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Assessment of the Adaptability of the Garden Pea (*Pisum sativum* L.) to the Agroclimatic Conditions of Daloa (Western Côte d'Ivoire): The Role of Nursery Substrates in Establishment and Production

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A B S T R A C T

The green peas consumed by Ivorians are available in cans imported from Europe and North Africa. Since this legume is produced in only small quantities in Côte d'Ivoire, its introduction into Ivorian production systems requires experimental evaluation. This study aims to determine the germination and production parameters of this plant in nurseries and in the field under the agroclimatic conditions of Daloa. The methodological approach involved growing this legume in various growing media and in the field, then transplanting the most vigorous seedlings into the field and into soilless culture. Five treatments were conducted: Control (soil), Treatment 1 (wood shavings + soil), Treatment 2 (coconut fiber + soil), Treatment 3 (wood shavings + coconut fiber), Treatment 4 (soil + 1/3 wood shavings + 1/3 coconut fiber), and the field. Data on germination, growth, flowering, and fruiting parameters were collected and analyzed using Statistica 8.0 software. In the nursery, the highest germination rate of 76.66 % was observed with Treatment 1, whereas no germination was recorded in the field. Regarding stem elongation and circumference, the best results were observed with treatment 2. After transfer to the field and in soilless culture, the survival rate was 80% for soilless cultures and 53.3% for the field; however, the average number of fruits was higher at 9±8.2 in the field, while in soilless culture it was estimated at 2±0.7.

Introduction

With an estimated population of 32.8 million in 2025 and a growth rate of 2.73%, Côte d'Ivoire continues to face multiple challenges related to food insecurity and poverty. The proportion of people facing food insecurity has doubled, rising from 7% in 2022 to 14% in 2024 (FAO, 2026). In November 2025, 1.03 million people were experiencing acute food insecurity, and more than 3.3 million were at risk of it. In 8 of the country's 31 regions, more than a quarter of the population cannot meet their basic food needs. Côte d'Ivoire therefore faces growing challenges in terms of food and nutrition security in a context marked by rapid population growth, the effects of climate change, and increased dependence on food imports, all of which affect people's lives. Diversifying agricultural production and introducing crops with high nutritional value is one way to strengthen food security.

Pulses are an important part of the global diet. They provide one-third of the total protein consumed by humans (Smykal *et al.,* 2012), particularly in developing countries, where they are the primary source of protein for humans (Lazrek-Ben Friha, 2008). Indeed, these legumes are rich in protein, vitamins, iron, zinc, magnesium, and calcium. In Côte d'Ivoire, legumes are a staple of the diet, featuring in many traditional dishes. The garden pea belongs to this family of legumes, which are valued for their food and nutritional benefits. The legumes cultivated and consumed by Ivorians include peanuts, soybeans, beans, and field peas. However, some legumes consumed by Ivorians are still rarely cultivated in Côte d'Ivoire, notably the garden pea (*Pisum sativum).*

In fact, the peas available on the Ivorian market are imported from Europe and the Maghreb in canned form. Diversifying vegetable production through the introduction of peas could help reduce this dependence, diversify protein sources, and improve the nutritional quality of diets in Côte d'Ivoire. The pea (*Pisum sativum*) is a plant native to temperate regions, and its growth is influenced by high temperatures. In Daloa, temperatures are relatively high, and the feasibility of establishing pea cultivation warrants further study. Identifying conditions suitable for the Ivorian context is important. The production of seedlings in a nursery is a fundamental step in establishing crops. Local materials such as sawdust and coconut fiber could improve seed germination and seedling establishment, as the choice of growing medium can influence germination, growth, and seedling development (Pascual *et al.,* 2018). The purpose of this study is to determine the optimal growing medium for peas under the agroclimatic conditions of Daloa by testing various substrates.

Materials and Methods

Geographic Location and Climate

The Daloa Department is the capital of the Haut-Sassandra Region. It is located between 6°27' and 6°35' west longitude and 6°40' and 6°55' north latitude, precisely 141 km from the political capital, Yamoussoukro, and 383 km from the economic capital, Abidjan. The department is bordered to the east and west by the departments of Zuenoula and Bouaflé, to the north by Duékoué, and to the south by Vavoua and Issia (Figure 1).

In terms of climate, Haut-Sassandra is characterized by a mild transitional climate with two uneven rainy seasons. The two rainy seasons are separated by a short, mild dry season and a long dry season at the end of the year, caused by the harmattan. The presence of heterogeneous vegetation cover and relatively abundant rainfall forms the basis for the organization of the region's agricultural production systems, particularly the distribution of low-lying areas suitable for vegetable farming.

Plant Material and Equipment

The plant material consisted of the "Éminent" pea variety purchased from a German seed supplier. This variety has round, smooth peas and can grow to over 50 cm in length.

The technical materials consisted of various growing media. Three basic components were used to prepare the growing media: soil, coconut fiber, and wood shavings. The coconut fiber was purchased from a nursery, while the wood shavings were collected from a sawmill.

Methods

Setup of the Nursery and Experimental Design

To facilitate the germination of pea seeds, 120 polyethylene bags measuring 25 cm in height and 15 cm in diameter were used. These bags were fully perforated to ensure proper drainage of the growing media. For the T0 control, soil was collected from the top 15 cm of the

ground in an area covered with brush. Leaves, dead stems, and animal and plant debris were removed to facilitate filling the bags. Treatment T1 consisted of a mixture of sawdust and soil in a 50:50 ratio (Table I). These components were mixed until a homogeneous mixture was obtained, while substrate T2 consisted of a mixture of 50% coconut fiber and 50% soil. The mixture was also cleared of wood chips, animal debris, and dead leaves. Finally, treatment T3 consisted of a mixture of 50 % coconut fiber and 50% sawdust. Treatment T4 consisted of a mixture of 1/3 soil, 1/3 coconut fiber, and 1/3 sawdust. The resulting mixture was homogeneous. The bags were filled with the different substrates, leaving 3 cm of headspace. The experimental setup consisted of a Fisher block made up of 5 subblocks. Each subblock consisted of 30 growing bags. The spacing between subblocks was 1 m, and 0.5 m between individual bags. Each subblock corresponded to one treatment. One subblock corresponded to one treatment. Three seeds were sown per bag, for a total of 90 seeds per treatment. A batch of seeds was sown in the field over an area of 8 m². The experimental design consisted of plot units measuring 2 m long by 1 m wide, for a total area of 2 m² per plot unit, with 3 replicates. The plot units were separated by 1-meter-wide aisles.

Sowing Pea Seeds

After filling the bags with the various growing media, the seeds were watered to ensure optimal germination conditions. Next, a 3-cm opening was made with two fingers to place the seeds inside. The seeds were covered with a thin layer of growing medium. Watering was done every 2 days. The experiment was conducted without a shade structure during the rainy season from May through July.

Resumption of Growth in Pea (*Pisum sativum*) Seedlings in the Field and in Soilless Cultures

After 3 weeks of growth, 30 of the most vigorous seedlings were selected and transferred to the field and to polyethylene bags for soilless cultivation 15 seedlings were transplanted into the field and 15 were set aside for soilless cultivation. Watering was performed every two days for both the field and nursery seedlings. Stem length, number of leaves, collar circumference, number of fruits and flowers, and survival rate were measured after 60 days for each seedling. The parameters measured for the nursery seedlings were the same as those measured for the field seedlings.

Measured Parameters

The parameters studied are stem length, number of leaves, diameter at the collar, number of fruits and flowers, germination rate, and germination time.

The germination rate is the ratio of the number of plants that germinated to the total number of packets.

The survival rate is the ratio of plants that continued to grow after transplanting to the total number of transplanted plants.

Plant height is measured from the collar to the apical buds of the plant using a tape measure.

The number of leaves, flowers, and fruits was determined by simple counting on plants with all parts fully developed.

Statistical Analysis

All data were subjected to statistical analysis. The data are expressed as means. STATISTICA 8.0 software was used to statistically compare the different treatments. The nonparametric Kruskal-Wallis test was used to evaluate plant height, the number of leaflets, and stem circumference for both the nursery and field experiments. After the seedlings were transferred to the field and to soilless culture, analysis of variance (ANOVA) was used to evaluate the effect of treatments on survival rate, number of leaflets, number of branches, flowers, and fruits, and to compare the means of the various factors studied in both the nursery and field trials.

For the analyses of variance (ANOVA), the Newman-Keuls test was used to group the different treatments into homogeneous groups when the ANOVA revealed a difference among treatments. This difference is considered significant when the probability (Pr) that there is a tie for a single factor or for a combination of two factors is less than 5%, our significance threshold. Thus, if Pr is less than 0.05, the difference is significant; if Pr is less than 0.01, it is considered highly significant; and if Pr is less than 0.001, it is considered very highly significant.

Results and Discussion

The Germination Rate of Peas on Different Substrates

When growing pea seeds on different substrates, the germination rate ranged from 0 to 76.6 %. In fact, under the soil and climate conditions in Daloa, no germination was observed in the open field. In the nursery, however, the sawdust + soil mixture recorded the highest percentage at 76.6 %. The coconut fiber plus wood shavings mixture recorded a germination rate of 53.33 %, while the potting mix consisting of coconut fiber plus soil recorded a rate of 23.3%. The potting mix consisting of coconut fiber, wood shavings, and soil recorded a germination rate of 16.66%. The control group, consisting of soil alone, recorded the lowest germination rate of 10%. The zero germination rate observed in the field demonstrates the difficulties peas faced in establishing themselves under the sowing conditions encountered during the experiment. This could be due to the fact that it is a plant native to the world's temperate regions. Thus, the average temperatures during this growing season, estimated at 28°C with occasional highs of 32°C, likely affected germination and emergence.

The optimal temperature for pea germination and growth ranges from 15 to 20°C. According to Hassan *et al.,* (2024), temperature is a key factor determining the rate and uniformity of germination. In the nursery, the high germination rate observed with treatment (T2) specifically, sawdust mixed with soil is likely due to the fact that the sawdust probably altered the physical properties of the growing medium by improving its porosity and aeration. These results contradict those of Nguema *et al.,* (2014), who studied the effect of the composition of different growing media on several growth parameters of *Gambeya lacourtiana* de Wild in a nursery in northeastern Gabon. These studies showed that the presence of sawdust in the potting mix caused a delay in germination. The very low germination rate in Treatment 3 (T3) indicates that coconut fiber did not provide optimal germination conditions for the "Eminent" pea variety. According to studies conducted by Vinkovic *et al.,* (2007), the horticultural quality of coconut coir depends on the behavior of the plant growing in it. Indeed, coconut coir retains a great deal of water, which can affect germination. In peas, water can influence germination and seedling establishment; precise water management ensures healthy germination and seed growth. The very low germination rate observed with treatment 4 (T4) a mixture of soil, coconut fiber, and wood sawdust could be explained by the fact that combining multiple substrates does not always promote good germination. The physical properties of substrates including water-holding capacity, porosity, and aeration can vary depending on the type and proportion of the substrates used (Carlite, 2015). In fact, the combination of growing media should ensure a balance between air, water, and nutrients.

Stem Length, Stem Circumference, and Number of Leaflets of Peas (*Pisum sativum*) on Different Substrates

The stem length of peas (*Pisum sativum*) varied across the different substrates. The greatest stem length was observed in plants grown in potting mix composed of coconut fiber and soil (treatment T2). The lengths recorded were significantly different from those of all other treatments. No significant differences were observed between the control and treatments T1, T3, and T4. The coconut fiber + soil mixture promoted seedling growth and development, although the germination rate was relatively low. The conditions favorable for seed germination are not the same as those favorable for seedling growth. Coconut fiber has a high water-holding capacity in air; thus, the coconut fiber-soil mixture likely altered the physical properties of the substrate and promoted the expansion of the root system, allowing for good stem growth. These results are similar to those of Mariotti *et al.,* (2020), who compared coconut fiber to peat and demonstrated that coconut fiber influences the morphological and physiological characteristics of the plant, particularly the root and stem.

Stem Circumference of Peas (*Pisum sativum*) and Number of Leaflets on Different Substrates

The results show that stem circumference varied depending on the treatment (Figure 4). Treatments T4 (soil + coconut fiber + wood shavings), T3 (wood shavings + coconut fiber), and T2 (coconut fiber + soil) promoted the development of larger stem circumferences. The values obtained were higher and significantly different from those of the control and treatment T1. No significant difference was observed between the control and treatment T1 (soil + wood sawdust).

Table.1 Composition of the growing media prepared for growing peas

Treatements	Composition	Potting soil
control	soil 100 %	T0
Treatement 1	50% soil + 50% sawdust	T1
Treatement 2	50% soil + 50% coconut fiber	T2
Treatement 3	50% sawdust + 50% coconut fiber	T3
Treatement 4	1/3 soil + 1/3 sawdust + 1/3 coconut fiber	T4
Treatement 5	field	T5

Table.2 Growth Parameters for Peas Grown in Fields and in Soilless Systems

Plant Growth parameters	Stem length	Number of leaflets	Circumference of stem	branching	Number of flowers	Fruits
In the field	118.25±31.9a	197±97.7 **a**	1.1±0.2a	2.5±1.2 a	2±1.2 a	9.5±8.2 a
Soilless cultivation	159.75±47.2a	112.37±32.1 **b**	0.78±0.1a	1±0.0 b	1.6±1.6 a	2±0.7 b

Values with different letters (a, b, c, etc.) in the same column ($p < 0.05$) are significantly different. The values are the mean ± standard deviation, as determined by the ANOVA test.

Figure.1 Map of the city of Daloa

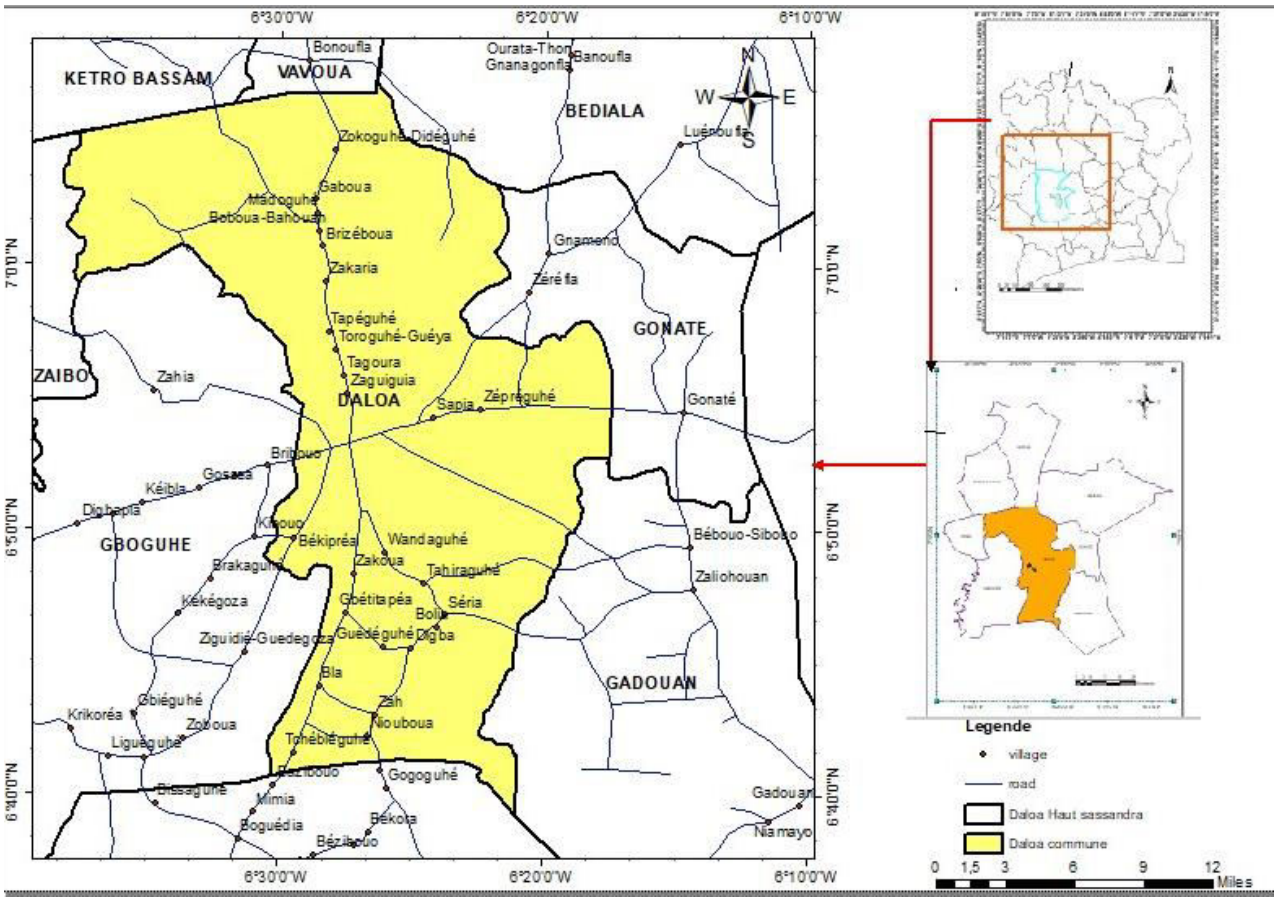


Figure.2 Germination rates of peas (*Pisum sativum*) on different substrates

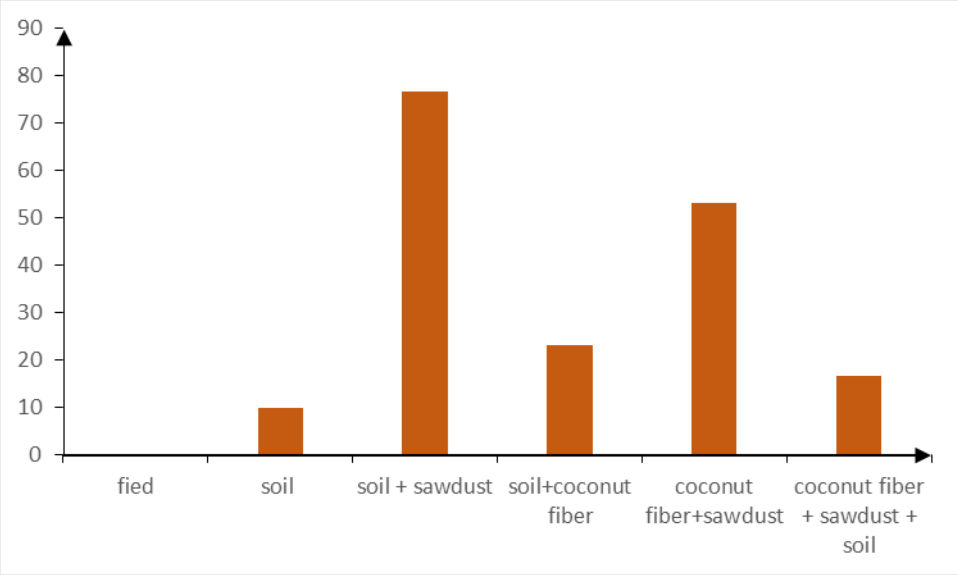
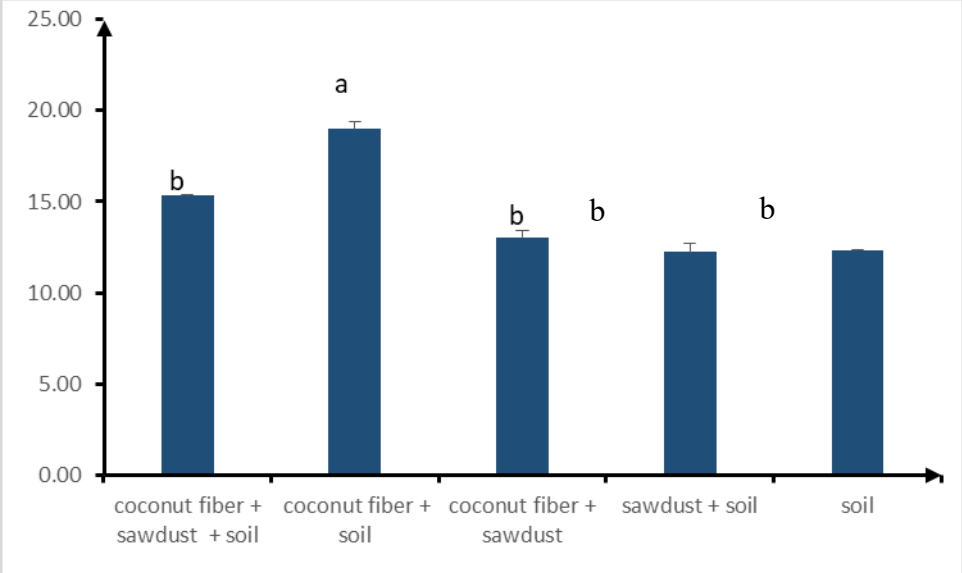


Figure.3 Stem length of peas (*Pisum sativum*) on different substrates



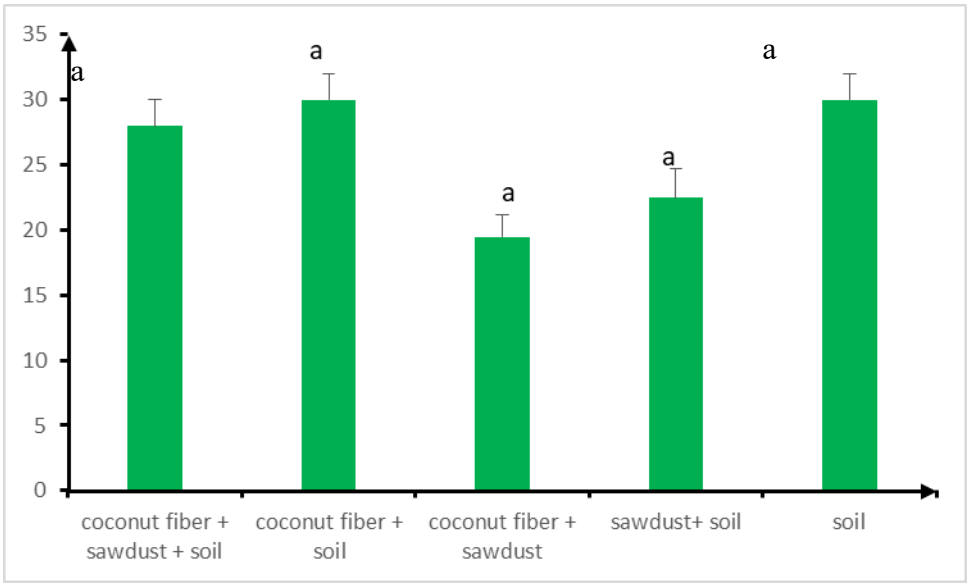
The means marked with the same letter are not significantly different at the 5% significance level.

Figure.4 Circumference of the pea (*Pisum sativum*) stem on different substrates



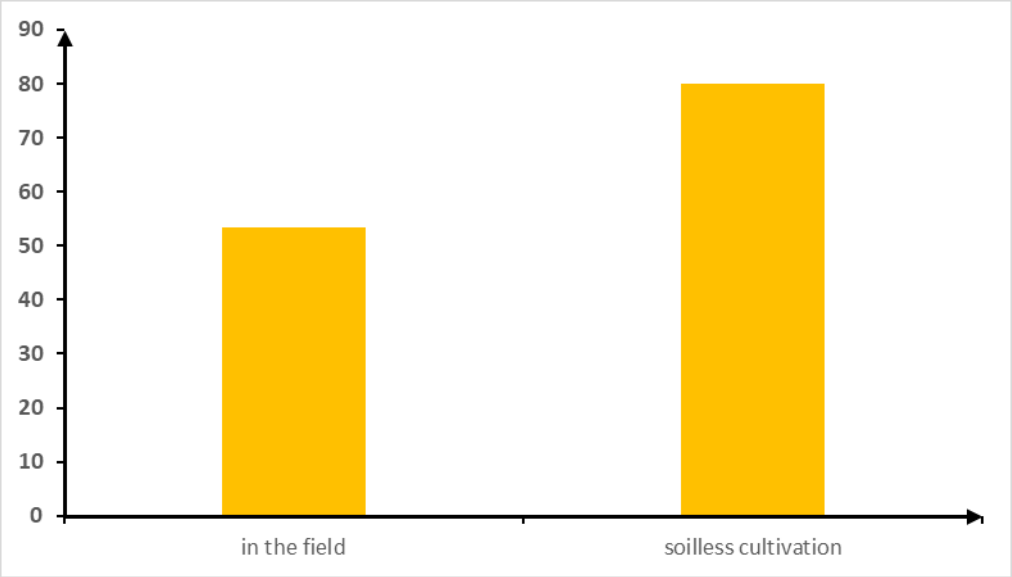
The means marked with the same letter are not significantly different at the 5% significance level.

Figure.5 Number of leaflets on the leaves of pea plants (*Pisum sativum*) grown on 5 different substrates



The means marked with the same letter are not significantly different at the 5% significance level.

Figure.6 Survival rate of pea seedlings (*Pisum sativum*) after transplanting to the field and in soilless culture



Regarding growth parameters, particularly stem height and circumference, treatment 2 (T2) was the only one to promote both greater stem elongation and increased circumference growth. Treatment T2 therefore improved vegetative development. These results are consistent with those obtained by Bongoua-Devisme *et al.,* (2018), who state that coconut fiber combined with soil promotes better growth of *Acacia mangium* seedlings. The number of leaflets on the different substrates was statistically identical.

Plant Survival Rates after Transplanting to the Field and in Soilless Culture

The survival rate of peas after transplanting varied depending on the growing system. In the field, the survival rate was relatively average at 53.33%, while in soilless culture, the survival rate was 80%. The recovery rate in soilless culture was 27% higher, representing a 50.6% improvement compared to field transplanting.

The average recovery rate in the field and the very high rate in soilless culture could be due to stress during transplanting. Indeed, when a plant is transplanted to the field, the environment differs in terms of climatic and edaphic characteristics, which tends to result in either the death of the plant or impaired growth (Close, 2005). Furthermore, the pea is a plant native to temperate regions. Transplant stress and climatic conditions (temperature differences) affected growth.

Growth Parameters of Pea Seeds Grown in the Field and in Soilless Culture

After transplanting the seedlings into the field and into soilless culture, the growth parameters stem length, number of leaflets, stem circumference, branching, and number of flowers and pods varied differently (Table II). The number of leaflets is significantly higher in the field than in soilless culture. However, there is no statistically significant difference in stem circumference or stem length between field and soilless culture. The number of branches on *Pisum sativum* plants in the field is higher than that of the same plants in soilless culture. A significant difference exists between these two values. Regarding the number of flowers, there was no significant difference between the number of flowers on field-grown peas and those grown in soilless culture. In contrast, there is a significant difference between the number of pods on field-grown plants and those grown in soilless culture. In fact, in the field, the average number of pods is 9.5, compared to 2 pods for peas grown in soilless culture. The number of pods produced by peas grown in the field is four times higher than that of peas grown in soilless media. The high number of pods and branches in the field could result from better expression of the vegetative and reproductive architecture in plants that were able to grow in the field. Development does not depend on survival and recovery but on the plant's ability to produce enough pods under the new environmental conditions. These results are

similar to those of Devi *et al.,* (2022), which demonstrate the importance of environmental conditions for the successful establishment of peas. Indeed, temperature, soil moisture, aeration, and seedbed structure can influence germination.

In conclusion, this study revealed that the success of pea establishment varies depending on environmental conditions. Direct seeding of pea seeds in the field did not result in seed germination. However, nursery cultivation promoted a high germination rate in potting mix consisting of soil and wood shavings, whereas the mixture of soil, coconut fiber, and wood shavings yielded the lowest germination rates.

Combining multiple substrates does not always promote good germination. The survival rate was low in the field but high in soilless cultivation; however, the number of branches and pods formed was higher in the field than in the nursery. Plants that successfully established themselves in the field yielded the best results. Nursery conditions play an important role in the success of the initial establishment of peas, while conditions encountered after transplanting influence production. Further experiments are needed to incorporate sowing dates, temperature, and humidity measurements to confirm and optimize this adaptive capacity. However, if peas are to be grown, they must go through a nursery-growing phase.

Authors Contributions

KONAN, A. E. designed the project, set up the experimental setup, and wrote the article; Kouamé K D performed the statistical analysis and revised the article to improve its editorial quality, Kouassi K J provided the coconut fiber and sawdust and collected data in the field, in the nursery, and in soilless cultivation

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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