Evaluation of genotypes of some cowpea (Vigna unguiculata (L.) walp) varieties for resistance to thrips (Megalurothripssjöstedti) in Burkina Faso.

ABSTRACT

Aims: Cowpea (*Vigna unguiculata* (L) Walp.) is one of the most important grain legumes grown in all arid and semi-arid zones of Africa. Its production helps to combat malnutrition and poverty, and contributes to food self-sufficiency. However, its production comes up against numerous abiotic and biotic constraints, including floricultural insects such as thrips (*Megalurothripssjöstedti*), which are small insects. They belong to the order Thysanoptera, family Thripidae, and cause considerable damage to cowpea crops, especially at flowering time.

Methodology: The aim of this study was to evaluate the behavior of eight lines from Burkina Faso compared with the thrips-resistant line (TVx3236) from the IITA collection (Nigeria).

A completely randomized block design with three replications in two trials (PT treated plot and PNT untreated plot) was used for the experiment.

Results: Results showed that some varieties were resistant to thrips, while others were sensitive. The best genotypes were those with a low number of thrips per flower and high pod production.

On this basis, KVx780-1 is the best genotype compared with KVx780-6 for varieties currently being popularized. The Nafi variety is the best compared with the varieties popularized in 2012 (Nafi, Gourgou, Komcallé and Tiligré).

Conclusion: In the case of the varieties that were previously popularized, the results confirmed the susceptibility of the KN-1 variety, the tolerance of the KVx165-14-1 variety and the resistance of the TVx3236 variety.

Key words: *genotypes, lines, varieties, cowpeas, resistance, thrips, Burkina Faso*

1.INTRODUCTION

Burkina Faso is one of the West African countries where agriculture plays an important role in the country's economy. Agriculture accounts for 40% of GDP, with crop production accounting for 25%, livestock production for 12% and forestry production for 3% (MAHRH, 2009). This sector is the main source of employment and income for over 80% of the working population. Agriculture is essentially cereal-based, and hardly covers the population's food requirements. Cereal-based diets are unbalanced and generally lacking in proteins and vitamins. This deficiency undoubtedly leads to malnutrition, the cause of several population growth anomalies. The quest for food security and balance is therefore a key objective for the country. Seed legumes such as cowpea (*Vigna unguiculata* (L.) Walp) can contribute to this objective.

Adapted to the country's climatic, edaphic and socio-economic conditions, cowpea is becoming a cash crop. Statistics give a production of 571304 tonnes of dry seeds for the 2014-2015 period (FAOSTAT, 2015). This level of production places Burkina in third place among African producer countries after Nigeria and Niger. Cowpea's contribution to GDP has averaged around twenty-two billion CFA francs in recent years (Statistica, 2002). Cited as a less expensive source of protein (23%-25%) than that of animal origin, cowpea is 100% useful. Its seeds are a valuable source of vegetable protein, vitamins and income for humans, as well as fodder for animals (Rachie, 1975). Juvenile leaves and immature pods are consumed as vegetables. Farmers who harvest and store cowpea fodder for sale at the height of the dry season increase their income by 25% (Dugje and al, 2009). In a crop rotation system, cowpeas also play an important role as a source of nitrogen for cereal crops. Its nitrogen requirements are low, and its roots are equipped with nodules populated with bacteria that contribute to atmospheric nitrogen fixation, thereby helping to reduce agricultural input costs (Bado, 2002). Cowpea is also used therapeutically to treat certain illnesses. Empty pods are used to cure gout, diabetes, obesity, urinary stones and prostate diseases (Nacoulma, 1996). Despite these multiple roles, cowpea cultivation in Burkina Faso is confronted with numerous climatic, socio-economic, abiotic and biotic constraints that affect grain and forage yields per hectare, as well as the quality of cowpea seeds. In fact, only a few characteristics of cowpea seeds are appreciated by consumers in West Africa, and they vary from one country to another or from one ethnic group to another. According to Drabo (1981), varieties with large white seeds and a wrinkled tegument are appreciated by women for their ease of cooking. To address these various production constraints, INERA's oilseed and protein crop program is conducting research aimed at selecting high-yielding cowpea lines that are resistant to disease and insects, and meet the requirements of producers and consumers. The present study concerns “the evaluation of genotypes of some cowpea varieties (Vignaunguiculata (L.) walp) for resistance to thrips (Megalurothripssjöstedti) in Burkina Faso”. The general objective of thisstudyis to evaluate the cowpealinesthat are mostresistant to a thrips population throughvarietalimprovement. Specifically, itinvolvesobserving the damage caused by thrips (Megalurothripssjötedti) to the cultivation of somecowpeavarieties in Burkina Faso on the one hand and identifying high-yieldingcowpeavarietiesthat are tolerant to thrips and meet the requirements of producers and consumers on the other hand. This studywascarried out at the Agricultural EnvironmentalResearch and Training Center (CREAF) in Kamboinsé.

2. MATERIALS AND METHODS

2.1. MATERIALS

2.1.1. Study site

The trials were carried out in Kamboinsé at the Centre de RecherchesEnvironnementalesAgricoles et de Formation (CREAF). The climate in this area is Sudano-Sahelian (GUINKO, 1984), with annual rainfall ranging from 600 to 1000 mm. The rainfall recorded in 2015 was 904.9 mm, well above the average for the last five years (2010-2014) of 739.78 mm (INERA/Kamboinsé meteorological station, 2015).

2.1.2 Plant material

The plant material used for the study comprised nine entries, eight of which were obtained in Burkina Faso (KN-1, Nafi, Komcallé, Gourgou, Tiligré, KVx165-14-1, KVx780-1 and KVx780-6) and a single variety from the IITA collection in Nigeria (TVx3236). KN-1 is considered a thrips-susceptible control, KVx165-14-1 a thrips-tolerant control and TVx3236 a thrips-resistant control. Photo 4 below shows the plant material used.

Figure 1: Cowpea varieties used

2.1.3. Technical equipment used

To carry out certain operations within the framework of our work, a certain number of technical materials were used, namely:

- plastic pots for sowing;
- electronic scales for fertilizer weighing;
- daba for weeding;

- metric tape for measuring the KN-1 plot of land;
- mosquito netting to cover the untreated plot against other insects;
- vacuum cleaner and cones for capturing thrips at the time of infestation;
- 30% alcohol and flasks to collect flowers for laboratory analysis;
- microscope and Loupe Lampe for observation and counting of thrips in the laboratory;
- red dye and tweezers (Horse) for observations.

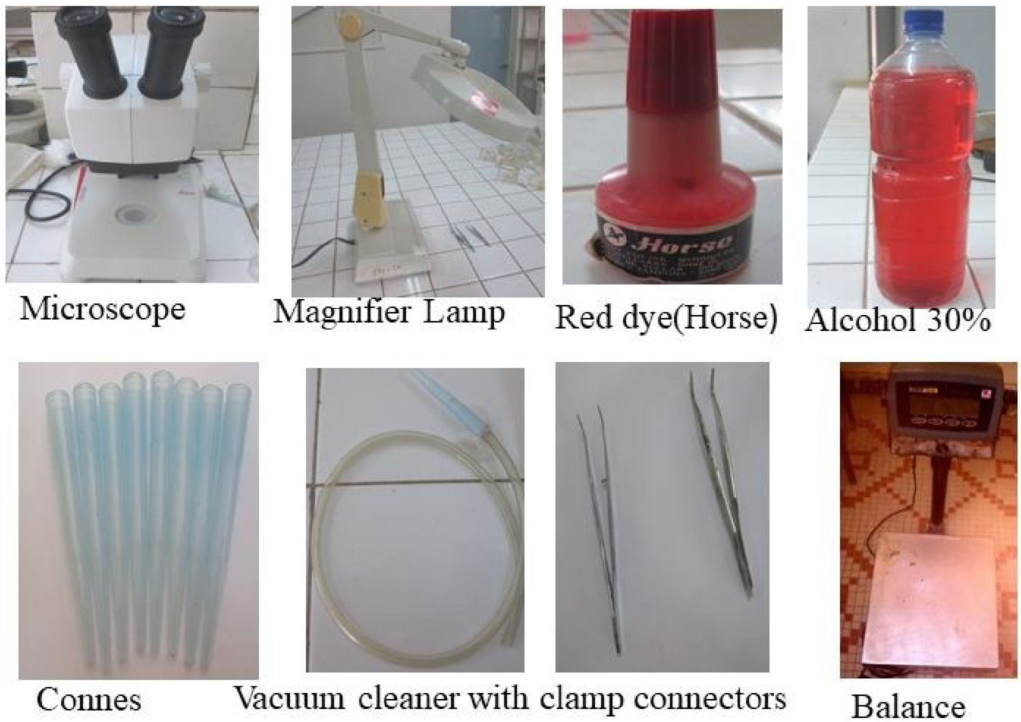

Figure 2: Laboratory equipment used

2.1.4. Fertilization

To enable the plants to develop properly, mineral fertilizer (NPK 14-23-14) was used as background fertilizer at the time of sowing in the pots at a dose of 100kg/ha, i.e. an estimated quantity of fertilizer of 3.5kg for the one hundred and eighty (180) pots.

2.2.Methodology

2.2.1. Experimental set-up

BMS (Breeding Management System 3.09) software was used to prepare the trials.

Two trials were set up on July 13, 2016 in plastic pots. The pots in each trial are arranged under a completely randomized block design with three replications. The elementary plot is composed of 5 pots with 2 plants per pot. One of the trials is untreated but protected against other types of insects by mosquito netting, and the other trial is protected against thrips by treatments with a mixture of insecticides (PACHA + ACARIUS18EC). The dose for the mixture is 40ml per 16L of water, i.e. 10ml PACHA + 10ml ACARIUS18EC per 8L of water. A total of three treatments were carried out in the treated plot. At sowing time, each line was sown in 10 pots at a rate of 3 to 4 seeds per pot sown initially, then broken up eight days after sowing to leave only 2 plants per pot. 12 lines of the KN-1 variety are sown in advance on soil for thrips production. Flowers containing thrips from these plants are harvested to infest pots in the field without insecticide treatment, protected by nets. Thrips infestation in the untreated plot began on August 22, 2016. It was carried out following the appearance of flower buds and flowers on the plants at a rate of ten thrips per pot after a laboratory count.

2.2.2. Cultural operations

These operations began with the planting of the KN-1 variety in the ground, with the aim of producing and maintaining thrips at the time of infestation of the untreated plot covered with netting. The plot was ploughed and ridged on June 15, 2016. A total of three sowing dates took place over a total area of twenty-four square metres (24 m2). Spacing was 80cm X 40cm, with 2 to 3 seeds per poquet for all sowing dates. A dose of NPK fertilizer (14-23-14) of 100kg/ha was applied, i.e. a total quantity of 350g for the entire surface area of KN-1.

Setting up the two trials in plastic pots began on July 07, 2016 with the filling of the earthen pots. The pots were labelled in a serpentine fashion on July 08, 2016. Sowing of the two trials took place on July 13, 2016, with 2 to 3 seeds per pot. A dose of NPK fertilizer (14-23-14) of 100kg/ha was applied at the time of sowing, i.e. a total quantity of 3.5kg for all pots in the two trials. Resowing was carried out on July 18, 2016 due to seed rot caused by the heavy rains of July 14 and 15, 2016. Weeding was carried out on July 28, 2016. Mosquito netting was installed in the untreated plot on August 9 and 10, 2016. Thrips infestation in this plot began on August 22, 2016, gradually following the appearance of flower buds and flowers. Cultural operations are summarized in the following table.

2.2.3. Observations

The method of Balde and Diop, 1995 and Balde, 1997 was used to observe parameters during the experiment. A maximum of five flowers were collected from the central pots of each elementary plot in flasks containing 30% alcohol, and the number of thrips adults and larvae was determined in the laboratory using a microscope. Counting began ten (10) days after infestation and took place every three days. The parameters observed were as follows:

- Total number of thrips per flower (NTT/FL): in the central pots of each plot, samples of 1 to 5 flowers were taken every three days and observed under the microscope;

- -Total number of peduncles (NTPed) and number of fruiting peduncles per plant (NTPe/pl): two plants are randomly selected in each elementary plot to be monitored from the start of flower formation to harvest at one-week intervals;
- Number of pods per peduncle (NTGPe): two plants from each elementary plot are randomly selected to form the observation sample and the number of pods per peduncle is counted;

- Total number of flowers per plant (NTFL/PL): difference between protected and unprotected plots. A daily count of the day's flowers is made on every two plants selected in each elementary plot from the start of flowering (40 JAS) to sixty (65) JAS;
- The total number of pods formed (NTGFor) and the total number of pods aborted (NTGAv): two methods are applied, namely random selection of individual plants during the fruiting phase for observation and calculation of the average production per plant from the total number of pods obtained by post-harvest counting.

2.2.4. Data analysis

All statistical analyses of the data were carried out using BMS 3.09 and SAS (Statistic Analyse System version 9.1) software. Graphs were produced using Microsoft Excel 2010 software. Differences between means were calculated using the LSD (Smallest Significant Difference) test with a probability of 5%.

3- RESULTS

3.1. Thrips population

An analysis of thrips population dynamics (figure 3) showed a difference between the untreated (PNT) and treated (PT) plots over time for all varieties combined, and also for all thrips collected during the various sampling periods. Treatment of plants with the insecticide mixture (PACHA + ACARIUS18EC) maintained a lower population level (less than 60 thrips) in the treated plot (PT) than in the untreated plot (PNT) over the sampling period. In the PT plot, the population trend was downward due to the action of the insecticide, while in the PNT plot, the dynamics of the trend were characterized by a descending curve followed by a slight rise at the second sampling. Figure 3 below shows thrips population dynamics in the two plots.

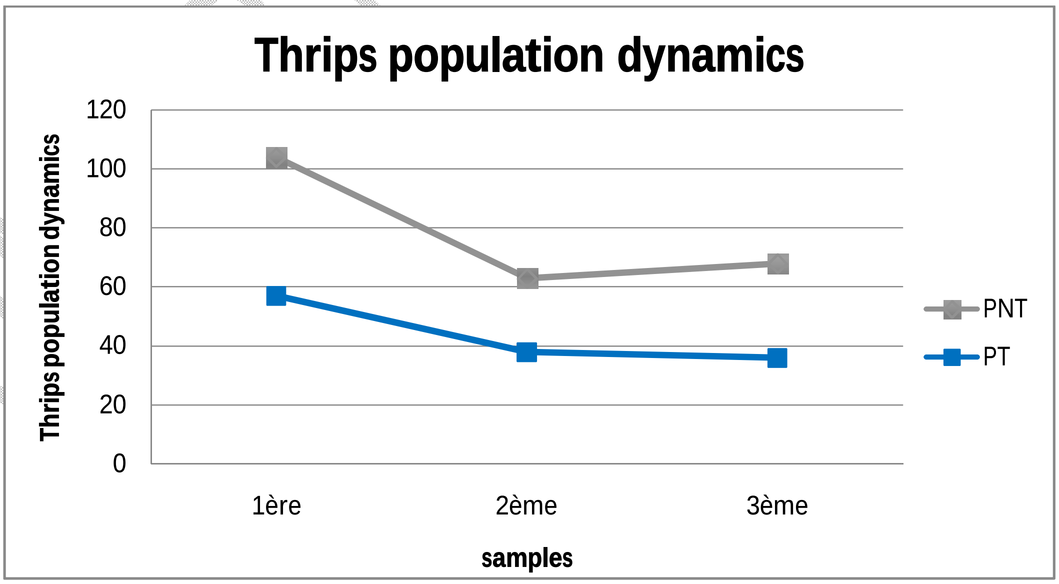

Figure 3: Thrips population trends for all varieties combined in the untreated (PNT) and treated (PT) plots.

The results of flower dissection for thrips counting revealed the presence of Megalurothripssjöstedti and also larvae of *Maruca vitrata*, which is also one of the most formidable enemies, capable of causing very serious damage to the cowpea crop, notably the death of flower buds and flowers (Anonymous, 1989).

From the point of view of thrips population evolution by variety, the averages of the total number of thrips counted per variety and the number of thrips per flower and per variety were considered in these analyses. The variety KN-1, initially considered a sensitive control, recorded the highest total number of thrips over the three samples (more than 26.14 thrips), with an average of 4.57 thrips per flower in the untreated plot (PNT). In the treated plot (PT), this variety recorded 8.33 thrips for all flowers sampled, with an average of 1.3 thrips per flower. It is therefore the variety most susceptible to thrips in both plots (PNT and PT). The variety TVx3236, considered a resistant control, recorded the lowest total number of thrips counted (0.25 thrips) and an average of less than 0.085 thrips per flower in the plot (PNT). In the PT plot, it recorded 1.79 thrips and 0.266 thrips respectively for total thrips counted and total thrips per flower. It is therefore the most resistant to thrips in terms of thrips population.

KVx165-14-1, considered a thrips-tolerant control, was indifferent in both plots for the total number of thrips counted (6.4 and 5.99 thrips respectively in PNT and PT). For the average number of thrips per flower, it recorded around 1.24 and 0.74 thrips per flower in the PNT and PT plots respectively.

For the other varieties (Komcallé, Nafi, Gourgou, Tiligré, KVx780-1 and KVx780-6), the total number of thrips counted varied between 1 and 4 thrips, with an average number of thrips per flower varying between 0.2 and 2 in both plots. Figs. 4 and 5 below illustrate thrips population comparisons between the varieties tested in the two plots (PNT and PT).

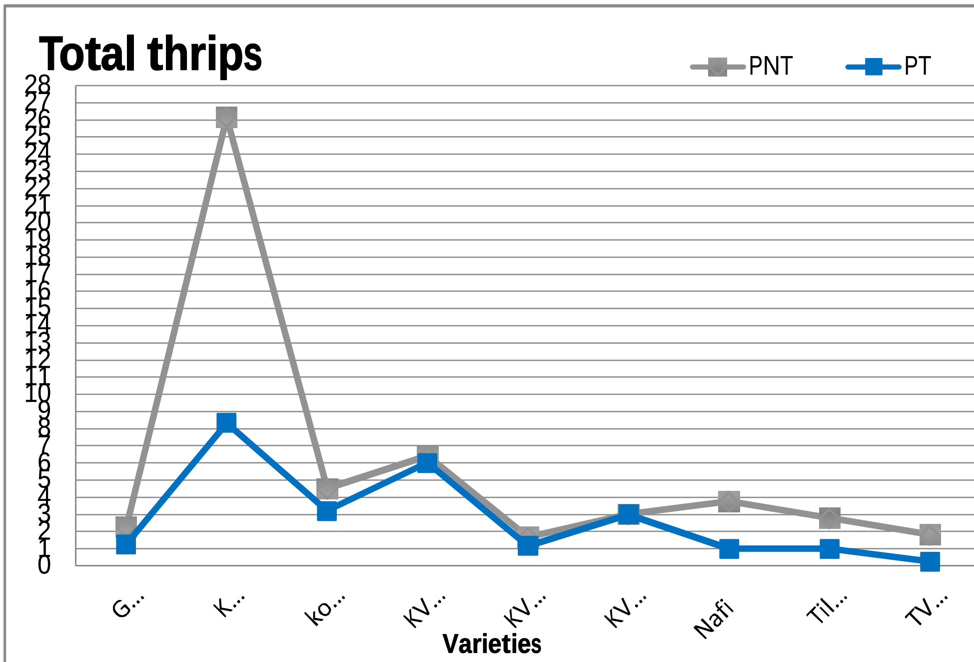

Figure 4: Evolution of the total number of thrips counted by variety in the untreated (PNT) and treated (PT) plots

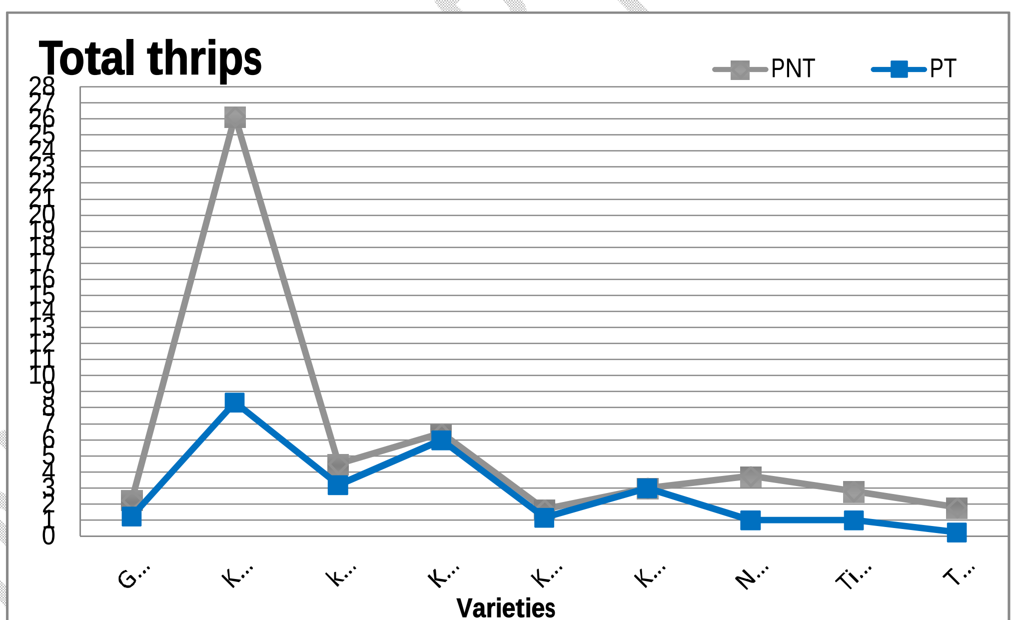

Figure 5: Evolution of the average number of thrips per flower and per variety (PNT and PT)

To confirm the results of our analysis of this parameter, another analysis of the data concerning the number of thrips per flower using SAS software (Statistic Analyse System version 9.1) classified the varieties according to their susceptibility to thrips populations in the following Table I.

Table I: Classification of varieties according to their susceptibility to thrips populations

Rank	Varieties		averge
1	KN-1		4,5222A
2	KVx165-14-1		1,6250 B
3	Komcallé		1,0000 B
4	KVx780-6		0,9524 B
5	Gourgou		0,5833 B
6	Tiligré		0,5238 B
7	Nafi		0,4167 B
8	KVx780- 1		0,4091 B
9	TVx3236		0,0500 B
R-squared0.727755	Coefficient of Variation 75.62488	Root MSE =1.099156	Thrips per flower Mean=1.453431
Probability	PPDS 5%	Pr > F	<.0001

Means with the same letter are not significantly different at significance level α =5%.LSD: Smallest Significant Difference

3.2 Production analysis

To assess the impact of thrips damage on cowpea production, parameters such as the total number of flowers per plant, the total number of pods formed and the total number of flowers and pods aborted are essential for proper analysis. Other parameters such as the total number of peduncles and the total number of fruiting peduncles have not been taken into account in the data analysis in this section. The latter parameters are in line with previous work by BALDE (1997), who showed that insecticide treatment could influence peduncle formation.

- **total number of flowers per plant.**

This parameter is of interest because flower abortion is generally due to the action of thrips. For a proper analysis of this criterion, a comparison between treated (PT) and untreated (PNT) plots seems to be of interest. Generally speaking, we found that flower production increased with plant development. This is particularly noticeable in the PT plot. This is remarkable in the PT plot as a whole.

The TVx3236 variety produced the most flowers (25 flowers per plant on average), followed by KN-1 (17 flowers per plant on average) in the (PT) plot.

For the other varieties (Nafi, Komcallé, Tiligré, KVx780-1, KVx780-6 and KVx165-14-1), total flower production per plant varied between 10 and 15 flowers in the PT plot.

On the other hand, in the PNT plot, KVx165-14-1 (13 flowers/plant) followed by KN-1 (12 flowers/plant) produced more flowers than TVx3236 (around 11 flowers/plant), considered thrips-resistant. In the same plot, Komcallé recorded the lowest average (6.9 flowers/plant) in terms of total flowers per plant. For the varieties (Nafi, Gourgou,Tiligré, KVx780-1 and KVx780-6), the total number of flowers produced varies between 6 and 10 flowers per plant on average. The varieties KVx165-14-1, considered the tolerant control, and KVx780-6 were practically indifferent in terms of total flower production per plant in the two (02) plots (treated and untreated). Figure 6 shows a comparison between varieties for total flower production per plant in the PNT and PT plots.

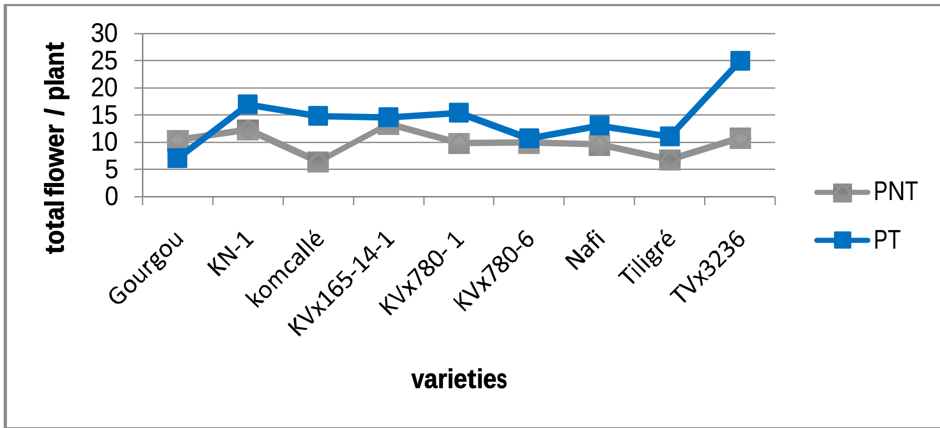

Figure 6: Evaluation of flower production per plant in plots (PNT and PT)

- **total number of pods formed per plant.**

Evaluating pod production per plant is an interesting way of assessing the tolerance of varieties to the thrips population. Generally speaking, the difference in pod production between varieties in the treated plot is lower than that observed between varieties in the untreated plot. In this evaluation of pod formation, we have considered the averages of observations by variety. In the plot (PNT), KVx165-14-1 produced the most pods (12.99 gusses). It was followed by KVx780-1 (11.67 pods). The Komcallé variety produced fewer pods (5gousses) in this plot.

On the other hand, in the PT plot, the Nafi variety produced more pods (12.83 pods). It was followed by TVx3236 (11.93 pods). The Gourgou variety produced fewer pods (5.19 pods). The variety KVx780-6 also produced approximately the same number of pods (11.00 and 10.84 pods) in the two plots, PNT and PT respectively. Figure 7 below shows the evolution of pod production by variety in the two plots (PNT and PT).

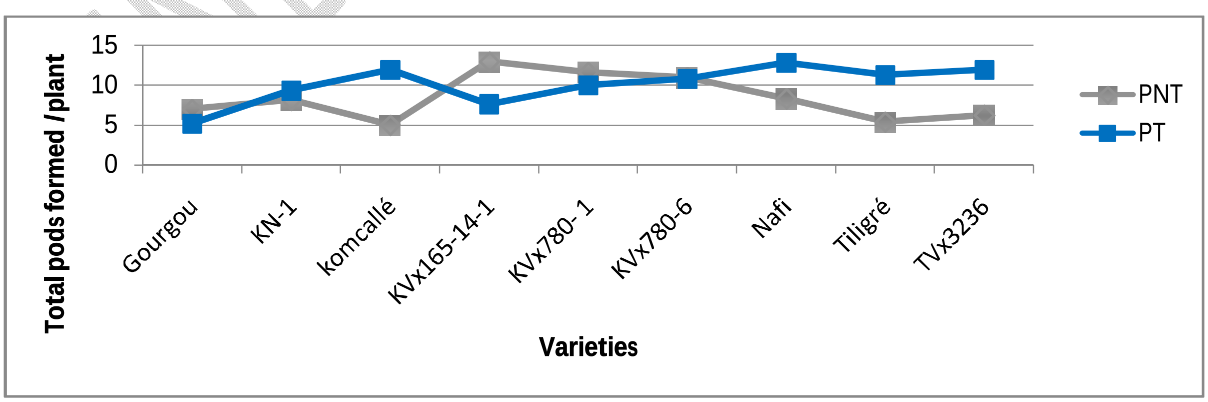

Figure 7: Pod production trends by variety in plots (PNT and PT)

- **Total number of aborted flowers and pods**

To assess the extent of thrips damage on the varieties used, this parameter seems to be the most important. To do this, the averages of observations on the lines used are taken into account in the analyses. A comparison of the total number of thrips counted and the number of aborted pods produced interesting results in each plot. In the plot (PNT), the thrips-susceptible control variety KN-1 recorded the highest number of pod losses (16.027 aborted pods), with a high thrips count per plant (26.14). This shows that thrips do indeed have a detrimental effect on flower production in this variety. The KVx165-14-1 variety also recorded the second highest number of thrips per flower and the second highest average number of aborted pods (14.08). TVx3236, on the other hand, had the lowest average number of thrips per flower (0.25), but recorded a high average number of aborted pods (10.96). This may be due to its high flower production per plant, which attracts other flower-eating insects (Maruca vitrata) to the plant. Figure 8 illustrates the loss of production in the PNT plot.

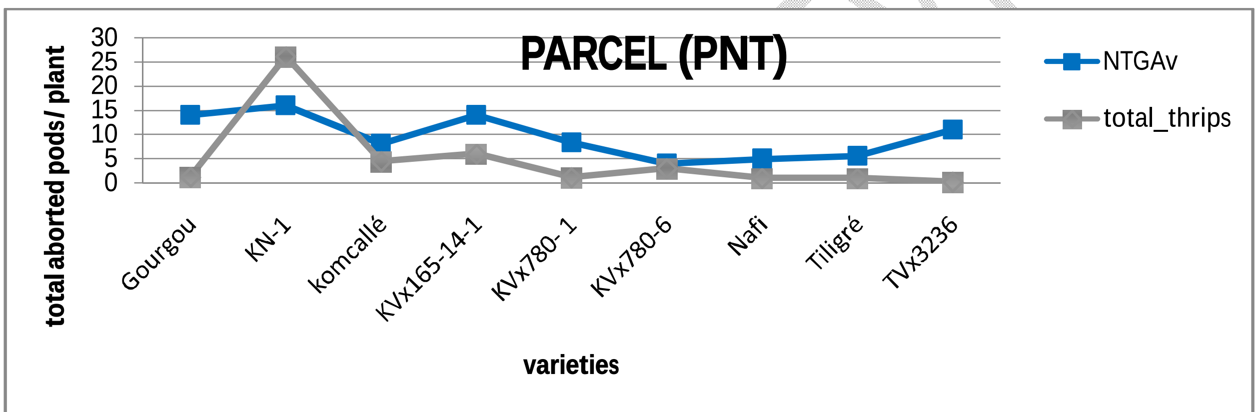

Figure 8: Evolution of aborted pods as a function of the total number of thrips in the untreated plot (PNT)

In the treated plot, too, the varieties with the highest number of thrips were generally those that lost the most pods, with the exception of TVx3236. This variety recorded a high number of aborted pods (38.02), but a low number of thrips per flower (1.79). This could also be explained by the fact that its higher flower production capacity attracts other crop pests such as *Maruca vitrata* larvae observed in the dissection of sampled flowers. Further experiments are therefore needed to determine the damage caused by these pests on this variety. The KN-1 variety, which attracts more thrips per plant, also records 24.66 aborted pods on average in line observations. It is followed by KVx165-14-1 (5.59 thrips per floret and 21.39 aborted pods) on average. For the other varieties, the difference in pod loss between these varieties is small in this plot. Figure 9 shows the number of aborted pods as a function of the total number of thrips counted per plant in the plot (PT).

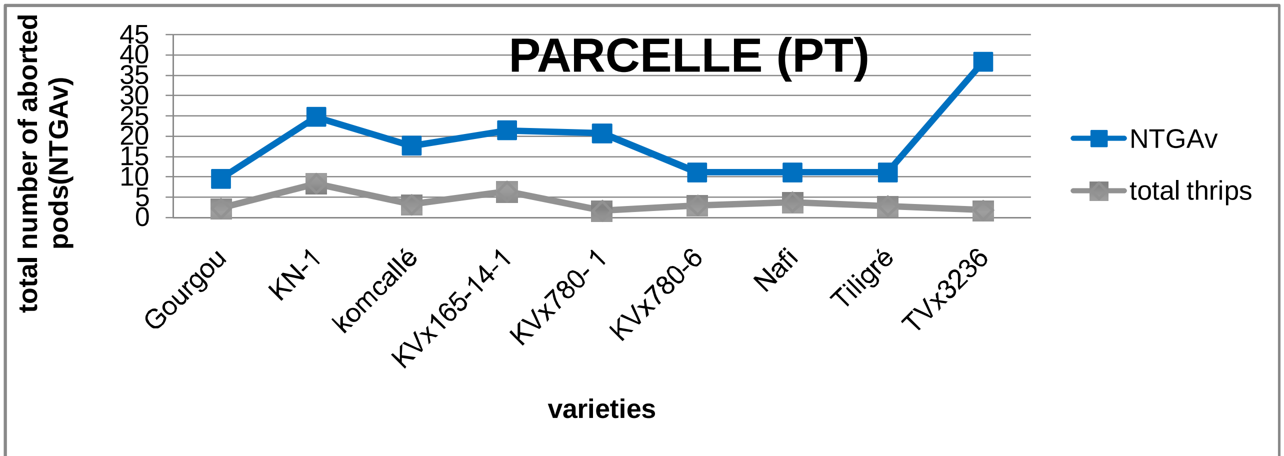

Figure 9: Trend in the number of aborted pods in the treated plot (PT)

3.3- Assessment of observation criteria

To assess the thrips resistance of the various inputs, all the criteria relating to the total number of thrips, the production of fruiting peduncles and stalks, and the production of flowers and pods in plots without protection (PNT) and with insecticide protection should be compared in terms of relevance. Analysis of the correlation between these measured parameters showed interesting results. In the PNT plot, the correlation coefficient between the total number of thrips per plant (TT/pl) and the total number of aborted pods (NTGAv) was positive (0.0825*). This explains why pod abortion per plant increases as the number of thrips in the flower increases. However, pod formation evolved in the opposite direction to the increase in thrips in the flowers, hence the existence of a negative correlation coefficient between the total number of thrips per plant and the total number of pods formed (-0.0062*). We also found that pod loss increased with the number of thrips per flower (0.7619). The parameters measured can be considered reliable for estimating the effect of thrips on the varieties used.

In the treated plot (PT), the correlation coefficients between the calculated parameters were also significant. The correlation coefficient between the total number of thrips per plant (NTT/pL) and the number of pods aborted was positive (0.314*). This also shows that pod loss increases as the number of thrips in the plant's flowers increases. However, pod formation decreased as the total number of thrips per flower increased (negative correlation -0.2119). These parameters can also be used to assess the resistance of varieties to thrips.

4. DISCUSSION

The aim of our study is to evaluate the genotypes of a number of cowpea varieties for thrips resistance in Burkina Faso, by comparing the varieties tested (KN-1, KVx165-14-1, KVx780-1, KVx780-6, Nafi, Gourgou, Tiligré, Komcallé) against TVx3236, considered to be resistant to thrips populations. Among the criteria measured, the total number of thrips per flower, the total number of flowers produced and the total number of flowers and pods aborted proved relevant for evaluating these genotypes and comparing varieties. The percentage of flowers aborted was 40.91% and 52.90% respectively in the treated (¨PT) and untreated (PNT) plots. These results confirm earlier work by Ndoyeand al, 1984 in Bambey, which showed that thrips damage is manifested by abortion and then flower drop (the percentage of drop was 51.15% and 80.46%, respectively in plots with and without phytosanitary protection).

In terms of the total number of thrips per flower, the results showed that KN-1, initially considered a thrips-susceptible control, was highly susceptible compared with the other varieties.

KVx165-14-1, considered a tolerant control, is ranked second in terms of thrips population. Its tolerance will be discussed at production level. Tvx3236, identified as resistant to thrips, ranked last in terms of sensitivity compared with the other varieties tested. This position confirms the work of SINGH, 1987 and SALIFU et al., 1988) which showed that this variety is resistant to thrips populations. These results also confirm the susceptibility of KN-1, the tolerance of KVx165-14-1 and the resistance of TVx3236 (SAFGRAD, 1982 and SAFGRAD, 1983). For varieties currently being popularized in Burkina Faso, KVx780-1 is less susceptible to thrips than KVx780-6. For those released in 2012, Nafi is less susceptible to thrips, followed by Tiligré then Gourgou and finally Komcallé in terms of thrips population.

In terms of pod production, the results showed that five (05) varieties stand out from TVx3236, the thrips-resistant control in the PNT plot. KVx165-14-1 produced more pods in this plot, showing that this variety tolerates a high thrips population. It is followed by the two varieties currently being popularized in Burkina Faso (KVx780-1 and KVx780-6) and two other varieties (Nafi and KN-1).

In the case of the varieties that have been popularized in 2012, the use of Nafi compared with the others (Komcallé, Gourgou and Tiligré) will increase yield in thrips-preferred areas.

In the plot (PT) and in general, the use of insecticides led to an increase in pod production for thrips-susceptible varieties (KN-1, Komcallé, Nafi and Tiligré). The Nafi variety produced more pods than the thrips-resistant control TVx3236.

A review of production levels in the two plots shows that the KVx780-6 variety may have sources of thrips tolerance. This variety maintained its production level in both plots. In the case of the varieties that have been popularized in 2012, the use of Nafi compared with the others (Komcallé, Gourgou and Tiligré) will increase yield in thrips-preferred areas. In the plot (PT) and in general, the use of insecticides led to an increase in pod production for thrips-susceptible varieties (KN-1, Komcallé, Nafi and Tiligré). The Nafi variety produced more pods than the thrips-resistant control TVx3236. A review of production levels in the two plots shows that the KVx780-6 variety may have sources of thrips tolerance. This variety maintained its production level in both plots.

5. CONCLUSION

Losses caused by thrips in cowpea cultivation are considerable. This constraint, added to the damage caused by other cowpea insects, threatens the food security of several million people in West Africa. For the evaluation of cowpea genotypes for resistance to thrips, the results enabled us to discriminate between varieties according to their susceptibility to thrips, in the following order (from most to least susceptible): KN-1, KVx165-14-1, Komcallé , KVx780-6, Gourgou ,Tiligré, Nafi, KVx780- 1 andTVx3236 .

For the number of total pods produced, the varieties are ranked in this order: KVx165-14-1, KVx780-1, KVx780-6, Nafi, KN-1, Gourgou, TVx3236, Komcallé, Tiligré.

The evaluation of varieties for resistance or susceptibility to thrips was an essential prerequisite for the development of appropriate breeding strategies, enabling the development of thrips-tolerant or thrips-resistant cowpea lines with interesting agronomic traits.

The results of this study led to the following conclusions and perspectives.

Concerning thrips susceptibility in terms of the size of the thrips population observed on flowers and pod production, the results show that: For varieties undergoing extension, line KVx780-1 showed much greater resistance to thrips than KVx780-6.

Comparing the varieties popularized in 2012, the Nafi variety is more resistant than the other varieties (Tiligré, Gourgou and Komcallé).

With regard to the controls used, the results confirmed the susceptibility of KN-1, the tolerance of KVx165-14-1 and the resistance of TVx3236.

In addition, KVx780-6 proved to be thrips-tolerant after KVx165-14-1, the thrips-tolerant control. Despite an average population of 0.79 and 0.66 thrips per flower in PNT and PT respectively, it was able to maintain its pod production (11 and 10.84 pods) in both PNT and PT plots.

In terms of future prospects, it would be interesting not only to repeat this study in the farming environment to confirm or invalidate the trends observed in this trial.

In addition, a possible cross could be envisaged between varieties that produced more pods in the presence of a high thrips population and varieties that proved tolerant or resistant to thrips.

Many other lines of research could also be explored, including the mode of inheritance of the thrips resistance gene. This study will enable us to search for molecular markers linked to this gene. All of which will enable marker-assisted selection for this thrips resistance gene.

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