AGRONOMIC PERFORMANCES AND TOLERANCE TO BROWN SPOT AND APHID ATTACKS OF COWPEA VARIETIES UNDER THE MINERAL FERTILIZERS' EFFECT IN BURKINA FASO

ABSTRACT

Cowpea (*Vigna unguiculata* L. Walp) is a leguminous crop whose cultivation facesto biotic constraints. In addition, the efficient use of mineral fertilizers is often necessary. This study aimed to evaluate the effect of four (04) mineral fertilizer formulations on the agronomic performance of the cowpea varieties like KVX442-3-25SH (*Komcallé*) and KVX775-33-2G (*Tiligré*) in Burkina Faso. The methodology used is based on apply the experimental design with completely randomized block. Five treatments and five replications were applied: T0 (control), T1 (NPK: 14-23-14); T2 (NPK: 14-18-18); T3 (NPK:16-16-16) and T4 (NPK: 15-15-15). The parameters used were the number of ramifications, pods and nodules per plant, the number of grains per pod, the weight of dry biomass, the grain yield per pot, the foliar severity of brown spot disease and the incidence of aphid attack.The results showed that treatment T4 recorded the highest performance in terms of the number of pods and nodules per plant, with respective values of 15 pods/plant and 25 nodules/plant for the *Komcallé* variety and 07 pods/plant and 21 nodules/plant for the *Tiligre* variety. Treatments T1 and T4 recorded the lowest leaf incidences of brown spot disease in the *Komcallé* (12.33%) and *Tiligré* (11.06%) varieties respectively. On the other hand, treatments T2 and T3 recorded the lowest incidence of aphid attacks on the *Komcallé* variety (19.67%) and the *Tiligré* variety (21.89%), respectively. In conclusion, mineral fertilizercan contribute to increase cowpea yields in Burkina Faso.

Key words: Burkina Faso, Cowpea, Mineral fertilizer, Pests, Yield

1. INTRODUCTION

Cowpea, *Vigna Unguiculata* L. Walpers, is the main food legume produced in the world, particularly in West Africa, and contributes to reducing poverty and improving food and nutritional safety (Mehinto*et al.*, 2014). Despite its food and economic importance, cowpea yields are very low and its production remains limited by several biotic and abiotic constraints, including poor soils and pest attacks (Abdoul *et al.*, 2016). According to Abdoul *et al.* (2016), production losses can reach 80 to 100% if no means of control are engaged against insect attacks, particularly aphids (*Aphis craccivora* Koch), which affect the crop from its earliest development stage through to harvest. Despite their ability to fix atmospheric nitrogen, legumes also need additional fertilizer to stimulate growth in the fields (Bado, 2002).To obtain the plant growth stimulation other parameters need to be taking into account as the type of fertilizer formulations used. In current contextthe combination of mineral and organic fertilizers in cowpea production, allowsfarmers to mitigate the acidifying effect of mineral fertilizers in comparison to their action when they are used alone (Houot*et al.*, 2009; Santos *et al.*, 2011).The results obtained bySermé*et al.* (2018)showed that the application of NPK (14-23-14) mineral fertilizer at the vulgarized dose could induce a significant increase in soybean yields of around 46% compared to farmers' practices. According to Omotoso (2014),the combined application of NPK (15-15-15) and pig manure had a significant effect on yields, number of leaves and ramifications compared with their individual application.The results of Daramy *et al.* (2017) showed that the application of nitrogen fertilizer at the vulgarised dose could also significantly increase cowpea yields. Due to the fact that cowpea play the key role in food safety of population in Burkina Faso, farmers are giving to it a capital role on the farm through sustainable intensification of its production. In this context, it is imperative to know the good proportion of fertilizer when usedin mixed formulation to improve production and economic profitability of this legume.This study aims to contribute to improving cowpea yields by optimizing mineral fertilization.

2. MATERIAL AND METHODS

2.1. Plant material

It consisted of two (02) cowpea varieties *Komcallé* (KVX 442-3-25 SH) and *Tiligré* (KVX 775-33-2G) with production cycles of 60 and 70 days respectively. The varieties were obtained from the Institute of the Environment and Agricultural Research.

2.2. Experimental design

Trials were carried out in Ouagadougou, Burkina Faso, during the 2023 rainy seasonby using a complete randomized block with five (05) modalities using four different formulations of mineral fertilizers composed of nitrogen (N), phosphorus (P), and potassium (K). The different proportions of each mineral in the formulations are presented as follows: NPK (14-23-14); NPK (14-18-18), NPK (16-16-16) and NPK (15-15-15) at the dose of 100 kg/ha. The different treatments applied are: T0 (no mineral fertilizer applied), followed by T1 (application of NPK: 14-23-14), T2 (application of NPK: 14-18-18), T3 (application of NKP: 16-16-16) and T4 (application of NPK: 15-15-15).Seeds were sown directly in the pocket at a spacing of 80 cm between rows and 40 cm within rows.Quantitative parameters were measured following the criteria defined by Esbern andSthapit(2000)to assess the effects of fertilizers on growing and yield parameters.These parameters have concerned the number of ramifications, average number of pods per plant, number of grains per pod, average dry biomass weight, average number of nodules per plant and grain yield per pot. The number of ramifications per plant on 42nd day after sowing was assessed. The other parameters were assessed at harvest. For phytosanitary parameters, observations of brown spot disease and attacks by *Aphis craccivora* were done the 42nd day after sowing.Disease severity was assessed using the scale described by (Sérémé*et al.*, 1992).The average infection index or percentage severity of brown spot disease was calculated for each treatment using the formula:I = $\frac{\sum(\mathbf{Xi-1}).\mathbf{ni}}{[\mathbf{E}(\mathbf{Xi})-\mathbf{1}].\mathbf{N}}$where Xi = disease score for each plant, ni = number of plants in the Xi category, N = total number of plants observed and E(Xi) = range of the scale.Incidence (IF) was assessed by counting the number of plants attacked by aphids on all plants per replicate. The incidence was evaluated on the 42nd day after sowing according to the following formula:

$$IF = \sum_{i=1}^{n} \left(\frac{xi+\cdots+xi+1}{X}\right) x\ 100.$$

n : number of replicates, xi: number of plants attacked and X : total number of plants.

2.3. Dataanalysis

In each pot, the number of ramifications, average number of pods per plant, number of grains per pod, average dry biomass weight, average number of nodules per plant and grain yield per pot were measured with mineral fertilization as the main factor and cowpea varieties as a secondary factor. Collected data were subjected to analysis of variance testsusing XLSTAT 2016 software at the 5% probability threshold using Fisher's test.

3. RESULTS

3.1. Brown spot disease severity and aphid attack incidence

Figures 2 and 3 show respectively the level of leaf severity characterized by brown spot disease and the incidence of aphid attacks. The leaf severity ofbrown spot diseasevalues varies from 12.33 to 26.12 and from 11.06 to 28.79 respectively for *Komcallé and Tiligré*. For both varieties, T0 represented by the control test without any treatment. For Komcalle variety, no significance difference was observed between treatments T3 (21.12), T2 (19.06) and T0 (26.12) on the one hand and between T1 (12.33) and T4 (13.41) on the other hand. However, the level of leaf severity observed between T0, T1, T2, T3 and T4 was significantly different. The lowest value corresponding to the low leaf severity is observed for the treatments T1 which is not significantly different from the value obtained for T4 (13.41). Concerning the variety of *Tiligre*, significance difference is observed between the treatments T2, T3 and T4. Same trend is obtained for the T4 which appears with the lowest leaf severity. In terms of incidence of aphid attacks, values vary from 19.67 to 36.57 and from 17.12 to 28.89 respectively for *Komcalle* and *Tiligre* varieties. For *Komcalle* variety no significance difference is observed between all treatments with low value obtained fom T2 (19.67). In parallel, for the second variety (*Tiligre*), no difference appears between T1 (24.87) and T3 (21.89); and between T2 (28.89) and T4 (27.89). However, the lowest value was obtained fom T3 (21.89) outside the control treatment.

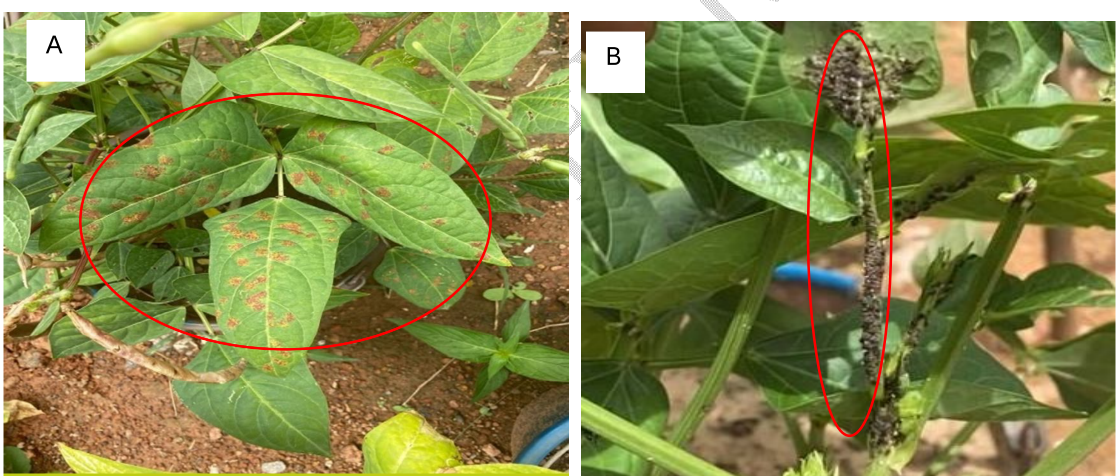
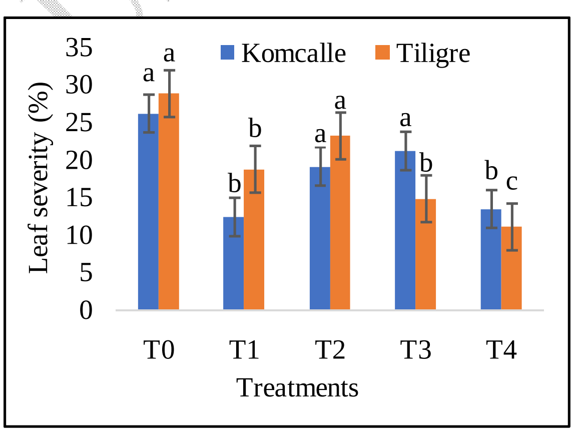


Figure 1 : Cowpea plant materialshowingleavesattacks

Legend: A: Symptoms of brown spot, **B**: Attacks of *Aphis craccivora*



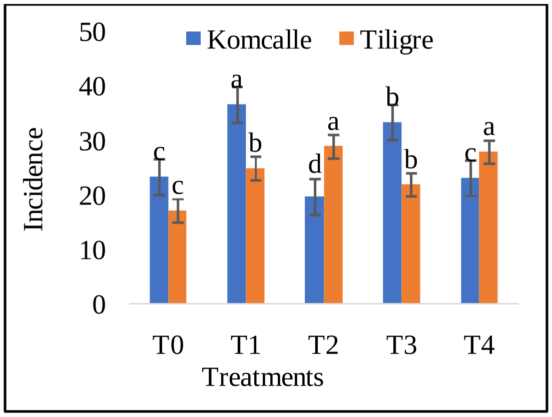
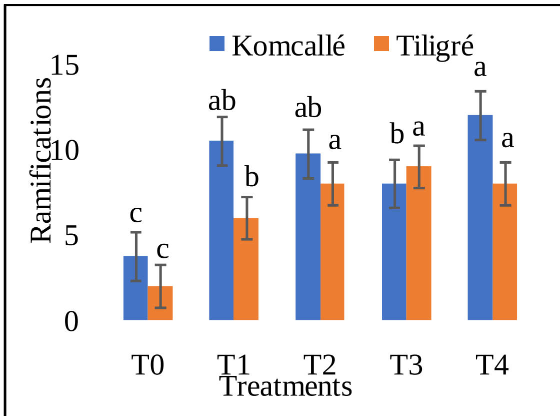


Figure 2 : Brown spot disease severity **Figure 3 :**Incidence of Aphidattack
Legend:T0 *(without fertilizer),* ***T1*** *(NPK: 14-23-14),* ***T2*** *(NPK: 14-18-18+6s+1B),* ***T3*** *(NPK: 16-16-16) et* ***T4*** *(NPK: 15-15-15).* ***a, b*** *and* ***c*** *are the hierarchical classification groups with a > b > c.*

3.2. Effects of fertilizer formulations on cowpea yield performance

Collected data were presented byfigures 4; 5; 6; 7; 8and9which show respectively the average number of ramifications per plant, the average number of pods per plant, the average number of grains per pod, the average weight of dry biomass per plant, the average number of nodules per plant and the average yield per pot. Whatever the type of treatment and the parameter chosen, *Komcallé* variety presents a higher performance than *Tiligré* variety. The results show a variation between treatments for each parameter measured.

The analysis of variance showed a highly significant difference between treatments at the 5% probability threshold according to the Fisher test. For the *komcallé* variety, treatment T4 (15-15-15) performed best in terms of average number of ramifications (12 ramifications/plant)while treatment T0 recorded the lowest performance (4 ramifications/plant) (Figure 1).The best performance of average number of pods per plant (15 pods/plant) was recorded by treatment T4(15-15-15) while the treatment T0 performed the lowest (5 pods/plant)(Figure 2). For average number of grains per pod, the results showed that the treatment T4 (15-15-15) has registered the best performance (9 grains/pod) while the treatment T0 recorded the lowest (5 grains/pod) (Figure 3).The highestaverage number of nodules per plant (25 nodules/plant)and the best performance of grain yield per pot (10.27 g of grain/pot) were registered by T4 (15-15-15). The lowest performances were recorded by the treatment T0 (Figure 5 and Figure 6, respectively).In the *tiligr*é variety, treatment T4 (15-15-15) recorded the highest performance of average number of pods per plant (11 pods/plant) (figure 2). Concerning the average number of nodules per plant, the results showed that thetreatment T4 (15-15-15) recorded the best performance (21 nodules/plant) (figure 5).For grain yield per pot, results showed that the treatment T4 (15-15-15) registered also the highest performance (5, 95 g/pot) (Figure 6).However, treatment T3 (16-16-16) recorded the highest values of average number of ramificationsper plant (9 ramifications/plant) (Figure 1).The results showed that the best performances of average number of grains per pod (7 grains/pod) andaverage dry biomassweight (16 g of dry biomass/plant) were recorded from treatment T3 (16-16-16)(Figure 3 and Figure 4 respectively). For each variety, the lowest performances were recorded by the controls.



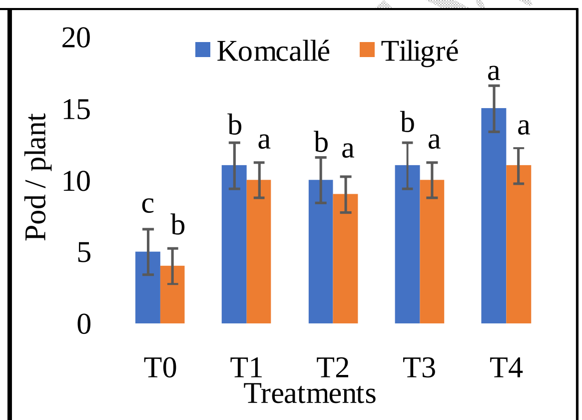
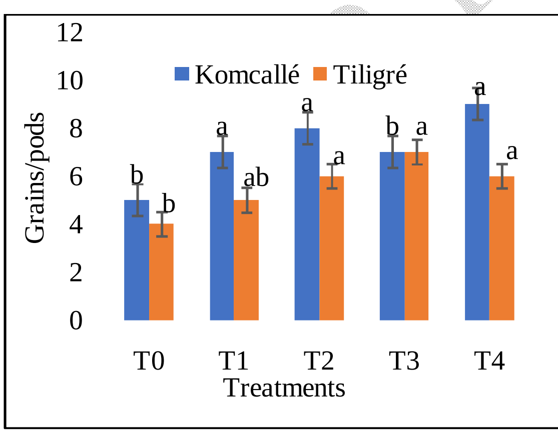


Figure 4: Number of ramifications per plant **Figure 5**: Number of pods per plant

Legend : ***T0*** *(without fertilizer),* ***T1*** *(NPK : 14-23-14),* ***T2*** *(NPK : 14-18-18+6s+1B),* ***T3*** *(NPK : 16-16-16) et* ***T4*** *(NPK : 15-15-15).* ***a, b*** *and* ***c*** *are the hierarchical classification groups with a > b > c.*



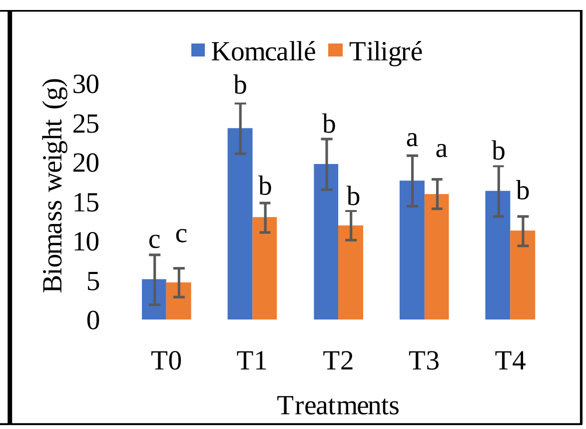
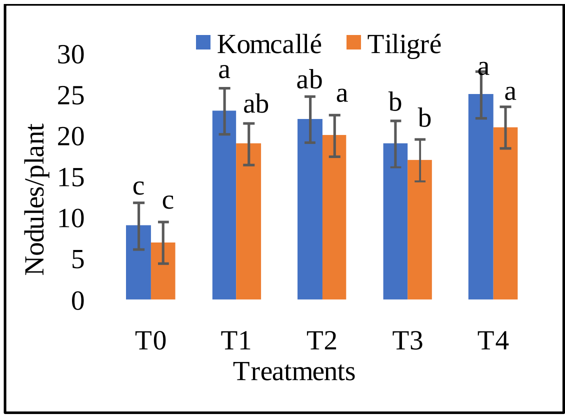


Figure 6 : Number of grains per pod **Figure 7** : Dry biomass weight

Legend :T0 *(without fertilizer),* ***T1*** *(NPK : 14-23-14),* ***T2*** *(NPK : 14-18-18+6s+1B),* ***T3*** *(NPK : 16-16-16) et* ***T4*** *(NPK : 15-15-15).* ***a, b*** *and* ***c*** *are the hierarchical classification groups with a > b > c.*



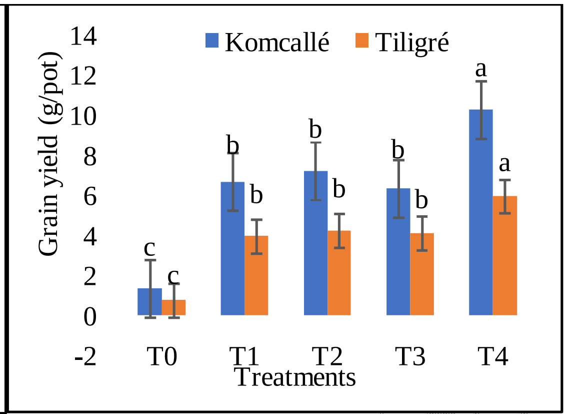


Figure 8 : Number of nodules per plant **Figure 9** : Grain yield per pot

Legend:T0 *(without fertilizer),* ***T1*** *(NPK: 14-23-14),* ***T2*** *(NPK: 14-18-18+6s+1B),* ***T3*** *(NPK: 16-16-16) et* ***T4*** *(NPK: 15-15-15).* ***a, b*** *and* ***c*** *are the hierarchical classification groups with a > b > c.*

4. DISCUSSION

Nowadays mineral fertilizers are mostly used in West Africa to control soil-borne diseases and enhance plant growth, productivity, and tolerance to abiotic stress. These fertilizers are used alone or in combination sometimes with organic fertilizers. For instance, in Nigeria, mineral fertilizer was applied in combination with pig manure to enhance cowpea yields(Adegoke *et al.*, 2019). Finding an optimum combination of mineral fertilizers remains a challenge as the rate of each mineral depends on the nature of the soil and plant. In the present study the different combinations used led to the results which vary from one variety to another and between treatments.Our study showed that for the treatment T4, the results obtained are different from those reported by Daramy *et al.* (2017) who noticed no significant effect by applying different rates of nitrogen (0, 10, 20, 30 and 40 kg N/ha) and phosphorus (0, 15, 30 and 45 kg P_2O_5/ha) fertilizer on the growth and grain yield of cowpea in Ghana. Nevertheless, the current study conducted in Burkina Faso showed that applying NPK in cowpea production can contribute to enhance yield. In this study, treatment T4 (NPK 15-15-15) had the highest yield performance in terms of average number of pods per plant, average pod weight per plant, number of grains per pod, average number of nodules per plant and grain yield per pot. This is because this NPK fertilizer formulation corresponds to the optimum dose and releases nutrients easily. Cowpea yields varied according to the type of mineral fertilizer formulation used, reflecting their different effectiveness on the parameters measured. This difference in measured parameters is explained by the different doses of N, P and K in the fertilizers applied to the plants. Cowpea does not need much nitrogen fertilizer because it can fix nitrogen from the air through nodulesin their roots. Work by Bado (2002) has shown that manure inputs have an influence on the yield of cowpea grains and haulms, as well as on their ability to fix atmospheric nitrogen by means of nodules. Among the fertilizer formulations applied, treatment T3 recorded the highest biomass content with low grain yield production. Like all legumes, cowpea needs nitrogen, but applying it at a high dose can have a negative impact on yield. This result corroborates with the work of Agossou*et al.* (2018) who showed that too much nitrogen fertilizer will lead to abundant vegetative growth to the detriment of seed production.

The level of leaf severity of brown spot disease and the incidence of aphid attacks varied from one variety to another and from one treatment to another. Varieties are not equally resistant to pests, depending on the treatments applied (Sérémé*et al.,* 1992; Abdoulaye *et al.*, 2019). The insect pests encountered in the various treatments were mainly aphids (*A craccivora*) in the absence of chemical treatment. In treatments T1 and T2 for the *Komcallé* and *Tiligré*varieties respectively, the results showed high pressure from the insect, with a more abundant population than in the control. The abundance of the insect population observed in treatments T1 (23% P) and T2 (18% P) could be explained by the fact that the application of higher doses of phosphorus would make the plant more susceptible to the insect. The works of Naseri and Hamzavi (2021) showed that the application of chemical fertilisers (triple superphosphate (TSP) and urea) and bio-fertilisers (*Bradyrhizobium japonicum*, *Pseudomonas putida* and *mycorrhizal fungi*) resulted in resistance of cowpea pods and grains to *Callosobruchus maculatus*.

These results contradict those obtained by Asiwe (2009)who showed that mineral fertilization with phosphorus led to a considerable reduction in certain insect pests of cowpea, such as *Maruca vitrata* and *Clavigrallatomentosicollis*. The fungal disease found on the leaves was brown spot caused by seed-borne *Colletotrichum capsici*(Kawube*et al.,* 2005). The seeds may have been contaminated before sowing.

CONCLUSION

This work which focused on the effect of four (04) mineral fertilizer formulations on the agronomic performance of cowpea, revealed that this performance depended on the type of fertilizer formulations applied and the variety. The results showed that the best yield performances were recorded for treatments T3 on the *Tiligré* variety and T4 on the *Komcallé* variety. As for brown spot disease, the results showed that treatments T1 and T4 recorded the lowest foliar severity in the *Komcallé* and *Tiligré* varieties, respectively.While, the lowest incidence of aphid attacks was recorded in treatments T2 and T3 in the *Komcallé* and *Tiligré*varieties, respectively. The use of fertilizer formulations can be strengthened on the farm to contribute to increasing cowpea yields.

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CONFLICT OF INTEREST

Theauthorsdeclare no conflicts of interest.

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