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Control of green peach Aphid *Myzus persicae* (Sulzer, 1776) (Hemiptera: Aphididae) on Brassica plants

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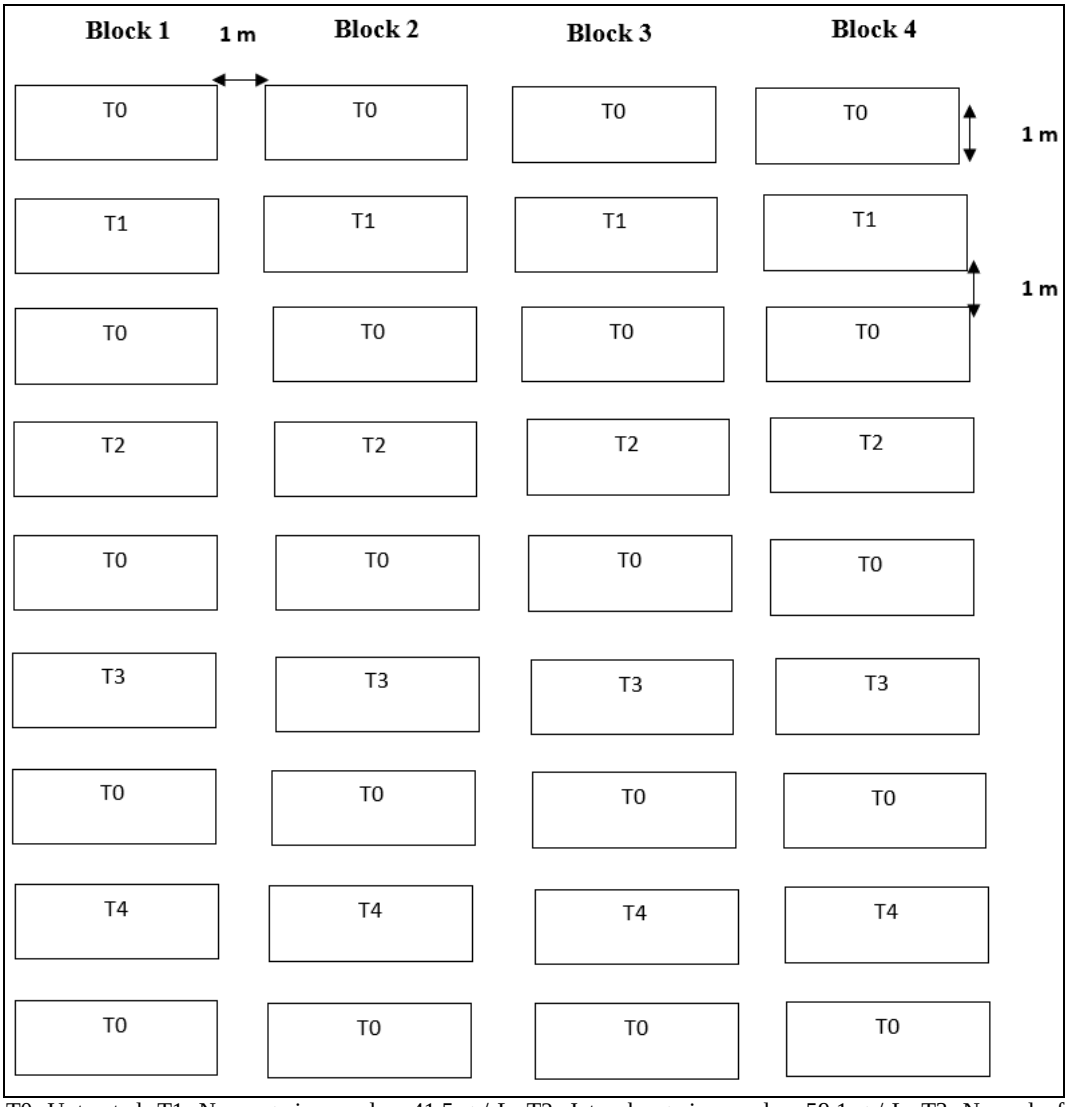
Abstract
The green peach aphid *Myzus persicae* (Sulzer) is an economically important pest of crucifer. We evaluated the efficacy of aqueous extracts of powder of grains and leaves neem *Azadirachta indica* (A. Juss) and a powder of jatropha curcas (*Jatropha curcas* L.) on the number of *Myzus persicae* (Sulzer) (P = 0.001) and on the cabbage yield (P = 0.001) in open field. All aqueous extracts of neem and of jatropha, and the insecticide Cypercal 50 EC (50 g / L of cypermethrin) have the same efficacy against *Myzus persicae*. Furthermore, only the aqueous extracts of neem grain powders 41.5 g / L increased yield (73 T/ha) compared to Cypercal 50 EC (45.5 T/ha). The aqueous extracts of neem leaf 67 g/ L (47.5 T/ha) had a similar efficacy to Cypercal 50 EC (45.5 T/ha). In addition, the aqueous extracts of jatropha grain powders 59.1 g/L gave a lower yield (39.25 T/ha) than that of the insecticide Cypercal (45.5 T/ha). Thus, aqueous extracts of neem grain powders 41.5 and neem leaf pulp 67 g/L can replace the insecticide Cypercal against *Myzus persicae* in cabbage farm.

Keywords: myzus persicae, aphididae, biopesticides, polyphagous insect, hemiptera

1. Introduction
Cabbage *Brassica oleraceae* (Linné, 1883) is an important vegetable crops in Côte d'Ivoire. They are important sources of proteins and vitamins (Philouse and Latterot, 1992; Willcox *et al*., 2003) [31]. They are practiced today in all agiculture areas in Côte d'Ivoire (Sangaré *et al*., 2009) [25]. However, cultivating Brassica plants often faces obstacles from pests such as *Myzus persicae* (Sulzer) and diseases. In fact, the green peach aphid *Myzus persicae* (Sulzer) is economically important pest of Brassicaceae worldwide (Blackman, 1986; Gupta and Yadava, 1989; Tuncer *et al*., 2001; Sachin Gahatraj, 2019) [4, 14 1, 11]. *Myzus persicae* (Sulzer) is a polyphagous pest wich infects important crops like Brassica througout the world feeds. It consistently feeds at all stages of nymphs and adults (Lee *et al.,* 2012; Sachin Gahatraj, 2019) [18, 11] and greatly reduces yield and quality of produce. *Myzus persicae* gets nutrition from plant phloem sap using specialized sucking-type mouthparts (Blackman, 1986; Tuncer *et al*., 2001; Sachin Gahatraj, 2019) [4, 1, 11]. (Blackman, 1986; Gupta and Yadava, 1989) [4, 14]. They secrete saliva and it transmits many viruses. It also decreases the photosynthetic function of plants (Schulten, 1997; Aker and Tuncer, 2016) [26]. Yield losses can be as high as 100% (Ahmad *et al*., 2010; Aker and Tuncer, 2016) [26]. For the control of *M. persicae*, most of pesticides used by farmers are persistent and accumulate in water, on food, soil and air (Doumbia and Kwadjo, 2009; Harris *et al*., 2001; Baglieri *et al*., 2011) [10, 15, 3]. These pesticides are dangerous, decompose slowly in the soil and contaminate food (Baglieri *et al*., 2011) [3]. They cause neurological disorders resulting in neurodegenerative diseases such as Parkinson's and Alzheimer's (Baldi *et al*., 2003) [5] and are endocrine disruptors (Baglieri *et al*., 2011) [3]. They constitute an ecological, environmental and health threat. One alternative approach to crop disease control is the use biological agents as substitutes for synthetic pesticides.

In order to guarantee food safety for consumers and to protect the environment, the maximum limits for pesticide residues in food and water must be lowered. The use of biological control methods can reduce the negative influences on the agricultural environment and its surroundings that are associated with most conventional pesticides.

2. Materials and methods
2.1. Study area
Cropping trials were carried out in Koffikro (6 ° 38'55'' North, 4 ° 11'57" West), located in the East of Côte d'Ivoire. The experimental design was a Fisher block with four replications. Each unit plot measuring 5 m on 1 m and all of the plots were separated from 1 m. Each elementary plot has 3 rows of 12 plants spaced to 0.40 m. The lines are arranged in a direction of the length of parcels (Fig.1).



T0: Untreated; T1: Neem grain powders 41.5 g / L; T2: Jatropha grain powders 59.1 g / L; T3: Neem leaf pasta 67 g / L; and T4: Cypercal 50 EC

Fig 1: Detail of the experimental plot arrangement (Randomized blocks)

2.2. Preparation of aqueous extracts of neem and jatropha, and of the insecticide Cypercal

The seeds and leaves of neem and jatropha seeds were collected during the day. The neem and jatropha seeds were dried in the shade for four weeks at room temperature (30 ± 2º C) and at a relative humidity of 72 ± 5% (Rani and Rajasekharreddy, 2009; Gnago *et al*., 2010) [24, 9].

For the preparation of the aqueous extracts, 41.5 grams of neem seed powder (T1) or 59.1 grams of jatropha powder (T2) are obtained respectively from 80 grams of neem seeds or jatropha, stripped of their shell then finely grounded in a mortar to obtain a packed powder using a 500 µm sieve (Rani and Rajasekharreddy, 2009; Tamgno and Tinkeu, 2014) [24]. Each ground product is macerated in 10 L of tap water. During maceration, the products are stirred manually every 2 hours using a stick. After 24 hours of maceration, the solutions are filtered through a very fine mesh sieve (Table 1).

For the preparation of macerates of neem leaves, the harvested leaves are immediately washed and then grounded in a mortar until a paste is obtained (N'Diaye and Seck, 1997; Bambara and Tiemtoré, 2008) [21, 6]. This paste is weighed (67 grams: T3) and introduced into a bucket containing water with a dose of 1 kilogram for 15 liters of water. The mixture is stirred vigorously every two hours. After three days of maceration, the solution is also filtered through a clean white cloth (Table 1).

The different filtrates obtained were distributed in 20 L cans, labeled and hermetically sealed. These filtrates were used for the different treatments of the plots.

Pesticide used in this study is Cypercal (50 EC, AF- CHEM SOFACO, Côte d'Ivoire). The active ingredient of Cypercal 50 EC is cypermethrin ($C_{22}H_{19}Cl_2NO_3$). They belong to the family of synthetic pyrethroids and EC formulation. The recommended dose is 40 mL in 15 L (T4) of water to 400 m^2. These are foliar insecticides acting by contact and ingestion (Table 1).

Table 1: Treatments applied to plots of Koffikro cabbage

Treatment	Abbreviation	Koffikro
Untreated	T0	0
Aqueous extract of neem seeds powders	T1	41,5 g/L
Aqueous extract of jatropha seeds powder	T2	59,1g/L
Aqueous extract of neem leaves powders	T3	67 g/L
Cypercal	T4	50 EC

2.3. Application of treatments

Using a backpack sprayer, the aqueous extracts of neem and

jatropha and the insecticide Cypercal were used for foliar applications of cabbage plants weekly from 6 am to 8 am (Nyasani *et al*., 2008; Gnago *et al*., 2010) [22, 9]. The first foliar applications in the field were made on the 26*th* day after transplanting the plants. The 10 L biopesticide treatable area is 200 m2 (Bambara and Tiemtoré, 2008) [6]. Only the control plots are not treated.

The spray calibration operations made it possible to determine the spray width, the nozzle flow rate, the applicator advancement speed and the spray volume applicable per hectare. Thus, the volume of spray applied to a plot of area P (VBP) was calculated from the following formula: VBP (L) = Dm (L / mn) x 600 x A (m2) / (Lm (m) x 10,000 x VA (km / h)) (Weber, 1982) [30], with: VBP: Volume of spray mixture applicable to a plot of area P; Lm: average spray width; Dm: nozzle flow rate; Tm: average journey time; VA: advancement speed of the applicator.

To apply the chosen slurry volume, we act on the parameters Dm, Lm and VA (Weber, 1982) [30].

2.4. Field efficacy trial

Myzus persicae adults were counted on cabbage *Brassica Oleracea*. *Myzus persicae* started on the 26th day after transplanting and ended on the 47th day after transplanting the cabbage plants. In fact, during this period, the levels of infestations of these pests are generally more visible. They were carried out from 6 am to 8 am weekly three days after each treatment on 10 plants in the central line of each elementary plot. The first survey was carried out one day before the first treatment. During each observation, the undersides of the upper leaves of the cabbage plants were observed to ensure the presence or not of *Myzus persicae* and its size was noted.

A total of 4 readings were taken and the number of *Myzus persicae* for each treatment was noted.

2.6. Production evaluation

The yields were evaluated from the weight of the cabbage plants by one square meter and is reduced to the hectare (R) by treatment according to the following formula: R (kg / ha) = P (kg) x 10,000 / S (m2) where P is the total weight of ripe cabbage harvested from an area S. They then brought back in tons per hectare.

2.7. Data analysis

Data of the frequency of *Myzus persicae* on cabbage plants in the field and the yield of treatments were analyzed using SPSS software, version 22.0 and XLSTAT 2016. The frequency of *Myzus persicae* on cabbage plants and the yield of treatments were subjected to an analysis of variance (ANOVA main effect) at the threshold of 5 % and the means discriminated with the Fisher test (LSD) using SPSS software, version 22.0.

3. Results

3.1. Calibration

The data collected during this calibration operation are the spray width, the nozzle flow rate, the applicator speed, the spray volume applicable per hectare and the product volume per 10 m2. When the average spray width, the nozzle flow; the forward speed of the applicator are 0.6 m, 0.45 L / min and 0.3 km / h respectively, the spray volume applicable per hectare is 1,500L and the spray volume applicable at 10 m2 is 1.5 L (Tab. 2).

Table 2: Values of the sprayer calibration parameters

Parameter	Value
Lm	0, 6 m
Dm	0,45 L/min
Tm	60 s
VA	0,3 km/h
VBAH	1 500 L/ha
VBP	1,5 L

Lm: average spray width; Dm: nozzle flow rate; Tm: average journey time; VA: advancement speed of the applicator; VBAH: Volume of spray mixture applicable per hectare; VBP: Spray volume applicable to 10 m2

3.2. Effect of treatments on the abundance of Myzus persicae at plant level

One day before the first treatment (26 th Day after Planting), there was not significantly different from all the treatments (T0, T1, T2, T3 and T4) on the number of *Myzus persicae* (P = 0.626) (Tab. 2). During the three observation times (1 DBT, 3 DAT1, 3 DAT2, 3DAT3), the aqueous extracts of neem grain powders 41.5 g / L (T1), jatropha grain powder 59.1 g / L (T2) and neem leaf paste (T3) were the same efficacy as the insecticide Cypercal (T4) on the number of Myzus persicae in the cabbage plants (Tab. 2). All of these tested treatments significantly reduce the number of *Myzus persicae* on the plants. However, there is a significant difference in the efficacy of the products tested and the control on the number of *Myzus persicae* per plant (P = 0.001) during the three surveys carried out respectively (Tab. 3).

Table 3: Effects of insecticides and aqueous extracts of neem and jatropha on number of *Myzus persicae* adults per 10 plants according to the dates of readings

Observation time	Treatment	Number *Myzus persicae per* 10 plants	CV (%)
	T0	42.00	14
	T1	50.50	12
1 DBT1	T2	41.50	9
	T3	38.0	11
	T4	57.50	8
p-value	0.626		
	T0	58.00 b	13
	T1	23.25 a	12
3 DAT1	T2	15.75 a	13
	T3	15.00 a	14
	T4	23.50 a	12
p-value	0.0001		
	T0	65.25 b	13
	T1	11.00 a	14
3 DAT2	T2	8.75 a	14
	T3	9.75 a	12
	T4	8.00 a	14
p-value	0.0001		
	T0	42.50 b	11
	T1	1.25 a	14
3 DAT3	T2	1.50 a	14
	T3	2.25 a	12
	T4	1.75 a	14
p-value	0.0001		

T0: Untreated; T1: Neem grain powders 41.5 g / L; T2: Jatropha grain powders 59.1 g / L; T3: Neem leaf pasta 67 g / L; T4: Cypercal

1 DBT: one day before the first treatment; 3 DAT1: three days after the first treatment; 3 DAT1: three days after the second treatment; 3 DAT1: three days after the third treatment

The means assigned to the same letter within the same column are not significantly different for the 5% Fisher test (LSD).

3.3. Impact of foliar application of biopesticides based on neem and jatropha, and Cypercal insecticides on cabbage yield

The yields obtained in the plots treated with the different products are significantly higher than that of the control (P = 0.001). The yield increased in the plots treated with aqueous extracts of neem seed powders 41.5 g / L (73 T / ha) than plots treated with Cypercal 50 EC (45.5 T / ha). The yields of the plots treated with the aqueous extracts of neem leaf pasta 67 g / L (47.5 T / ha) are similar to those of the plots treated with Cypercal 50 EC (45.5 T / ha). However, the yield of cabbage occurred in the plots treated with aqueous extracts of jatropha seed powders 59.1 g / L (39.25 T / ha) was low compared to those of plots treated with Cypercal 50 EC. The lowest yield of cabbage occurred in the untreated plots (28 T / ha) while the highest yield was in the T1 treatment (Tab. 4).

Table 4: Effects of insecticides and aqueous extracts of neem and jatropha on cabbage yield

Traetment	Yield (T/ha)	CV (%)
T0	28,00 d	5,1
T1	73,00 a	1,4
T2	39,25 c	2.8
T3	47,50 b	5.5
T4	45,50 b	5
p-value	0,0001	

T0: Untreated; T1: Neem grain powders 41.5 g / L; T2: Jatropha grain powders 59.1 g / L; T3: Neem leaf pasta 67 g / L; T4: Cypercal

The means assigned to the same letter within the same column are not significantly different for the 5% Fisher test (LSD).

4. Discussion

Calibration is an important operation which makes it possible to determine the volume of product applicable on elementary plots. This method made it possible to apply 1.5 L of biopesticides per elementary plot for young cabbage plants (24 days after transplanting). This value is similar to that obtained by Goudegnon (2000) [13] for the treatment of young cabbage plants of 9 leaves (21 days after transplanting).

The aqueous extracts of neem grain powder 41.5 g / L,

jatropha powder 59.1 g / L and neem leaf pulp 67 g / L have remarkably reduced the number of *Myzus persicae* on cabbage plants. These biopesticides used in the field have an effectiveness comparable to that of the Cypercal 50 EC insecticides commonly used by market gardeners. This efficacy of the aqueous extracts of neem and jatropha observed in this study agrees with those of Jide-Ojo *et al.* (2011) [16] and Senthil-Nathan *et al.* (2013) [28] who have already demonstrated the efficacy of neem and jatropha products on insects.

The aqueous extracts of jatropha grains and leaves contain curcin, and a very small amount of flavonoids and diterpenoids (Devappa *et al*., 2010) [8]. During foliar applications, plants and insects are impregnated with these compounds with insecticidal and fungicidal properties contained in the aqueous extracts of jatropha. These compounds would adhere to the cuticles of plants and insects, cause the death of insects by contact or consumption and thus reduce the frequency of insects in plants (Diabaté *et al*., 2014). The efficacy of aqueous extracts of grains and leaves, of neem and jatropha, and the insecticide Cypercal on the population of *Myzus persicae* is due to the fact that these biopesticides and insecticides have repellent and antifeedant effects (Devappa *et al*., 2010; Senthil-Nathan, 2013; Diabaté *et al*., 2014) [8, 28].

The aqueous extracts of neem grain powder were effective against Myzus persicae and gave the best yields. This efficacy of aqueous extracts of neem grain powder is linked to the presence of azadirachtin. Azadirachtin is believed to be a major disruptor of the growth and development of insects by inhibiting their endocrine systems. This is consistent with the work of Mordue-Luntz and Nisbet (2000) who showed that azadirachtin inhibits the biosynthesis of ecdysteroids by the inhibition of the prothoracicotropic hormone (PTTH), a polypeptide produced by brain cells neurosecretors of insects which is responsible for the production of ecdysone by the prothoracic glands. When azadirachtin enters the larva's body, it is mediated by its binding to the ecdysone receptor (EcR), in the presence of a heterodimeric partner, Ultraspiracle Protein (Usp) (Zhao *et al*., 2014) [32]. Ecdysone activity is suppressed and the larva is unable to moult and remains in the larval stage and eventually dies (Koul and Isman, 1991; Zhao *et al*., 2014) [17, 32]. According to Banerjee and Rembold (1992) [7], azadirachtin causes serotonin to build up in neuroendocrine organs, interferes with this neurotransmitter, and inhibits the release of ecdysone involved in regulating the growth and development of insects.

The secondary metabolites of biopesticides based on neem and jatropha would act on the chemoreceptors of insects and prevent food intake. Mordue and Blackwell (1993) [19] have shown that the azadirachtin contained in aqueous neem extracts acts on chemoreceptors and inhibits food intake.

The best yields obtained with aqueous extracts of neem grain powders 41.5 g / L are explained by the fact that this biopesticide is more phagorepulsive on contact and by ingestion than the insecticide Cypercal (Diabaté *et al*., 2014), and compared to the aqueous extracts of neem leaves and jatropha grain powder (Diabaté *et al*., 2014). The repellent and anti-palatable effects of these aqueous extracts of neem and jatropha would be due to the high concentrations of their secondary or primary metabolites which would very quickly induce a toxic effect and a phagorepulsive effect high in *Myzus persicae*.

The low yield of the aqueous extracts of neem leaf pulp compared to the aqueous extracts of neem grains is linked to the low toxicity of the aqueous extract of neem leaves compared to those of the aqueous extract of neem grains. Indeed, the concentration of toxic secondary metabolites in the leaves is low compared to that of the seeds. Furthermore, the aqueous extracts of neem leaves have the same efficacy on *M. persicae* and in the yield of cabbage as cypercal. The low yield of the aqueous extract of jatropha grain powder 59.1 g / L is linked to the low amount of phorbol ester in this aqueous extract of jatropha grain (Devappa *et al*., 2010) [8]. Its low efficiency in terms of yield is linked to the low persistence and low penetration of curcine into the plant.

Furthermore, Al-Sayeda (2007) [2] has shown that insecticides owe their toxicities to the inhibition of cholinesterases responsible for the inactivation of acetylcholine at neuromuscular junctions and certain synapses of the central and peripheral nervous systems. However, Cypercal has a weak repellent and anti-palatable effect compared to aqueous extracts of neem seeds and has a repellent effect similar to aqueous extracts of neem leaves (Diabaté *et al*., 2014).

5. Conclusion

On cabbage, all the aqueous extracts of neem and jatropha, and the insecticide Cypercal have the same efficacy on Myzus persicae. Furthermore, only the aqueous extracts of neem grain powders 41.5 g / L were more effective and gave the best yields compared to Cypercal 50 EC. The aqueous extracts of neem leaf pasta 67 g / L had a similar efficacy to Cypercal in terms of yield. In other words, the aqueous extracts of jatropha grain powders 59.1 g / L gave a lower yield than that of the insecticide Cypercal 50 EC. Aqueous extracts of 41.5 neem grain powders and 67 g / L neem leaf pulp can replace the insecticide Cypercal in the fight against Myzus persicae in cabbage. These aqueous extracts are easy to produce locally, are less dangerous and less expensive than chemicals. Unlike chemical insecticides with a single molecular target, natural insecticides are made up of several compounds with multiple action mechanisms, which can delay the development of resistant populations for their use in agriculture.

6. References

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