Cowpea mosaic virus*

**Table 5: Number of seeds and seed weight of cowpea plants infected with single and mixture of *Blackeye cowpea mosaic virus* (BICMV) and *Cowpea mottle virus* (CPMoV) at Mokwa in 2017**

Cultivar	Number of seeds per pod			Seed weight per plant (g)		
	BICMV	CPMoV	BI + CP	BICMV	CPMoV	BI + CP
Ife Brown	2 <sup>c</sup>	1 <sup>b</sup>	1 <sup>b</sup>	1.6 <sup>d</sup>	2.0 <sup>d</sup>	1.7 <sup>c</sup>
IT90K-277-2	2 <sup>c</sup>	3 <sup>ab</sup>	2 <sup>b</sup>	1.4 <sup>d</sup>	7.5 <sup>c</sup>	1.4 <sup>c</sup>
IT96D-610	1 <sup>c</sup>	4 <sup>a</sup>	1 <sup>b</sup>	1.8 <sup>d</sup>	10.8 <sup>b</sup>	1.8 <sup>c</sup>
IT97K-499-35	2 <sup>c</sup>	2 <sup>ab</sup>	2 <sup>b</sup>	1.7 <sup>d</sup>	1.7 <sup>d</sup>	1.2 <sup>c</sup>
IT97K-568-18	5 <sup>ab</sup>	2 <sup>ab</sup>	2 <sup>b</sup>	11.7 <sup>b</sup>	1.8 <sup>d</sup>	7.8 <sup>b</sup>
IT97K-573-2-1	2 <sup>c</sup>	2 <sup>ab</sup>	4 <sup>b</sup>	1.6 <sup>d</sup>	1.6 <sup>d</sup>	1.3 <sup>c</sup>
IT98K-205-M8	2 <sup>c</sup>	2 <sup>ab</sup>	2 <sup>b</sup>	2.0 <sup>d</sup>	2.0 <sup>d</sup>	2.0 <sup>c</sup>
IT98KD-288	2 <sup>c</sup>	1 <sup>b</sup>	6 <sup>a</sup>	1.8 <sup>d</sup>	1.8 <sup>d</sup>	12.5 <sup>a</sup>
IT99K-316-2	2 <sup>c</sup>	4 <sup>a</sup>	3 <sup>b</sup>	1.7 <sup>d</sup>	10.0 <sup>b</sup>	1.8 <sup>c</sup>
IT99K-377-1	1 <sup>c</sup>	2 <sup>ab</sup>	1 <sup>b</sup>	1.6 <sup>d</sup>	1.6 <sup>d</sup>	1.7 <sup>c</sup>
IT00K-901-5	2 <sup>c</sup>	2 <sup>ab</sup>	2 <sup>b</sup>	1.8 <sup>d</sup>	1.8 <sup>d</sup>	1.6 <sup>c</sup>
IT03K-337-6	5 <sup>ab</sup>	2 <sup>ab</sup>	2 <sup>b</sup>	7.6 <sup>c</sup>	1.6 <sup>d</sup>	1.8 <sup>c</sup>
IT04K-267-8	2 <sup>c</sup>	4 <sup>a</sup>	4 <sup>b</sup>	2.0 <sup>d</sup>	11.4 <sup>b</sup>	1.6 <sup>c</sup>
IT04K-291-2	1 <sup>c</sup>	3 <sup>ab</sup>	1 <sup>b</sup>	2.0 <sup>d</sup>	2.1 <sup>d</sup>	1.6 <sup>c</sup>
IT04K-321-2	3	3 <sup>ab</sup>	3 <sup>b</sup>	2.0 <sup>d</sup>	2.1 <sup>d</sup>	2.1 <sup>c</sup>
IT04K-332-1	2 <sup>c</sup>	3 <sup>ab</sup>	2 <sup>b</sup>	2.0 <sup>d</sup>	10.2 <sup>b</sup>	2.1 <sup>c</sup>
IT06K-124	5 <sup>ab</sup>	4 <sup>a</sup>	4 <sup>b</sup>	7.8 <sup>c</sup>	10.5 <sup>b</sup>	8.5 <sup>b</sup>
IT06K-137-1	2 <sup>c</sup>	3 <sup>ab</sup>	2 <sup>b</sup>	2.0 <sup>d</sup>	2.1 <sup>d</sup>	1.6 <sup>c</sup>
IT07K-211-1-8	2 <sup>c</sup>	3 <sup>ab</sup>	3 <sup>b</sup>	2.1 <sup>d</sup>	2.1 <sup>d</sup>	1.7 <sup>c</sup>
IT07K-222-2	1 <sup>c</sup>	4 <sup>a</sup>	1 <sup>b</sup>	1.8 <sup>d</sup>	10.1 <sup>b</sup>	2.0 <sup>c</sup>
IT07K-243-1-10	1 <sup>c</sup>	3 <sup>ab</sup>	1 <sup>b</sup>	1.9 <sup>d</sup>	11.0 <sup>b</sup>	1.7 <sup>c</sup>
IT07K-251-3-3	2 <sup>c</sup>	1 <sup>b</sup>	2 <sup>b</sup>	1.8 <sup>d</sup>	1.8 <sup>d</sup>	1.9 <sup>c</sup>
IT07K-292-1-10	6 <sup>a</sup>	4 <sup>a</sup>	1 <sup>b</sup>	18.6 <sup>a</sup>	18.1 <sup>a</sup>	12.2 <sup>a</sup>
IT07K-299-6	2 <sup>c</sup>	1 <sup>b</sup>	4 <sup>b</sup>	1.6 <sup>d</sup>	1.6 <sup>d</sup>	1.3 <sup>c</sup>
IT07K-318-33	1 <sup>c</sup>	2 <sup>ab</sup>	1 <sup>b</sup>	1.8 <sup>d</sup>	1.6 <sup>d</sup>	1.4 <sup>c</sup>
± SEM	0.59	0.47	0.6	0.46	0.57	1.25

Means with the same letter (s) within the same column are not significantly ( $p < 0.05$ ) different by Student Newman-Keuls (SNK) test

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