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Germination Capacity of Porophyllum Ruderale (JACQ.) Cass (Asteraceae) A Food Crop Weed in Côte d'Ivoire

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Abstract

Porophyllum ruderale is a weed present in all the regions of Côte d'Ivoire. It is a weed that rapidly colonizes agricultural parcels. A comparative study of its seed germination in relation to agro ecological areas was carried out. Selected seeds were sown in three different environments to test their germinative capacity. These are a closed environment and two opened environment in the south and central western Côte d'Ivoire. To determine the effect of sowing depth on the germination capacity, six sowing depths were tested: 0 cm, 0.5 cm, 1 cm, 2.5 cm, 5 cm and 10 cm. The results showed that the germination rate in the open environment is significantly different from that of the closed environment. We have 40-70% in natural environments and 10% in closed environments. For the depth test, the highest germination rate was obtained with seeds sowed at soil surface (0 cm) and the smallest one at 2.5 cm. These are 84% and 2.5% respectively. Our work has shown that Porophyllum ruderale is a heliophilic species because the presence of light activates its germination capacity. In a closed environment, the absence of this factor delays the growth of the weed until preventing flowering. It therefore fails to complete its life cycle, which is about six months. Thus, deep plowing cold prevent the development of Porophyllum ruderale.

Keywords: Weeds, biology, Porophyllum ruderale, Côte d'Ivoire

1- Introduction

Weeds have a remarkable ability to compete with crops because of their germinative capacity and rapid growth. Weeds colonize all natural or anthropized ecosystems when they find favorable conditions for their development. For their control, the study of their biology and ecology remains a necessity to define effective methods of management. The Asteraceae family is often cited among the most important weed families (Mangara, 2010; Kouakou, 2016). Several studies have been carried out on major weeds belonging to this family. The best known and identified as true scourge are: Chromolaena odorata, (Aboh et al., 2008, Touré et al., 2008), Tridax procumbens, Ageratum conizoides (Traoré et al., 2007), Bidens pilosa (Touré et al., 2008), and Tithonia diversifolia (Ipou Ipou et al., 2011a). These authors have shown that these plants have a very high capacity of seed production and regeneration.

Porophyllum ruderale, like almost all Asteraceae, also produces a lot of seeds and is found along roadsides, fields, fallows, rubble, and all other open spaces (Kissmam et al., 1999; Frangiote-Pallone and De Souza, 2014). De Marinis et al (1980) have shown that the more developed the Porophyllum ruderale phytomass, the higher the seed production. In addition, this author obtained a germination rate of 80%. Indeed, seed plays an important role in the survival and proliferation of the species (Akobundu, 1987). Porophyllum ruderale is already reported as an invasive plant in Latin America by De Marinis et al (1980) and by Kissmam et al (1999). In Côte d'Ivoire, the reporting of Porophyllum ruderale as a major weed is very recent. Its potential for invasion is due to its high seed production coupled with a high rate of emergence.

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The aim of this study is to demonstrate the germinative potential of Porophyllum ruderale in order to understand its biological strategy and to establish appropriate methods of management.

2- Materials and Methods

2-1 Choice of study sites

The study was conducted in two localities (Abidjan and Daloa), respectively in the South and Central Western Côte d'Ivoire. These localities have been chosen because the climatic conditions they offer are favorable to the development of Porophyllum ruderale, hence its abundance in these zones. In Abidjan, the National Center of Floristics (CNF) at Université Félix Houphouët-Boigny located between 5 ° 19 'north latitude and 4 ° 01' west longitude hosted the tests. This center is marked by the Guinean climate; characterized by four distinct seasons. A great rainy season from March to July with the peak in June and a small season from October to November. The great dry season extends from December to February with the peak in January and the small from August to September. Vegetation in this area is a rain forest (Doumbia, 2014). The soil type of this region consists of strongly desaturated ferralitic soils under high rainfall (Aubert, 1961).

The locality of Daloa (Tazibouo), lies between 07 ° 83 'north latitude and 07 ° 64' west longitude. The climate is a tropical humid climate (Ipou Ipou et al., 2011a). It is characterized by a long rainy season from February to October having two maxima, one in June and the other in September, and then a dry season from November to January. Most of the vegetation consists of semi-deciduous dense forest. However, it is in constant decline due to agricultural activities (Kpla, 2014). The soil is strongly or moderately desaturated ferralitic soil (Ligban et al., 2009).

2-2 Equipment and Data Collection

The plant material consists of seeds of Porophyllum ruderale harvested in the regions of Adzopé (August 2015) and Daloa (June 2016). They have been collected and have not received any special treatment, and then stored in plastic mesh bags. The technical equipment consists of plastic bags (25 cm in deep and 50 cm in diameter), and an ordinary watering can. Monitoring of Porophyllum ruderale seed emergence was carried out every seven days from the onset of the first two leaves of the seedling. The factors taken into account in this study are the growing environment (emergence in a greenhouse / emergence in the natural environment), the type of seeds (picked seeds / harvested seeds) and depth of sowing (0 cm, 0.5 cm, 1 cm, 2.5 cm, 5 cm and 10 cm).

2 2 1- Influence of the study environment on germination capacity

In order to observe the effect of the environment on the germination capacity of Porophyllum ruderale, two types of seeds were chosen: picked seeds and harvested seeds. Then they were sown in the greenhouse (closed environment) and in two fallows (open environment), at the National Center of Floristic (CNF) and Daloa. After sowing, observations were made every seven days for a period of six weeks. These observations consist in a direct count of the seedlings raised in the different environments.

2 2 2- Influence of the study environment on the life cycle of Porophyllum ruderale

The biological cycle of the weed was observed in the fallow and in the CNF greenhouse to identify the different phenological stages and their duration. Then we compare the plant stages of the two environments in order to check if there is a concordance.

2 2 3- Influence of depth of sowing

Seeds of Porophyllum ruderale were sown at different depths (0 cm, 0.5 cm, 1 cm, 2.5 cm, 5 cm and 10 cm), with four repetitions of 100 seeds at each sowing depths. For this, plastic bags were used. The soil was sterilized and sieved with 0.2 cm mesh sieves (Porophyllum ruderale seeds measuring about 1 cm). Ideal moisture conditions were applied and the bags were covered with nets to avoid loss or contamination. A seed is considered germinated when the first two leaves appear with a radicle of about 5 mm (Nerson, 2002). Observations were made over a period of 3 months (90 days), by direct counting of each seedling every seven days.

2-3 Data analysis

The calculation formulas for germination rate and germination speed were used (Ipou Ipou, 2005). The formula for calculating the germination rate is as follows:

$$Tg = (Nsg / Nst) \times 100$$

Tg: the germination rate
Nsg: the number of germinated seeds
Nst: the total number of seeds sown.
The formula for calculating the germination speed (Vt) is the expression of the germination rate (Tg) as a function of time (t = 24 hours)

$$Vt = Tg / t$$

The test of Mann-Whitney was used to compare the two seed types to the 5% threshold. Analysis of variance (ANOVA) with a factor allowed to compare the effect of environment and the depth on the average rates of germination. In case of a significant difference the test of Tukey was used for the segregation of the averages. Statistica software version 7.1 was used to make these analyzes.

3 -Results

3-1 Influence of the study environment on the germination rate

Germination rates of picked seeds and harvested seeds were respectively 10.5% and 9% in the closed environment. In the open environment of the CNF, the germination rate was 50% and 72% respectively for the picked seeds and harvested seeds. In Daloa, we obtained the respective rates of 53 and 44.5% (**Table I**). The analysis of variance (**Table II**) showed a significant difference between the germination rates obtained in closed and opened environments (F = 63.4336, P = 0.0001). The Tukey test differentiates three classes (Figure 1). The first is the germination rate of the fallow of the CNF "a", followed by that of Daloa "b", and the third class is that of the greenhouse "c". The corresponding germination rates are respectively 61; 48.75; and 9.75%.

Table I: Germination rate (%) according to the type of seeds and the growing environment

Germination rate (%)	Greenhouse	Fallow CNF	Fallow Daloa
Picked seeds	10,5	50	53
Harvested seeds	9	72	44,5

Table II: Analysis of variance for the study environment

	DDL	Sum of squares	Average of squares	**F**	**P*****
Model	2	11460,333	5730,167	**63,4336**	**0,0001**
Error	21	1897,000	90,333		
Total adjusted	23	13357,333			

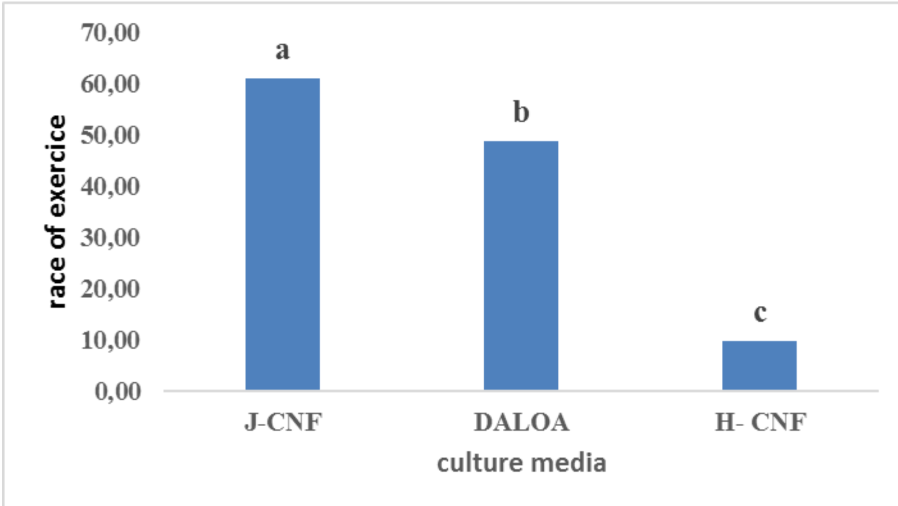

Figure 1: Culture medium of function in raising rates

The values assigned to the same letter are not significantly different at the 5% threshold according to the HSD test in Tukey
J-CNF: seeds of P. ruderale sown in the CNF fallow
DALOA: seeds of P. ruderale sown in the fallow of Daloa
H-CNF: seeds of P. ruderale sown in CNF greenhouse

3-2 Potential for germination depending on the type of seed

The germination rate of the picked and harvested seeds is shown in Table I. The test of Mann-Whitney showed that there was no significant difference between the two seed types (U = 5,000 and P = 0.386).

3-3 Germination speed depending on the environment

The germination rate (Table III) reaches a maximum value of 3 seeds per day for the CNF fallow site, while the lowest is the greenhouse (0.37 seed / day).

Table III: Germination rate based on the culture medium

	Growth rate (seeds / day)	
Sites	Seeds picked up	Seeds harvested
Greenhouse	0,43	0,37
Fallow CNF	2,08	3
Fallow Daloa	2,20	1,85

3-4 Influence of the study environment on the life cycle of Porophyllum ruderale

Life cycle observations (**Table IV**) in the CNF greenhouse and fallow indicate that development of the weed is slowed in the shade. There was no formation of flower buds or fruiting; and the plants remained stunted (30 cm) after a long vegetative phase of more than four months.

Table IV: Phenological stages of Porophyllum ruderale in the greenhouse and fallow of the CNF

Stages of development	**CNF greenhouse (September to April)**	**CNF fallow (November to April)**
First seedlings	7th day	5th day
The foliage	From the 35th day	From the 12th day
flowering	absent	75th day: formation of the first flower buds
Fruiting: seed release	absent	From the 82nd day
senescence	Progressive after 3 months of existence and reaching to the maximum 30 cm of height	From the 6th month after 180 days for a height of 60 to 160 cm

3-5 Depth of burial

The analysis of variance (Table V) showed a significant difference between the different treatments (F = 468.896, P = 0.0001). The test of Tukey distinguished three classes. The first "a" is that of the rate at 0 cm depth with 84%; the second "b" at the depth of 0.5 cm, obtains 21%; and the last "c" consists of the depths of 1- 2.5- 5-10 cm with 5.5-2.5- 0-0%, respectively (Figure 2).

Table V: Analysis of variance ANOVA

Source	DDL	Sum of squares	Average of squares	**F**	**P***
Model	5	21621,333	4324,267	**468,896**	**0,0001**
Error	18	166,000	9,222		
Total adjusted	23	21787,333			

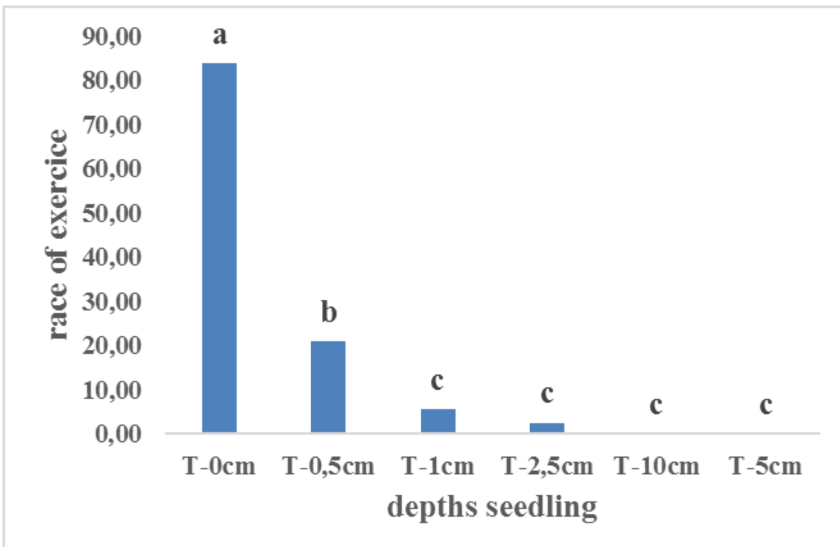

Figure 2: Emergence rate according to landfill depths

The values assigned to the same letter are not significantly different at the 5% threshold according to Tukey's HSD test.

T-0cm: sowing at 0 cm depth of burial
T-0,5: sowing at 0.5 cm depth of burial
T-1cm: sowing at 1 cm depth of burial
T-2,5cm: sowing at 2.5 cm depth of burial
T-5 cm: sowing at 5 cm depth of burial
T-10cm: sowing at 10 cm depth of burial

4 -Discussion

The germination rate of Porophyllum ruderale evaluated in open environments (40-60%) is four times that of the shaded medium (≈10%). That shows that a shady environment is not conducive to germination of the weed. Indeed the absence of light limited the emergence and also affected the development of Porophyllum ruderale. The greenhouse plants were unable to reach either the flowering stage or the fruiting stage. Whereas the seedlings of the natural environment are reached in seventy-five days (two and a half months), for a cycle of six months. Light is therefore a catalyst for the process of floral bud formation. The work of Ipou Ipou (2005) shows the importance of light to the germination of Euphorbia heterophylla (Euphorbiaceae). The rate of emergence of this weed was between 5 and 8% when its seeds are placed in the dark for 15 days.

Indeed, the majority of heliophilic weeds no longer manage to proliferate when the vegetation cover becomes more and more dense because it prevents the light rays from reaching the ground. The sensitivity of the heliophilic weeds to the absence of light allowed the use of cover plants in the cultivated plots to limit the germination of these plants. The work of Ipou Ipou et al., (2011b) has shown that certain legumes such as Mucuna pruriens and Vigna unguiculata, Fabaceae, can be used to control weeds in cotton growing. Its legumes are capable of producing a very abundant phytomass and covering the soil in a short period. Thus they harm the emergence of weeds, participate in the restoration of soils by the contribution of organic matter and reduce erosion. Pre-culture residues, straws or black plastics can play the same role in reducing the light intensity reaching the ground (Horowitz, 1993).

Significant difference was also observed between growing environment for emergence rate. The lowest rate obtained in the greenhouse confirms the influence of the shaded environment. The comparison of the germination potential of the two seed types according to the study environment showed no significant difference between them. The picked seeds of Porophyllum ruderale as well as those harvested have retained the same germinative ability. The rate of emergence according to the depth of burial is better for seeds sown to the surface. Significant differences observed showed that seed emergence decreases from the surface to higher and higher depths. The work of Holm (1972), Como (1975) and Roberts (1981) showed that the emergence dynamics is more pronounced at shallow depths. Indeed, these authors claim that most seeds of weeds occupy the first centimeters in order to benefit from the nutrients of the soil and climatic conditions favorable to their germination. Thus at the (rainy) growing season these weeds compete with the crop chosen because they germinate faster and quickly invade the plot.

The emergence dynamics of Porophyllum ruderale in the natural environment is between 40 and 70%. De Marinis et al., (1980) obtained an average germination rate of 80% Porophyllum ruderale under controlled conditions (laboratory). Under the same conditions Yao et al. (2017) had a rate of 98%. This weed has very high germination capabilities compared to other weeds considered to be plagues. In particular, for Chromolaena odorata (Aboh et al., 2008) and Tithonia diversifolia (Ipou Ipou et al., 2011a), these authors obtained a germination rate of 30%.

5- Conclusion

In this study, we assessed the germination rate of Porophyllum ruderale, an invasive weed. This weed has a very high germination capacity (40 to 70% emergence). The presence of light is a factor that activates the number of seedlings of Porophyllum ruderale. In a shady environment, this weed does not realize its different phenological stages. For example, farmers may be advised to carry out deep plowing to reduce weed germination or to use the false seeding technique after weeding. Certain cultivation practices could reduce the light intensity reaching the surface of the soil, to prevent abundant emergence. For example, by spraying organic material consisting of pre-crop residues (mulch) or covering with straw or black plastic. The adoption of a cover crop could also be beneficial as it is inexpensive and enriches the soil. It would also be advantageous to carry out weeding before the flowering phase of the weed. Then, destroy the feet around the field because of its large seed production, easily transportable by the wind. For the plots grassed by this weed a regular weeding is necessary. Chemical control may be considered with a post-emergence or crop-specific herbicide.

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