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The use of plants extracts in the improvement of cowpea yield at dang (Ngaoundere, Cameroon)

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Abstract

In the substitution of chemical insecticides with potential biopesticides, the efficiency of *Lippia multiflora, Plectranthus glandulosus* and *Callistemon rigidus* were evaluated on the improvement of cowpea (*Vinia unguiculata*) in Dang (Ngaoundere, Cameroon). The experiment was conducted in a completely randomized block design with 5 treatments repeated 4 times each: the negative control, the positive control (Decis), *L. multiflora*, *P. glandulosus* and *C. rigidus*. These different insecticides were sprayed on cowpea plants with 14 days interval starting from the 14th day after sowing. The parameters collected were the diversity of insect pests, the number of pods, and the dry weight of the grains. All of the insecticides used improved cowpea yields. Although less efficient than Decis, most biopesticides significantly ($p < 0.001$) improved the yield of cowpeas compared to the negative control. This improvement was 260% for *C. rigidus*, and 120% for *P. glandulosus*. These results suggest that *C. rigidus, P. glandulosus* and *L. multiflora* could be considered as potential substitutes for chemical insecticides in improving cowpea yields.

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Introduction

Agriculture in sub-Saharan Africa is essential to reduce poverty and strengthen food security (FAO, 2009a). *Vigna unguiculata* which occupies an important place in the Sudano-Sahelian and Guinean zones (Isubikalu *et al.*, 2000) would therefore be a major asset, not only for food balance, but also for economic development (Adeoti *et al.*, 2002). Indeed, this leguminous plant is cultivated for its richness in food proteins (20-25%) (Bressani, 1985; Rivas-Vega *et al.*, 2006), but its production is rather low (MINADER, 2012).

More than 80% of this low production is due to insect pests (Tamò *et al.*, 1993), and the use of chemical pesticides has often caused more problems than it has solved (Bambara and Tiemtoré, 2008). In the development of healthier control strategies to increase the productivity of cowpea, plants extracts or botanicals could be used to substitute chemical insecticides (Barry *et al.*, 2017).

This is the case *of Lippia multiflora,* which efficiency has been demonstrated on *Sitophilus zeamais* (Nukenine *et al.*, 2007), *Callistemon rigidus* which has been found to be efficient against *Aedes aegypti* and *Anopheles gambiae* larvae (Danga *et al.*, 2014b), as well as *Plectranthus glandulosus* which has been shown to be efficient against *Sitophilus oryzae, Sitophilus zeamais* and *Prostephanus truncatus* (Ngamo *et al.*, 2007a; Nukenine *et al.*, 20010a).

Therefore, the aim of this work was to further research on other plants (*Lippia multiflora, Plectranthus glandulosus* and *Callistemon rigidus*), which extracts could be of potential use as biopesticides against cowpea pests, so as to improve the yield.

Material and methods

Study site

The experiment was carried out from August to November 2017 at Dang (Ngaoundere, Cameroon). The cowpea seeds used in this work were of the BR1 variety obtained from IRAD (Research Institute for Agriculture and Development) in Maroua.

Experimental layout

The field was conducted on a 494 m² flat surface in a completely randomized blocks design comprising 5 treatments repeated 4 times each. The experimental plots separated by 1m were (4×3.5)m². The five treatments were the negative control, the aqueous extract of *Lippia multiflora* leaves, the aqueous extract of *Plectranthus glandulosus* leaves, the aqueous extract of *Callistemon rigidus* leaves, and the positive control (Decis or Deltamethrin). Plant extracts were sprayed using 4 different manual sprayers (marques), each corresponding to an insecticide treatment. These different insecticides were applied every two weeks after sowing until harvest.

Formulation of insecticides

The aqueous extracts were obtained according to Sreekanth's method (2013). A total of 125g leaves from each plants used was weighed, pounded in a mortar and macerated in 1.25L tape water for 12 hours. After maceration, the mixture was filtered using a 0.2mm pore size sieve before each filtrate was introduced into the corresponding sprayer. The synthetic insecticide Decis was formulated, following the instructions of the manufacturer by diluting 3mL of Decis in 15L of tape water.

Assessment of devastating pests and yield parameters

Data collection started 3 weeks after sowing, and repeated every 10 days. The parameters measured were the number and the diversity of insect pests, the number of pods per foot and the grain yield. A lens was required to identify tiny insect pests (such as *Aphis cracivora* and *Megalurothrips sjostedti*). The number of pods per plant was counted according to the phenology of the plant. Concerning the yield, the dry weight of the seeds (inkg) was evaluated per plot.

Statistical analyses

Data were analyzed using SAS 2003 software. Data were transformed into a square root for the insect pest population, and logarithm for the number of pods and the dry weight of grains. This was to reduce variance errors. All these parameters were subjected to the analysis of variance (ANOVA) and the graphs were produced with the Excel spreadsheet of Office 2010 software.

Results

Diversity and density of insect pests on *Vigna unguiculata* plants. Several insect pests were counted in the experimental field and *Clavigralla tomentosicollis, Aphis cracivora, Megalurothrips sjostedti* and *Maruca vitrata* were respectively the most numerous (Fig. 1).

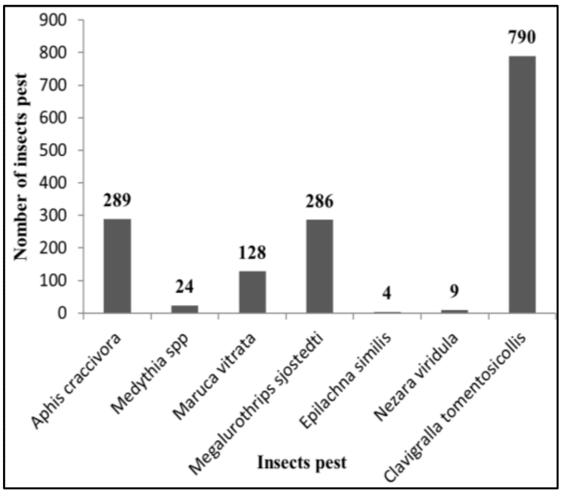

Fig. 1. Number of insect pest species.

Effect of treatments on pod production

The influence of the treatments on the production of pods is shown in fig. 2. It is observed that, all the biopesticides have significantly (p <0.001) improved the production of pods compared to the negative control. However, Décis has been the most efficient insecticide.

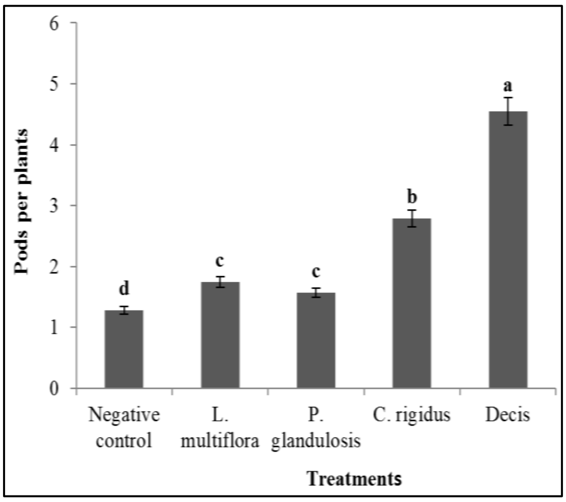

Fig. 2. Variation mean of cowpea pods per plants between treatments.

Bars affected with the same letters are not different at 5% level of significantly.

Effect of treatments on grain yield (kg / ha)

The insecticide treatments significantly (p <0.001) improved the cowpea yield compared to the negative control, except for *L. multiflora*. These results are shown in Fig. 3.

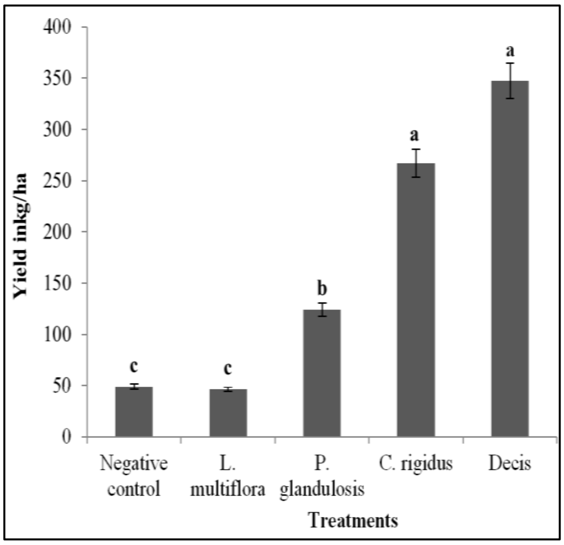

Fig. 3. Variation cowpea yield (kg/ha) between treatments.

Bars affected with the same letters are not different at 5% level of significantly.

Discussion

In the improvement of cowpea yield by using biopesticides as substitutes for chemical insecticides, the treatments used in this work had an influence on the parameters measured.

With regard to the density and diversity of cowpea insect pests, the high number of *A. craccivora, M. sjostedti, M. vitrata* and *M. tomentosicollis* highlights the consideration of these insects as major pests of cowpea (Mehinto *et al.*, 2014). *A. craccivora* by attacking the young plant and the soft parts of the plant (Dougje, 2009), severely reduces the development of cowpeas. *M. sjostedti*, which causes necrosis of flower buds and flowers (Dougje, 2009), destroys the reproductive organs of cowpeas, with consequence that the plant can no longer produce fruits (Barry, 2018). As for *M. vitrata* and *M. tomentosicollis*, they drill and dry the pods (Dougje, 2009). Attacks on cowpea by these insects pest therefore contribute to considerable yield losses.

In pod production, the major efficiency of Décis compared to that of biopesticides would be due to its broad spectrum of action and the fact that it is systemic (Barry *et al.*, 2017). The reduced efficiency of *L. multiflora* and *P. glandulosis* when compared to that of *C. rigidus* is due to their volatility. This would explain their high efficiency in storage rather than in the field, which is not a confined place. These results are similar to those of Barry *et al.*, 2019 and those of Bambara and Tiemtoré (2008) who showed the reduced efficiency of neem in the field.

The properties of *P. glandulosus* (Ngamo *et al.*, 2007a; Nukenine *et al.*, 20010a) and *C. rigidus* (Danga *et al.*, 2014b) have enabled them to improve cowpea yield, and even to equal the efficiency of the Decis with regard to *C. rigidus*. Indeed, the efficiency of *P. glandulosus* higher than that of L. multiflora could show the higher volatility of the latter, thus highlighting the importance of adhesion in the effciency of insecticides (Ibrahim *et al.*, 1999). These results are similar to those of Barry (2018). The terpenoids, flavonoids, steroids and saponins (Praveen *et al.*, 2012) contained in *C. rigidus*, give it its insecticidal activities. *C. rigidus* therefore fought the insect pests responsible for cowpea yield losses as effectively as the Decis.

Conclusion

This work is a contribution to the improvement of cowpea yield through the use of biopesticides. It appears that the treatments used in this work as potential substitutes for chemical insecticides, *P. glandulosus* and *C. rigidus* have proven to be effective in improving cowpea yield. Much more, C. rigidus was as effective as the Decis. However, we have to seek the improvement of the efficiency of less effective treatments.

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