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Impact of *Phragmanthera capitata* (Sprenge.) Balle on pod and beans production of two Cocoa clones in Nkoemvone seed fields (South Cameroun)

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Abstract

Theobroma cacao L. known as cocoa plant is a cash crop for all producing countries, and a significant source of income for agricultural families. In Cameroon, cocoa production is threatened by parasitic vascular plants belong to Loranthaceae. Among those parasitic vascular plants *Phragmanthera capitata* (Spreng.) Balle is the most abundant species. This parasitic plant causes severe damages to cocoa plants in Nkoemvone seed fields. The main purpose of this research was to find out if *Phragmanthera capitata* attack has an impact on the number and weight of pods produced. The experiment was done on two cocoa clones SNK 64 and UPA 143 from 2016 to 2018.Student t test was used to compare the production of pods, the weight of pods; the number of beans produced per pod as well as their weight between parasitized and non-parasitized cocoa plants. A total of 1280 cocoa plants belonging to all cocoa clones in the area were randomly selected and divided in two groups, parasitized and non-parasitized cocoa plants. The study results indicated the number of cocoa plants without pods in parasitized cocoa plants (468 cocoa plants , 73.12% in 2016; 468 cocoa plants, 73.12% in 2017 and 479 cocoa plants, 74.84% in 2018; χ^2= 0.650; ddl = 2 and p = 0.7312) is higher than the number of cocoa plants without pods in non-parasitized ones (265 cocoa plants, 41.41% in 2016; 243 cocoa plants 37.96% in 2017 and 231 cocoa plants, 36.09% in 2018; χ^2= 3.925; ddl = 2 and p = 0.139). Concerning the quantity of beans produced by pods, the results revealed that there is no significant difference between parasitized cocoa and non-parasitized ones.

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Introduction

Cocoa (*Theobroma cacao* L.) is an important cash crop in Cameroon. The country is the fifth world producer, and nearly 75% of the population, mostly peasant farmers derive their livelihood from the crop (Tcharbuahbokengo, 2015). In Cameroon, cocoa is mainly cultivated in two agro-ecological zones: the mono-modal humid forest zone and the bimodal humid forest zone. The bimodal humid forest zone produces more than 70% of Cameroonian exports of cocoa (Ngala., 2015). Being an exotic product in most of its production areas, cocoa has contracted several diseases which are caused by pathogens and ravagers, against which it does not dispose appropriate defense mechanism. It consequently leads to considerable production losses and thus explains the small productivity (Nganti *et al*., 2018).

Among pathogens and ravagers which attack cocoa, there are vascular parasites belonging to Loranthaceae. The Loranthaceae, are small chlorophyllous epiphytic shrubs living as hemiparasites on branches of wild or cultivated trees (Polhill & Wiens ,1998). These hemiparasites look like clumps ones anchored (Balle, 1982). The tufts of such plants are anchored in the wood of the host through a specialized organ, the haustorium, which establishes functional connections with the host vascular tissues. Through the haustorium, the parasite absorbs water, mineral salts and organic matter required for it development from the host (Kuijt 1969; Sallé *et al*., 1998).

Loranthaceae is widespread and consists of 77 genus and 950 species (Polhil and Wiens, 1998). In Cameroon, they are represented by 26 species in seven genera. Among these species, *Phragmanthera capitata* (Spreng.) S. Balle is the most abundant and attacks most of cultivated or spontaneous trees (citrus fruits, avocado trees, cocoa trees, coffee trees and guajava trees) whose fruits are marketed and exported (Dibong *et al*., 2009).

The infestation of cocoa trees by Loranthaceae is one of the main phytosanitary problems encountered in Cameroon, especially within the main seed field located at Nkoemvone in south Cameroon where *Phragmanthera caipitata* is by far the most abundant parasite among the five species identified and represents 94.14% of identified Loranthaceae (Ondoua *et al*., 2015). Damages caused by Loranthaceae are difficult to assess because they affect both fruits and vegetative apparatus with damages that can be accumulated over time. Despite numerous studies on these hemiparasite plants, few studies have focus on quantifying losses caused by these Loranthaceae on the trees and on the fruits (Dibong *et al*., 2009; Edagbo *et al*., 2013). The aim of this study was to assess the impact of *Phragmanthera capitata* attack on cocoa plants especially on the number and weight of cocoa pods produced in Nkoemvone seed fields.

Materials and methods

Study area

Nkoemvone houses the main Cameroonian cocoa seed production station. This seed production station belongs to the state company in charge of developing cocoa in Cameroon (SODECAO). The choice of this site was motivated by the high frequency of Loranthaceae in seed fields and increasingly significant yield losses. This station contains 11 biclonal fields, 22extends over 50 ha and produces more than 200,000 pods per year. The study was done in seed field number two.

Nkoemvone is located in the south region of Cameroon, between 11.1° - 12.2° longitude West and between 2.4° - 2.8° North latitude, at 630m of altitude and 15 km from Ebolowa on the Ebolowa - Ambam road (Fig. 1). This site is submitted to a humid and equatorial climate with four seasons; a long dry season (December - March), a short dry season (June - August), a long rainy season (September - November) and a short rainy season (April - May). Its precipitations reach 1755 mm and the average temperature is 25.5° C (Fines *et al*., 2001).

Evaluation of the impact of Phragmanthera capitata on cocoa plants production

To determine the impact of *P. capitata* on cocoa plants, the diameter (cm) of different plants (parasitized and non-parasitized) were measured at breast high and all the data were collected below that level. Two cocoa plant clones were chosen because of their higher infestation by Loranthaceae, SNK 64 and UPA 143 (Ondoua *et al.*, 2015). This evaluation was done in the seed fields whose origin and characteristics of different clones were perfectly known.

Impact of P. capitata on the number of pods produced

A total of 1280 cocoa plants belonging to SNK64 and UPA143 were randomly selected and followed for 3 years (From 2016 to 2018). These 1280 cocoa plants were divided in two groups. (1) 640 parasitized cocoa plants and (2) 640 non-parasitized cocoa plants. Concerning the parasitized plants only cocoa plants having between 3 and 5 tufts of *P. capitata* were selected. Each year the number of pods produce by each cocoa plant was recorded.

Impact of P. capitata on the number of bean produced and weight per pod

For the two clones SNK 64 and UPA 143, 177 pods for parasitized cocoa plants and 177 pods for non-parasitized cocoa plants were selected for each clone among the 1280 cocoa plants. For the parasitized cocoa plants only those which had 5 tufts of *P. capitata* were selected. Each pod was then opened with a knife without wounding the beans, beans were extracted and counted. After extraction, beans were weighed with a sensitive balance to obtain their fresh weight, then put in envelops and kept in the oven at 105°C for 72 hours. After 72 hours the beans were weighed again to obtain their dry weights. All these processes were done in 2017 and repeted in 2018.

Impact of P. capitata on pods weight

Forty five pods belonging to parasitized cocoa plants and 45 pods belonging to non-parasitized ones for each clone (SNK 64 and UPA 143) were randomly selected among cocoa plants having 5 tufts of *P. capitata*. Those pods were weighted and results were compared.

Data analysis

Proportion statistical analysis were done using Stat Xact software version 3.1 while Sigma Stat version 2.03 was used to compare quantitative series. The simultaneous comparison of many quantitative data series were done using ANOVA one way test followed by analytic comparisons by Student-Newman-Keuls when normality conditions and variance equality were verified.

Results

Impact of Phragmanthera capitata (Spreng.) Balle on the weight and the number of pods produced

Impact on the number of pods produced

Results show a significant difference between the number of pods produced by the parasitized and non-parasitized cocoa plants. Indeed, out of 640 parasitized cocoa plants checked, it was noted that each year, and for the 3 years, a high percentage of parasitized plants did not produce pods at the breast height (Fig. 2). The number of cocoa plants without pods in parasitized cocoa plants (468 cocoa plants , 73.12% in 2016; 468 cocoa plants, 73.12% in 2017 and 479 cocoa plants, 74.84% in 2018; χ^2= 0.650; ddl = 2 et p = 0.7312) was higher than the number of cocoa plants without pods in not parasitized ones (265 cocoa plants, 41.41% in 2016; 243 cocoa plants 37.96% in 2017 and 231 cocoa plants, 36.09% in 2018; χ^2= 3.925; ddl = 2 et p = 0.139) below the diameter at the breast height (exact test of Fisher: p<0.001) as shown in Fig. 2.

Whatever the year of the survey, the percentage of cocoa plants without pods below the diameter at the breast height was significant higher in parasitized cocoa plants than non-parasitized ones (Fig. 2). This result suggests that the presence of *Phragmanthera capitata* (Spreng.) Balle contibute to reduce the outcome of parasitized cocoa plants (exact test of Fisher: p<0.001).

Impact of P. capitata on the number of bean produced per pod.

For the SNK 64 the results revealed that for the year 2017, 32.24 ± 0,12 beans were produced for non-parasitied and 32.26 ± 0.12 for parasitized ones (t = 0.164; ddl = 352; p = 0.870 ns) and in 2018 there were 32.23 ± 0,10 for non-parasitized and 32.20 ± 0,10 for parasitized.

The quantity of beans contained in the pods from cocoa plants of SNK 64 clone, collected at 1.3 m above the ground, did not vary in 2017 and 2018 between non-parasitized and parasitized. Similar results were obtained with UPA 143 (39.58 ± 0,07 for non-parasitized and 39.55 ± 0,12 for parasitized ones; t = 0.327; ddl = 352; p = 0.744 ns in 2017) and in 2018; 39.58 ± 0,09 for non-parasitized and 39.58 ± 0,09 for parasitized ones (t = 0.183; ddl = 352; p = 0.855 ns) leading to a conclusion that *P. capita* does not have any impact on the number of beans produced whatever the clone.

Impact of P.capitata on the dry weight of beans

The survey results showed that there was a significant difference between the dry weight of beans from non-parasitized and parasitized ones whatever the clones. For SNK 64, the results showed 80.9 ± 3,3g for non-parasitized plants and 31.0 ± 1,1g for parasitized ones (t = 14,308; ddl = 88; p<0,001 ***).

Concerning the UPA 143 clone the results revealed 12.1± 0.7g for parasitized and 50.3± 1.8g for non-parasitized cocoa plants (t = 20.146; ddl = 88; p<0.001 ***) .

Impact on pods weight

The presence of *P. capitata* on the 2 cocoa clones SNK 64 and UPA 143 had a significant impact on pod weight and data between parasitized and not parasitized cocoa plants confirm the impact as shown on Tables 1-C and 1-D. For SNK 64 the results showed 394.4 ± 15.6g for non-parasitized plants and 325.3 ± 9,5g for parasitized ones (t = 3.780; ddl = 88; p<0.001 ***).

Concerning the UPA 143 clone the results revealed 318.4± 11.1g for parasitized and 261.8± 8.8g for non-parasitized cocoa plants (t = 4.014; ddl = 88; p<0.001 ***).

Impact of P. capitata (Spreng.) Balle on the quantity of beans

Impact on beans quantity per pod

The quantity of beans produce by pods of SNK 64 below the diameter at the breast height varids slightly in 2017 and 2018 between parasitized and non-parasitized cocoa plants. Statistical differences in all cases were not significant (Table 1-A) suggesting that the presence of *P. capitata* does not have any impact on the number of beans produced per pod. Similar results were obtained for UPA 143 (Table 1-B). Differences in all cases were not significant (Table 1-B) indicating that whatever the clone *P. capitata* does not have any impact on the number of pods produced.

Comparison between SNK 64 and UPA 143 showed that in 2017 whatever the status of the cocoa plant (parasitized or non-parasitized), pods from UPA143 clone had more beans than SNK 64 clone (Student test for non-parasitized cocoa plants: t = 51.278; ddl = 352; p <0.001; student test for parasitized cocoa pants: t = 51.773; ddl = 352; p <0.001). In 2018 results obtained were similar to those in 2017 (Student test for non-parasitized cocoa plants: t = 54.715; ddl = 352; p <0.001; student test for parasitized cocoa pants: t = 55.297; ddl = 352; p <0.001). Those observations suggest that whatever the status of the plant, UPA 143 clone is more productive than SNK 64.

Impact on beans weigh

The presence of *Phragmanthera capitata* on the 2 cocoa clones SNK 64 and UPA 143 has a considerable impact on beans weight and data between parasitized and non-parasitized cocoa plants confirm the impact and show significant results (Tables1-C and 1-D).

For SNK 64 concerning the fresh weight results showed 170.7 ± 7.1g for non-parasitized plants and 129.3 ± 4.4g for parasitized ones (t = 4.945; ddl = 88; p<0.001 ***) while in dry weight the results showed 80.9 ± 3.3g for non-parasitized plants and 31.0 ± 1.1g for parasitized ones (t = 14.308; ddl = 88; p<0.001 ***).

Concerning the UPA 143 clone the fresh weight results showed 108.7 ± 4.1g for non-parasitized plants and 60.6 ± 2.7g for parasitized ones (t = 9.872; ddl = 88; p<0.001 ***) while in dry weight the results showed 50.3 ± 1.8g for non-parasitized plants and 12.1 ± 1.1g for parasitized ones (t = 20.146; ddl = 88; p<0.001 ***).

The difference between water content of beans from parasitized and non-parasitized cocoa plants is also significant.

The water content in beans from non-parasitized cocoa plants is higher than water content in beans from non-parasitized cocoa plants.

Table 1. Variation of pods and beans produced on non-parasitized cocoa plants and parasitized cocoa plants by *Phragmanthera capitata* (Spreng.) Balle from Nkoemvone seed fields

	Non-parasitized cocoa plants				Parasitized cocoa plants				Student t test
	n	Min.	Max.	Average ± SE	n	Min.	Max.	Average ± ES	
Diameter of cocoa plants (cm)	640	5.62	14.23	10.27 ± 0.09	640	5.10	14.97	10.35 ± 0.09	t = 0.613; ddl = 1278; p = 0.540 ns
A. Number of beans inside SNK 64 pods collected below the diameter at breast height									
Beans production in 2017	177	30	34	32.24 ± 0,12	177	30	34	32.26 ± 0.12	t = 0.164; ddl = 352; p = 0.870 ns
Beans production in 2018	177	30	34	32.23 ± 0,10	177	30	34	32.20 ± 0.10	t = 0.158; ddl = 352; p = 0.875 ns
Cumulative beans of 2 years	354	30	34	32.23 ± 0,08	354	30	34	32.23 ± 0,08	t = 0.025; ddl = 706; p = 0.980 ns
Student t test comparison	t = 0.071; ddl = 352; p = 0.944				t = 0.397; ddl = 352; p = 0.692 ns				//
B. Nomber of beans inside UPA 143 pods collected below the diameter at breast height									
Beans production in 2017	177	38	42	39.58± 0.07	177	36	42	39.55 ± 0.07	t = 0.327; ddl = 352; p = 0.744 ns
Beans production in 2018	177	35	42	39.58 ± 0.09	177	36	42	39.55 ± 0.09	t = 0.183; ddl = 352; p = 0.855 ns
Cumulative beans of 2 years	354	35	42	39.58 ± 0,06	354	36	42	39.55 ± 0.06	t = 0.351; ddl = 706; p = 0.726 ns
Student t test comparison	t = 0.0495; ddl = 352; p = 0.961				t = 0.0496; ddl = 352; p = 0.960 ns				//
C. Pods and beans weight produced by SNK 64 cocoa plants clone									
Pods weight (g)	45	260	640	394.4 ± 15,6	45	220	460	325.3 ± 9,5	t = 3,780; ddl = 88; p<0.001 ***
Beans fresh weight (g)	45	100	280	170.7 ± 7,1	45	80	220	129.3 ± 4,4	t = 4,945; ddl = 88; p<0.001 ***
Bean dry weight (g)	45	48	129	80.9 ± 3,3	45	19	46	31.0 ± 1,1	t = 14,308; ddl = 88; p<0.001 ***
Beans water content (g)	45	49	153	89.8 ± 3,8	45	61	114	98.3 ± 3,5	t = 1,652; ddl = 88; p = 0.001 ***
D. Pods and beans weight produced by UPA 143 cocoa plants clone									
Pods weight (g)	45	220	500	318.4 ± 11,1	45	190	470	261.8 ± 8,8	t = 4.014; ddl = 88; p<0.001 ***
Beans fresh weight (g)	45	70	190	108.7 ± 4,1	45	30	120	60.6 ± 2,7	t = 9.872; ddl = 88; p<0.001 ***
Beans dry weight (g)	45	35	87	50.3 ± 1,8	45	6	25	12.1 ± 0,7	t = 20.146; ddl = 88; p<0.001 ***
Beans water content (g)	45	33	103	58.4 ± 2,3	45	24	95	48.5 ± 2,1	t = 3.176; ddl = 88; p = 0.002 ***

Percentages are calculated in relation to the total number of sélected cocoa plants and followed during the 3 years of the study. ns = Not significant (p>0.05); *** = highly significant (p<0.001) SE= Standard Error

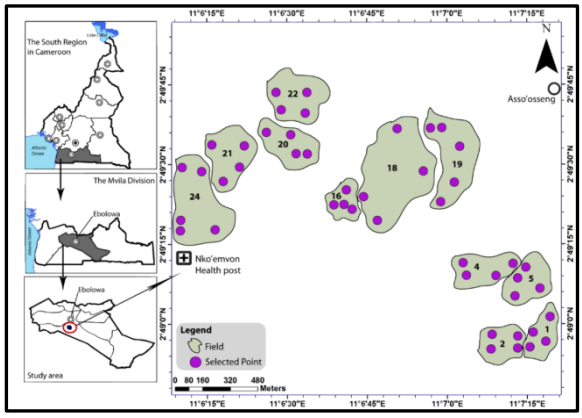

Fig. 1. Location of cocoa seed fields at Nkoemvone.

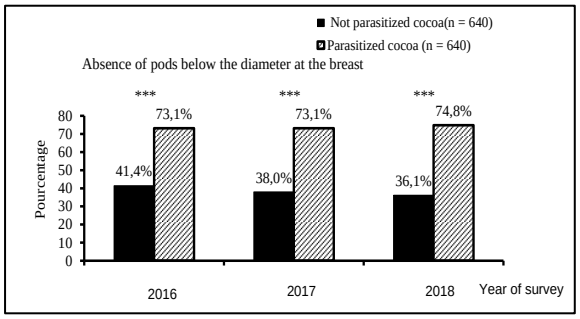

Fig. 2. Percentage variation of parasitized and non-parasitized cocoa plants below the diameter at the breast height in Nkoemvone seeds fileds. *** = highly significant differences.

Discussion

Impact of Phragmanthera capitata (Spreng.) Balle on cocoa production

Pods production

The results of the study indicated that *Phragmanthera capitata* has a significant impact on pods production. There was a difference between parasitized cocoa and non-parasitized cocoa plants. This difference was important regardless of the clone and was greater than 60%. These results were in conformity with the work of Edagbo *et al.*, (2013), who showed that the rate of fruits productivity is generally higher on non-parasitized plants than parasitized ones. The productivity difference between parasitized and not parasitized cocoa plants shows the impact of *P. capitata* on cocoa plants. It has been

reported that in addition to the fruits productivity decline, sensitive hosts to Loranthaceae show generally reduced foliage, architectural damages and a reduction in branches (Howell & Mathiassen, 2004). Others authors have reported that among the factors influencing pod production in cocoa are Loranthaceae (Cilas, 1991; Cilas *et al.*, 1999; Sounigo *et al.*, 2003).

These authors also said that, to increase pods production, it is necessary to implement good agricultural practices and a better diseases control.

Number of beans produced

Results obtained comparing two clones parasitized and non-parasitized cocoa plants showed that there is not any difference among them. For UPA 143, around 40 beans per pod were comptabilized both for parasitized and non-parasitized cocoa plants. SNK 64 showed similar results and 32 beans were recorded both for parasitized and non-parasitized. The different results showed that *P. capitata* plants does not affect seed production per pod. These results are consistent with findinds of Cilas *et al.* (2010) who showed that number of beans per pod depend on several factors such as the number of ovules per ovary, the ovary fertility and the ability of clones to be polinised.

Beans and pods weight

Impact of *P. capitata* plants on pods and bean weight was significant whatever the clone. The reduction percentage of *P. capitata* on cocoa plant was around 17.5% on pods weight. This reduction percentage varied from different clones. Concerning pods dry weight; it was 76% for UPA 143 clone and 61.7% for SNK 64 clone. These results showed that beans weight is not link to hereditary factors but link to environmental factors (Cilas *et al.*, 2010).

Conclusion

Phragmanthera. *capitata* has a considerable impact on cocoa plants, it affects cocoa plants performance. *P. capitata* reduce the production of pods considerably, this reduction may reach 80%. *P. capitata* also has an impact on pods weight and on beans fresh and dry weight. The impact on the fresh and dry weight varies according to the clones, however the parasitism by *P. capitata* has no effect on the number of beans produced for each pod. This impact on cocoa production requires that we should become aware of the extent of the damage that these hemiparasites can cause at the plantation scale, and that adequate control measures are considered, particularly in the search for varieties resistant to these plants.

References

Balle S. 1982. Loranthaceae, Flore du Cameroun, Vol. 23, Sabatié B, Leroy JF, Yaoundé

Cilas C, Mochado R, Motamayor JC. 2010. Relations between several traits linked to sexual plant reproduction in *Theobroma cacao* L.: number of ovules per Ovary, number of seeds per pod, and seed weight. Tree Genetics & Genomes **6,** 219-226.

Cilas C, Paulin D, Clément D, Baradat Ph. 1999. Selection multi-caractères dans un plan factoriel de croisement en Côte d'Ivoire. Définition d'un index de selection. In : Proc. 12e conference international sur la recherché cacaoyère, 20-25 Octobre 1996, Salvadore de Bahia, Brazil 411-416.

Cilas C. 1991. Estimation de quelques paramètres génétiques pour différents plans de croisement chez lz cacaoyer. Café, Cacao, Thé **35,** 3-14

Dibong SD, Engone Obiang NL, Din N, Priso RJ, Taffouo VD, Fankem H, Sallé G, Amougou A. 2009. Niveau d'infestation des arbres fruitiers des groupements végétaux par *Phragmanthera capitata* (Sprengel) S. Balle (Loranthaceae) dans la région littorale du Cameroun. International Journal of Biological and Chemical Science **3,** 347-354.

Edagbo DE, Ighere DA, Michael C. 2013. The influence of African mistletoe (*Tapinathus bangwensis*) on the conservation status and productivity of *Irvingia gabonensis* in Moor plantation area of Ibadan, Nigeria. Green Journal of Agricultural Sciences **3,** 743-747

Fines JP, Ngibaot F, Ngono G. 2001. Aconceptual forest management plan for a medium size forest in southern Cameroon. Tropenbos Cameroon 185 p.

Howell BE, Mathiasen RL. 2004. Growth impacts of *Psittacanthus angustifolius* Kuijt on *Pinus oocarpa* Schiede in Honduras. Forest Ecology and Management **198,** 75-88.

Kuijt JL. 1969. The Biology of Parasitic Flowering Plants, University of Calofornia press, Berkeley, Los Angeles 246p

Ngala TJ. 2015. Effect of shade trees on cocoa yield in small-holder cocoa (*Theobroma cacao*) agroforests in Talba, Centre Cameroon. University of Dschang 64p

Nganti MD, Ambang Z, Essouma MF, Moutock F, Nourou KA, Pegalopo NA. 2018. Investigation about dieback in cocoa orchards in the bimodal humid forest zone of Cameroon. American Journal of Innovative Research and Applied Sciences 2429-5396I

Ondoua JM, Dibong SD, Taffouo VD, Ngotta Biyon JB. 2015. Parasitisme des champs semenciers de cacaoyers pars les Loranthaceae dans la localité de Nkoemvone (Sud Cameroun). Journal of Applied Biosciences **85,** 7794-7803.

Pohill R, Wiens D. 1998. Mistletoes of Africa, The Royal Botanic, Kew: 370 p

Sallé G, Tuquet C, Raynal-Roques A. 1998. Biologie des Phanérogames parasites. Comptes rendus de Sociologie et de Biologie de France **192,** 9-36.

Souningo O, Coulibaly N, Brun L, N'Goran J, Cilas C, Eskes AB. 2003. Evaluation of resistance of *Theobroma cacao* L. to mirids in Côte d'Ivoire: results of comparative progeny trials. Crop Prot **22,** 615-621.

Tcharbuahbokengo N. 2005. Cocoa production in Cameroon. AFTA Conference Proceedings 4p.