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Comparative Effects of Natural and Synthetic Fungicides on the Pink Root Disease of Onion (*Allium cepa* L.), in Nursery

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Abstract

Onion is an important vegetable in Senegal horticulture, where it occupies the first place. However in the greatest areas production like the Gandiolais, in the North of Senegal, Pink root disease caused by a soil born fungus *Pyrenochaeta terrestris* (Hansen) Gorentz, Walker and Larson affects its productivity especially in nursery. On soil sterilized and inoculated by the fungus, we tested 5 natural fungicides and 2 synthetic fungicides, to measure their effectiveness on the Pink root disease on onion, in nursery. The device used is a split plot with 4 repetitions and 8 treatments. The measured variables are the emergence rates, the survival rates and the infestation rates. Our experimentations have shown that, for the emergence rates, there is no significant difference between thiophanate-methyl (Pelt 44), Carbendazim (Bavistine), *Azadirachta indica* A. Juss and *Carica papaya* L. It is the same between *C. papaya* and *Moringa oleifera* Lam, between *M. oleifera* and *Cassia alata* L. It is also the same between *C. alata* and *Crotolaria retusa* L. Regarding the survival rates, there is no significant difference between thiophanate-methyl, *Azadirachta indica*, Carbendazim, *C. papaya* and *M. oleifera*. The same is true between *M. oleifera* and *Cassia alata*, and between *C. alata* and *C. retusa*. Concerning the infestation rates, apart from the control check, all other treatments show no difference.

Keywords

Onion, Pink Root, *Pyrenochaeta terrestris* Hansen, Fungicides

1. Introduction

Onion (*Allium cepa* L.) is a consumer product in Senegal and imports represent

57% of vegetable volumes (Direction de l'horticulture, 2013). In the Sudano-Sahelian zone, Senegal is one of the main producers, behind Niger, Ethiopia and Sudan [1].

National requirements are estimated at 300,000 tons per year. In 2012, production is estimated at 210,000 tons and imports at 123,350 tons (Direction of Horticulture, 2013). Nearly half of this production comes from the Gandiolais, located 30 km south of Saint-Louis, where the soil is infested by *Pyrenochaeta terrestris* (Hansen) Gorentz, Walker and Larson. This soil fungus is responsible for the pink root disease of the onion, which is spreading gradually in other areas of the "Niayes". Studies on the disease, conducted in the Gandiolais, have shown low productivity of nurseries and a high heterogeneity in the stand [2]. Pink root symptoms are common in onion fields, especially in old nurseries, and on soils poor in organic matter [2] [3] [4] [5] [6].

Pyrenochaeta terrestris infected plants often have a reduction in growth and may die [7] [8]. Bulb quality and yields are also affected [8] [9]).

Laboratory and field results showed tolerance of *Pyrenochaeta terrestris* to Benomyl, Iprodione and Procymidone fungicides, whereas they were effective against *Fusarium oxysporum* and *Botrytis allii*, respectively responsible for basal rot and collar rot [10] [11] showed that the treatment of onion plants by the fungicide Basamid (dazomet), favored their vegetable development.

According to [12], products based on *Azadirachta indica* act as an insecticide, fungicide and antiviral. [13] Cited *Azadirachta indica*, *Moringa oleifera* and *Carica papaya* as fungicides. *Cassia alata* and *Crotolaria retusa* are also reported as fungicides by [14].

The results obtained on the action of these natural fungicides and of synthesis deserve to be deepened. Thus the effects of some of them as well as others are sought, on the pink root disease, on soil infested by the pathogen.

The objective of this study is to find natural fungicides effective against pink root disease of onions in the nursery.

2. Material and Methods

Sowing trays measuring 44 cm long by 29 cm wide and 7 cm deep were used. Each tray contained 3 kg of Gandiolese soil sterilized with steam for 2 hours and then inoculated by burying inoculum consisting of sickly cut roots (at a rate of 0.2 g of root per kg of soil) and stirring of the mixture for homogenization. The sandy texture was composed of fine sand 44.5%, coarse sand 51.4%, clay 3%, fine silt 0.1% and coarse silt 1%. Its pH was 8.5 and the relative humidity was 0.31 at 105˚C, the C/N ratio was 7.33.

Five natural and two synthetic fungicides were used.

Natural fungicides are plants with antifungal properties (*Azadirachta indica*, *Carica papaya*, *Moringa oleifera*, *Cassia alata* and *Crotolaria retusa*) whose leaves have been harvested and then dried in the shade and crushed. The powder obtained was incorporated into the soil one week before sowing at a rate of 10 g per

tray to avoid the soil compactness observed in the preliminary test with 20 g of powder for the particular study of the Violet de Galmi which is a cultivar that is largely produced in Senegal, which is well adapted and which therefore constitutes an ecotype.

The synthetic fungicides are:

- Thiophanate-methyl at 450 g/l (Pelt 44) which is a derivative of carbamic acid. It is a product of Japanese origin which is in the form of a colorless crystalline solid. Its spectrum of activities extends to both vascular and root diseases. It acts by destruction of the mycelium and sterilization of the forms of fructification; it is used in the dose of 2 ml/l,
- Carbendazime at 500 g/l (Bavistine), which is a methyl carbamate. It is in the form of a light gray powder. It is a versatile and systematic fungicide. Its action is both preventive and curative. It is used at a dose of 1.5 g/l.

The treatments are made at the time of planting the Violet de Galmi, then, every day at a rate of one liter per tray. Watering is done every day at the rate of 1 liter of water per tray.

The experimental design is in randomized complete blocks with eight treatments (Table 1) repeated four times:

The seedlings are made in the trays described above, at the rate of 200 seeds per tray. Each tray represents a treatment; the different treatments are arranged according to a complete randomization inside the blocks. A total of 32 trays were followed (Table 2).

2.1. Measurement of Variables

After 45 days of nursery, three variables are measured:

- Emergence rate: the germination test of our seeds was not determined before sowing. However, a preliminary test on untreated soil was done to determine the average rate of emergence on the variety Violet de Galmi (VDG). This rate is 78.75%. The rate of emergence is determined one week after sowing, by direct count in relation to the number of seeds sown;

Table 1. Application rates of different natural and synthetic fungicides on onion (*Allium cepa* L.) sown in tray containing soil taken from Gandiolais (Niayes area) and inoculated with roots infected with *Pyrenochaeta terrestris.*

Treatments	Application rates
Control (untreated)	
Thiophanate-méthyl (Pelt 44)	2 ml/l water/tray
Carbendazime (Bavistine)	1.5 g/l water/tray
Carica papaya L.	10 g/tray
Crotolaria retusa L.	10 g/tray
Cassia alata L.	10 g/tray
Azadirachta indica A. Juss.	10 g/tray
Moringa oleifera Lam.	10 g/tray

Table 2. Experimental design.

Repetitions	***Plots***							
R1	*Azadirachta indica*	Bavistine	*Carica. papaya*	*Moringa. oleifera*	*Crotolaria retusa*	Pelt 44	*Cassia alata*	Control
R2	*Crotolaria retusa*	Pelt 44	*Cassia alata*	Control	Bavistine	*Moringa oleifera*	*Azadirachta indica*	*Carica. papaya*
R3	Pelt 44	*Carica. papaya*	Control	*Cassia alata*	*Moringa. oleifera*	*Azadirachta indica*	*Crotolaria retusa*	Bavistine
R4	*Moringa. oleifera*	*Cassia alata*	*Azadirachta indica*	Bavistine	*Crotolaria retusa*	Control	*Carica papaya*	Pelt 44

- Survival rate: it is calculated from the percentage of emergence already known and the number of plants kept alive at the end of the nursery;
- Infestation rate: the plant is excavated from the nursery, and as soon as a root is colored pink, the plant is considered diseased (infected).

It is the infestation expressed by the pink color of the root that is taken into account. The rate of infestation is then calculated from the survival rate already known. This is the number of diseased plants relative to the number of plants that survived at the end of the nursery.

2.2. Results Analysis

It is achieved with the STATITCF software (Institut Technique des Céréales et des Fourrages de Paris). The separation of the averages is fully developed by the NEWMAN-KEULS test (P = 0.05), each time that a significant difference is observed.

3. Results

The results are indicated in Table 3.

3.1. Emergence Rates

The emergence rates range from 48.50% (for *Crotolaria retusa*) to 79.00% (for Thiophanate-methyl). For thiophanate-methyl, Carbendazime, untreated control and *Azadirachta indica*, the emergence rate is over 70%. On the other hand, it is more than 60% for treatments with *Carica papaya* and *Moringa oleifera*. The lowest rates were noted in the trays treated with *Cassia alata* (56.50%) and *Crotolaria retusa* (48.50%).

It shows that there is a significant difference between Thiophanate-methyl, the most effective treatment, and other treatments. The same is true of *Crotolaria retusa*, the least effective treatment and the others, as for Carbendazime, untreated control and other treatments.

3.2. Survival Rates

Survival rates ranged from 95.65% to 16.34%. Four treatments induced a rate greater than 90%: the control (95.65%), Pelt 44 (96.03%), *Azadirachta indica*

Table 3. Violet de Galmi emergence, survival and infestation rates after treatments carried out in nursery.

Treatments	Emergence rates (%)	Survival rates (%)	Infestation rates (%)
Control (untreated)	74.50 ab	95.65 a	5.18 a
Thiophanate-méthyl	79.00 a	93.03 a	0.00 b
Carbendazime	76.00 ab	90.21 a	14.95 b
Carica papaya L.	65.50 abc	74.24 a	20.60 b
Crotolaria retusa L.	48.50 d	16.34 c	21.87 b
Cassia alata L.	56.50 cd	29.75 bc	18.27 b
Azadirachta indica A. Juss.	71.00 abc	91.78 a	09.56 b
Moringa oleifera Lam.	61.00 bcd	57.01 ab	08.09 b

(91.78%) and Carbendazime (90.21%). A single treatment is 74.24% *Carica papaya*, followed by *Moringa oleifera* (51.01%). Two treatments are only at less than 50% survival rate: these are *Cassia alata* (29.75%) and *Crotolaria retusa* (16.34%). There is a significant difference between treatments. Thiophanate-methyl, Carbendazime, untreated control, *Azadirachta indica* and *Carica papaya* (which are not significantly different) and *Moringa oleifera*, *Cassia alata* and *Crotolaria retusa* (which are significantly different).

3.3. Infestation Rates

Infestation rates ranged between 54.18% (for the untreated control) and 0% (for Pelt 44).

Seven treatments out of eight have an infestation rate of less than 25%, considered as the acceptable reference level. Of these, three have an infestation rate of less than 10%: Pelt 44 (0%), *Moringa oleifera* (8.09%) and *Azadirachta indica* (9.50%). No differences were observed between the other treatments.

4. Discussion

In all treatments, the rate of emergence is higher than 60%, except for *Cassia alata* and *Crotoloria retusa*, which have the lowest rates. The best rates (over 70%) are obtained with Pelt 44, Carbendazime, untreated control and *Azadirachta indica*. Other treatments *Carica papaya* and *Moringa oleifera* have intermediate lifting rates. For survival, those of *Crotolaria retusa* and *Cassia alata* are the lowest, the highest are obtained respectively with the untreated control, Pelt 44, *Azadirachta indica* and Carbendazime. The other treatments gave intermediate values varying between 47.01% (for *Moringa oleifera*) and 74.24% (for *Carica papaya*).

For the infestation rate, the untreated control had the highest rate (54.18%), which means that more than half of the plants are infected. *Crotolaria retusa* and *Cassia alata*, which have low survival and survival rates and infestation rates of

21.87% and 18.27% respectively, give the following explanations for these contradictory results: The few plants that remained Live at the end of the nursery are because they are very little infested or not at all infested. If the percentage of infestation is calculated from this small number, the rate of infestation will be low while the real rate is high, and it is this rate that has resulted in the low survival rate. For the control that has the highest infestation rate, this is due to the total lack of treatment. It should be noted, however, that this infestation did not result in high mortality in the nursery. The incidence of this high infestation could be seen in the open fields, as it would be a second stress in addition to that due to transplanting, resulting in a high probable mortality after transplantation [4] [5] [6]. Indeed, plants infested with *P. terrestris*, if they do not die, often have a reduction in growth [8] [13]. This is not however confirmed by [9] which showed a 13% efficiency of *Trichoderma* applied to onion. The rate of infestation of *P. terrestris* is 33% compared to 46% for the control. However, this improvement in onion resistance results in a loss of bulb yields due to *Trichoderma*: 169 g per bulb and 70.9 t/ha for the control against 212 g of bulb and 80.9 t/ha for *Trichoderma*. Other Pelt 44, Carbendazime, *Azadirachta indica*, *Carica papaya* and *Moringa oleifera* treatments that have high survival and survival rates and low infestation rates are also useful to control the incidence of the disease in the nursery .

Our results with synthetic fungicides are comparable to those of [11], which showed that Basamid (dazomet) favors the vegetative development of onion plants on soil treated with this fungicide.

In the case of *Azadirachta indica*, *Moringa oleifera* and *Carica papaya*, their fungicidal effect was cited by [13]. The fungicidal properties of *Cassia alata* and *Crotolaria retusa* were studied by [14]. In view of the results obtained during these various experiments, we find that plants with a fungicidal effect could be very useful for the protection of crops against certain enemies. However, beyond its fungicidal aspects, *Azadirachta indica* would also have insecticidal actions. These are confirmed by [15] [16] on two Cabbage Lepidoptera (*Plutella xylostella* and *Hellula undalis*) and on the mealybug (*Dysmicoccus brevipes*) of pineapple, respectively.

5. Conclusion

The rate of infestation of onion plants is below the tolerance level (25%) accepted in the nursery regardless of the treatment used. Without treatment, it exceeds 54%. This shows the importance and effectiveness of the onion fungus treatment. Indeed, no infestation is noted with Pelt 44 whereas *Azadirachta indica* has a lower infestation rate than that obtained with Carbendazim. This low infestation rate is accompanied by a 60% to 94% survival rate for both synthetic fungicides and the two best natural fungicides (*A. indica* and *Carica papaya*). Emergence and onion survival are among the highest. This goes with the highest infestation rate. It would be interesting to consolidate these scientific results by

analyzing the cost of the needs of healthy plants with or without treatment by integrating the surplus seed and labor required. This will make it easier to disseminate the use of cheaper natural fungicides that are more respectful the environment and the quality of the products.

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