Influence of winds and rains on pawpaw cultivation (*Carica papaya*) in the locality of Meyomessala

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DOI: 10.29322/IJSRP.13.02.2023.p13448
http://dx.doi.org/10.29322/IJSRP.13.02.2023.p13448

Paper Received Date: 20th January 2022
Paper Acceptance Date: 20th February 2023
Paper Publication Date: 2nd March 2023

Abstract- Wind and rain are climate hazards that threaten crops in agriculture. They contribute to crop yield losses in some areas of the world. They belong to the category of climate hazards classified as climate extremes. Our study aimed to investigate the influence of these two climatic threats on the cultivation of pawpaw *(Carica papaya)* in Meyomessala, South Cameroon. After three months of observation of 120 pawpaw plants sown in intercropping the first year and then in monoculture the second year; we used the Zephyr application and Daily Weather version 59 to measure wind and rainfall. The method for calculating vulnerability by weighting and Spearman's coefficient were used for statistical processing of the data. We have shown that pawpaw plants have a low vulnerability to both threats because the calculated index is 6. In intercropping, no plants fell. The index of Spearman's coefficient has a value of -664.4 for Rs1, it is close to -1 which means a negative correlation between wind speed and the number of pawpaw plants. For Rs2, it has a value of -294.3 which is also close to -1, this means negative correlation between rainfall and the fall of the pawpaw trees. The natural adaptive capacity of pawpaw trees is made up of a root network of 25 roots per plant with an average length of 50 cm for plants over 1 meter and a diameter of 5 cm.

Key words: Pawpaw, winds, rains, vulnerability, Spearman's coefficient, natural adaptation natural adaptive capacities.

I. Introduction

The study of climate change has three aspects: the scientific basis of climate change, which are observed and measured modifications in the components of the climate (temperature; precipitation; heat); the impact, which are the damage to the biophysical and human environment linked to climate change; and adaptation and mitigation measures which represent the means implemented to resist or live with the impacts of the climate. The science of climate change provides the foundation for evidence-based climate decision-making. It ensures that the links between climate impacts, climate action and social benefits are fully grounded in the best available climate science and data [1] [5]. The IPCC report "Climate Change 2013: the scientific elements" is a comprehensive assessment of the physical aspects of climate change, which emphasizes the elements relevant to understanding the past, analysing the present, and predicting the future. Future climate change [2]. To pursue this view of the scientific basis of climate change that (Eckstein et Al, 2018) have shown that hurricanes and their direct effects (precipitation, floods and landslides) were one of the major causes of damage in 2017. Of the ten countries the most affected in 2017, four were affected by tropical cyclones [12]. Cameroon, like these countries, is also facing the negative impacts of climate change. This affects several sectors of the economy, including agriculture and more specifically annual crops. Surface observations conducted in 2019 and 2020 at the start of the season transition in the town of Meyomessala in southern Cameroon showed palm branches being torn apart by violent rain-laden winds and growing plantain plants toppled over. . This is what prompted this study of the influence of winds and rain in a field island located in the forest zone of Dja, locality of Meyomessala where certain forest units are converted into fields. We therefore undertook to analyse the influence of winds and rains on the cultivation of papaya in this locality. The study is conducted by researchers from the Meyomessala station of the Agricultural Research Institute for Development (IRAD) in Cameroon.

II-MATERIALS AND METHODS

I.1. Devices on the test

Pawpaw seedlings (*Carica papaya*) solo N8 with an average size of 15 cm extracted from the nursery was transplanted two by two by alignment following a line spacing of 2.5 m and sowing interval of 2. 5 meters on an area of 800 m ^{2} in the locality of Meyomessala located in the bimodal agro-ecological zone of southern Cameroon. It is a forest area. This trial is launched in the first agricultural campaign of the year 2020 (March 30, 2020). This is a total of 120 seedlings. The experimental site is located on flat ground where there is a bit of weeds with an average size of 2 meters on three sides of the field. These weeds are made mainly of vetiver we also have some wild species such as wild beans *Mucuna pruriens* very dangerous for human health. Corn is sown intercropped pawpaw plants at a distance of 1 meter.This trial is repeated in 2021 in April following the same system but in monoculture (photo 3).The following treatments are made to the culture as in the first year: mechanical weeding with a machete and ridging every three weeks; fertilizer application. Starter fertilizer (100g of chicken droppings per hole); fertilizer at 1 month (100g fertilizer 20.10.10 and 50g urea). The dose of the one-month fertilizer is increased after each month until flowering. The 2021 experimental site is surrounded on all four sides by a belt of wild ferns, the maximum size of which is 1 meter. It is the dominant weed approx. It occupies 80% of the border landscape.

I.2. Measurement of winds and rains

►In the early 2020s; the winds are measured in situ (in the experimental site) during the day in dry weather by the Zephyr application (photo 1) and the rains are monitored in the daily weather application version 59 (photo 2). These parameters are taken every two weeks after transplanting the cultures. To measure the winds; we choose the time when the leaves swing with force as is shown by the Beaufort scale. Thus in the absence of rain.

►The second year 2021; winds and rain are tracked on the Weather Avenue website (photo 6). Indeed, the application and the android phone used in the year 2020 have deteriorated. This site provides weather forecasts for a month in a defined study area. In the case of this study, the city of Sangmélima the area closest to the place of the test, which was found on the site. It is 50km away from Meyomessala.Weather Avenue gives 8 daily parameters (average minimum temperature; average maximum temperature; average temperature; maximum and minimum temperature records; cloudiness; humidity; precipitation and winds). What interests our case is data on winds and rainfall. Thus, for each monthly series, we calculate the weekly average according to our measurement method for the first year.This means that a month is divided into five weeks and each week have an average. The monitoring begins in June for the second year and April of the first year and only covers 3 months of this first year.

I.3. Study of the natural adaptability of plants to winds and rains

To study the natural adaptability of pawpaw trees to the winds and rains, we uprooted (photo 4), five (5) male pawpaw plants after flowering, then counted and measured the length and diameter of the main roots and secondary roots.

I.4. Data processing

Data processing is done in Excel; it covers:

- the dates on which the plants fell; the scale being the week,
- the number of plants that fall under the effect of both factors (wind and rain),
- calculation of Spearman's correlation coefficient for winds and rains,
- Calculation of the climate vulnerability index (wind and rain) of this crop

I.4.1 Calculation of the index of vulnerability to winds and rains

Vulnerability is defined in the literature (IPCC, 2001) as a function of the exposure of the system to climate change (nature, magnitude, rate of change), of its sensitivity (possible consequences) and of its capacity to adapt. Adaptive capacity (or adaptability) here refers to the ability of a system to adjust in the face of climate change (including climate variability and climate extremes) in order to mitigate potential effects, exploit opportunities, or face the consequences.

Indicators or indices of vulnerability to climate change have mainly been used at a national level, particularly in the framework of international negotiations on climate change [3]. The indices provide a quick approach and understanding of phenomena that can be very complex, such as poverty. This allows adequate decision-making by the decision-makers who are the first users of this type of tool (Eriksen and Kelly, 2006) [11]. At the global level, these indices allow comparisons between regions and countries and thus serve to determine areas most in need of aid. On a local scale, they make it possible to reveal heterogeneities, which are masked on a small scale (Sullivan and Meigh, 2006), and to once again target priority areas.

Vulnerability has no unit of measurement, so in order to be able to be interpreted, local data must be "normalized", for example, projected on scales ranging from 0 to 5. The use of composite indicators makes it possible to obtain a general vision of a situation (taking several aspects). But can bias the comparisons (the weight of each element being no longer differentiable, two different situations can obtain the same value indicator.

This vulnerability is obtained by the following formula:

Exposure + Sensitivity=Risk+ adaptive capacities = **Vulnerability**

Chain of impacts according to IPCC AR4, 2017

The weighting method we used for the calculation of this vulnerability is as follows:

Exposure. Note 1 means Low exposure of papaya trees to wind and rain. This means that they are grown in the lowlands or in a greenhouse. An exposure rating of 2 means Medium; That is to say the pawpaw trees are obstructed by a natural obstacle (hedges of grass; mountains; or windbreaks). A rating of 3 means Strong exposure. This means that there is no natural obstacle; nor artificial on all sides of the pawpaw field.

Sensitivity. It is Low if the average maximum monthly wind speed and/or the average maximum monthly rainfall causes not less than 50 pawpaw trees to fall; in the event that they cause 50 pawpaw trees to fall, it is Average; and when they knock down more than 50 pawpaw trees she is Strong. The values 1; 2 and 3.

Ability to adapt. If less than 50 plants fall; the capacities of adaptations (main roots and secondary root) are Strong; if 50 plants fall they are Medium and if more than 50 plants fall they are Low. The values 3 are assigned; 2; 1

Vulnerability index. An index close to 3 is strong and an index far from 3 is weak.

4.2 Spearman's correlation coefficient

It is a correlation coefficient that examines whether there is a relationship between observations for two characters X and Y [4]. The idea is to substitute their ranks for the observed values. Basically, Spearman's coefficient is also a special case Pearson's coefficient, calculated from the transformations of the original variables. It allows to detect the existence of monotonic relations (increasing or decreasing), whatever their precise form (linear, exponential, power ...). This coefficient is therefore very useful when the analysis of the scatter plot reveals a curvilinear shape in a relationship that seems to fit poorly on a straight line. The correlation coefficient is independent of the units of measurement of the variables, which allows comparisons. The measurement is normalized, it is defined between square.

Spearman's coefficient is obtained by the following formula

$$Rs = \frac{1-6\sum (x_i-y_i)^2}{n(n^2-1)}$$

xi variable x and yi variable y; n is the total number of xi or yi

The Spearman coefficient is interpreted as follows: Rs close to -1 shows a strong negative correlation between the variables; Rs close to 0 reflects an absence of correlation between the variables and Rs close to 1 shows a strong positive correlation.

Photo 1. Wind speed measurement by the "Zephyr" application

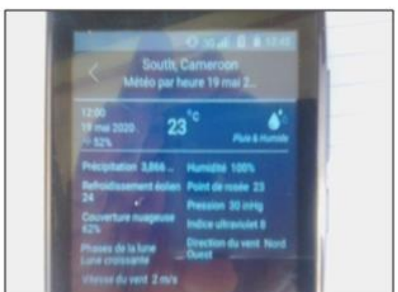


Photo2 .Monitoring local weather data through the "Daily Weather" app

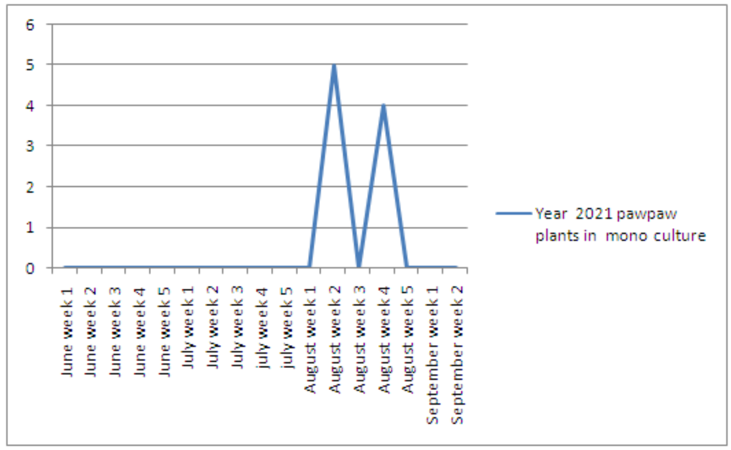
III-RESULTS

III.1 Number of fallen pawpaw plants and period of fall

III.1.1. Number of fallen pawpaw plants in monoculture and weeks of fall 2021

Table I below shows the number of pawpaw plants that fell in monoculture and their falling dates. We can therefore clearly see 5 and 4 plants fell respectively the 1st and 4th week of August 2021. It is only on these dates that these falls were observed during the monitoring of the culture over three months (June, July and August). These plants have a size that varies from 1.5 to 1.8m (Table 3) has not reached flowering.

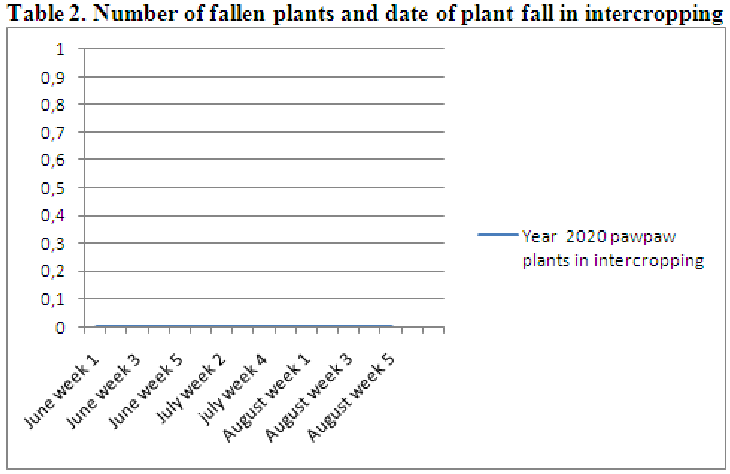
Table 1. Number of plant drops and date of plant drop in monoculture



1.2 Number of fallen pawpaw plants in intercropping and weeks of fall 2020

The table below shows the number of fallen papaya plants intercropped with maize; in 2020. It appears that no papaya plant fell during the three months of June, July and August of crop monitoring.

Table 2. Number of fallen plants and date of plant fall in intercropping



1.3 Average wind speeds and rainfall in 2021

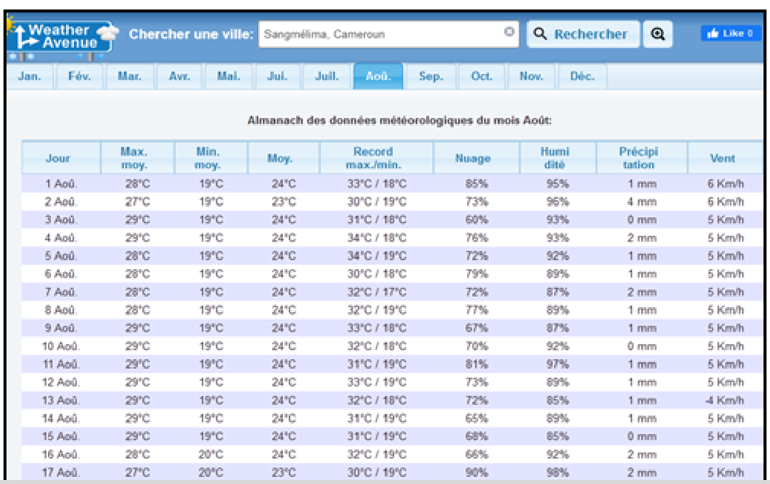
Table 3 below presents the results of the wind speed that caused the monoculture papaya plants to fall, the rainfall and the average size of the fallen plants. It shows that 3.85km/H and 4.71km/H is the wind speed that knocks down papaya trees with an average size of 1.5 and 1.8 meters. The related rainfall is 1.57 and 1.71mm/month.

Table3. Wind speed; rainfall and size of plants that fall

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 1	Week 2	Week 3	Week 4	Week 5	Week 1	Week 2	Week 3	Week 4	Week 5
Average Weekly Wind Speeds in Km/H	3.71	3.42	4	4	3.66	4.14	4.28	3.85	4.57	4.66	3.85	4.85	5.14	4.71	5
Average weekly rainfall in mm	1.57	1.57	1.14	1.85	0.85	2.28	1.85	1.85	1.28	1	1.57	0.85	1.42	1.71	2.5
Number of fallen plants	0	0	0	0	0	0	0	0	0	0	5	0	0	4	0
Average size of fallen plants in monoculture in Meters	0	0	0	0	0	0	0	0	0	0	1.5	0	0	1.8	0

2 Spearman correlation between variables

Table 4 below allows us to calculate the Spearman correlation of the influence of winds and rains of pawpaw plants. Xi is the number of fallen plants, Yi, the weekly average wind speed, and Zi the weekly average rainfall. The results of the calculation of this Spearman index presented in 2.1 and 2.2 reveal that the Rs 1 index is -664.4 for the correlation between the wind speed and the number of papaya trees that falls. And Rs 2 it is -294.3 for the correlation between the monthly rainfall and the number of pawpaw trees that falls. The value of this index in both cases approaches -1. This means a negative correlation between wind speed and the number of pawpaw plants that falls and between rainfall and the fall of pawpaw trees.



Almanach des données météorologiques du mois Août:

Jour	Max. moy.	Min. moy.	Moy.	Record max./min.	Nuage	Humi dité	Précipi tation	Vent
1 Aoû.	28°C	19°C	24°C	33°C / 18°C	85%	95%	1 mm	6 Km/h
2 Aoû.	27°C	19°C	23°C	30°C / 19°C	73%	96%	4 mm	6 Km/h
3 Aoû.	29°C	19°C	24°C	31°C / 18°C	60%	93%	0 mm	5 Km/h
4 Aoû.	29°C	19°C	24°C	34°C / 18°C	76%	93%	2 mm	5 Km/h
5 Aoû.	28°C	19°C	24°C	34°C / 19°C	72%	92%	1 mm	5 Km/h
6 Aoû.	28°C	19°C	24°C	30°C / 18°C	79%	89%	1 mm	5 Km/h
7 Aoû.	28°C	19°C	24°C	32°C / 17°C	72%	87%	2 mm	5 Km/h
8 Aoû.	28°C	19°C	24°C	32°C / 19°C	77%	89%	1 mm	5 Km/h
9 Aoû.	29°C	19°C	24°C	33°C / 18°C	67%	87%	1 mm	5 Km/h
10 Aoû.	29°C	19°C	24°C	32°C / 18°C	70%	92%	0 mm	5 Km/h
11 Aoû.	29°C	19°C	24°C	31°C / 19°C	81%	97%	1 mm	5 Km/h
12 Aoû.	29°C	19°C	24°C	33°C / 19°C	73%	89%	1 mm	5 Km/h
13 Aoû.	29°C	19°C	24°C	32°C / 18°C	72%	85%	1 mm	4 Km/h
14 Aoû.	29°C	19°C	24°C	31°C / 19°C	65%	89%	1 mm	5 Km/h
15 Aoû.	29°C	19°C	24°C	31°C / 19°C	68%	85%	0 mm	5 Km/h
16 Aoû.	28°C	20°C	24°C	32°C / 19°C	66%	92%	2 mm	5 Km/h
17 Aoû.	27°C	20°C	23°C	30°C / 19°C	90%	98%	2 mm	5 Km/h

Photo 6. Extract of the weather data on the site Weather avenue city of Sangmelima south Cameroon

2.1Rs for the correlation between the fall of pawpaw trees and the wind speed

According to the formula below, this coefficient is:

$$Rs = \frac{1-6\xi\,(Rxi-Ryi)^2}{n\,(n^2-1)}$$

$$Rs_1 = \frac{1-6x\ 372100}{15(15^2-1) = 3360}$$

$Rs_1 = -664.4$

2.2Rsfor the correlation between plant fall and rainfall

The coefficient is:

$$Rs = \frac{1-6\xi\,(Rxi-Rzi)^2}{n(n^2-1)}$$

$$Rs_2 = \frac{1-6x164836}{15(15^2-1)}$$

Rs2 = -294.3

Table 5. Wind vulnerability index

Exposure =2
Sensitivity=1
Adaptive Skills= 3
Wind vulnerability index = 6

Table 6. Rain vulnerability index

Exposure =2
Sensitivity=1
Adaptive Skills= 3
Rain vulnerability index = 6

Table 4. Data used to compute correlations of pawpaw plant fall.

Xi	0	0	0	0	0	0	0	0	0	0	5	0	0	4	0
yi	3.71	3.42	4	4	3.66	4.14	4.28	3.85	4.57	4.66	3.85	4.85	5.14	4.71	5
Zi	1.57	1.57	1.14	1.85	0.85	2.28	1.85	1.85	1.28	1	1.57	0.85	1.42	1.71	2.5
R Xi	1	1	1	1	1	1	1	1	1	1	3	1	1	2	1
R Yi	3	1	5	5	2	6	7	4	8	9	4	11	13	10	12
RZi	6	6	3	8	1	9	8	8	4	2	6	1	5	7	10
Ʃ(R Xi -R Yi)² =372100	4	0	16	16	1	25	36	9	49	64	1	100	144	64	89
Ʃ(R Xi -R Zi)² =164836	25	25	4	49	0	64	49	49	9	1	9	0	16	25	81

Rxi rank of variable xi number of fallen papaya trees; Ryi rank of the variable yi wind speed; Rzi rank of the variable zi rainfall

3. Wind and rain vulnerability indices

The results in tables 5 and 6 below give the vulnerability indices of pawpaw trees to the winds and rains during the year 2021. This vulnerability is low because the result of the index calculation for the two wind and rain variables is far from the value 3 for the two parameters in this study area during this period of the first agricultural campaign from June to August.

Photo 5. Pawpaw root network adapting to wind and rain

IV- Interpretation of results

4.1 Spearman's correlation between number of falls and wind speed

The results of the calculation of this Spearman index reveal that the Rs 1 index is -664.4 for the correlation between the wind speed and the number of papaya trees that falls. The value of the index approaches -1 for Rs 1. This means a negative correlation

4. Pictures

Photo 3. Monoculture experimental plot in April 2022 in production phase

Photo 4. Uprooted pawpaw for root count

between wind speed and the number of papaya plants that falls. Indeed, 5 papaya trees and only 4 papaya trees fall in monoculture the 1st and4thweeks; and no papaya trees fall in intercropping. This number of falls at a wind speed of (3.85km/h and 4.71km/h) or (1.06m/s and 1.30m/s) is therefore insignificant on a sample of 120 papaya trees installed on this device**.** These results are different from those of (N'guetti et Al, 2013) which showed in Côte d'Ivoire as part of the 2013 study conducted by UNDP on the vulnerability of the agricultural sector to climate change. That the speed of the prevailing winds recorded in Abidjan, Bouaké and Korhogo shows that the average speed varies between 2 and 5 m/s in Abidjan, 3 and 5.5 m/s in Bouaké and between 2.5 and 6 m/s in Korhogo over the period 1961 – 2000[6]. These strong winds with speeds sometimes exceeding 60 m/s are often devastating for certain crops such as banana, corn, rice and rubber. This is also the case of the study of the impacts of climate change on market gardening in northern Burkina Faso: The case of Ouahigouya (Bognini, 2011) which showed that during the rainy season, it is the maritime trade winds or pseudo- monsoon, cool and humid winds which dominate especially between the months of May and October[7]. The average speed observed in the area is 2.4 km/h. In addition, the speed is considerably reduced between August and October (1.6 km/h). The wind is therefore a major climatic threat in the destruction of crops according to the results of these studies. (Pesant et Al, 2005) reports that a wind of 30 kilometers per hour, circulates at about 15 km/h on the surface of the ground and triggers the process of wind erosion of sensitive soil. Thus, a wind twice as strong has an erosive power three times greater. This means that a wind of 120 km/h has an erosive force three times greater than a wind of 60 km/h.

4.2 Spearman's correlation between the number of falls and rainfall

The result of the calculation of the Spearman coefficient reveals for Rs2 that it is -294.3 for the correlation between the monthly rainfall and the number of papaya trees that falls. This also means that this coefficient is close to -1 to Rs2 and therefore a negative correlation between rainfall and the fall of papaya trees. This can be justified by the fact of low rainfall which does not influence the fall of the papaya trees. The rainiest week over the entire series of months (June to August) for observing the fall papaya plants is the 1st week of July. It has a rainfall value of 2.28mm and the falls are not occurring this week but at 1.57mm and 1.71mm. We also note that, during the month when the falls are the most important (5 papaya trees), the number of rainy days of this month is only 3 days and these rains are not consecutive. Indeed, it is the last month of the small dry season. This negative correlation therefore reflects a rainfall deficit for the growth of the pawpaw tree, because according to (Lassourdiere, 1969) the papaya tree requires abundant rainfall throughout the year. A well-distributed rainfall of 1800 to 2000 mm seems correct. Irrigation is often necessary. It takes 100 to 150 mm of water per month [8].

These results are different from those of the study of the impacts of climate change on market gardening in northern Burkina Faso: the case of Ouahigouya, which showed a positive correlation between tomato yield, which increased from 600 tonnes to 900 tonnes, and that of cabbage from 300 to 400 tons with rainfall of 10,000 to 14,000 mm/year from 2004 to 2006 [7]. Regarding rainfall, the months with low rainfall of less than 50 mm/month: the months of November, December, January and February are concerned. These months mark the major dry season in the study area. During this period of the year, precipitation represents between 1 and 3% of the annual total. However, this study also reveals that the months with heavy rainfall (>150 mm): August, September and October are the rainiest, they represent between 55 and 75% of annual rainfall in the Sudano-Oubanguian and Sudano-Sahelian areas. Rain events are of great importance for the development and maturity of the plants; the heights of water recorded during a day can exceed 50 mm in places during these months with heavy rains and cause flooding of fields near watercourses or in alluvial plains.

4.3 Wind and rain vulnerability indices

The calculation of the papaya tree vulnerability indices to wind and rain gave a value of 6 in both cases. This vulnerability is low because the result of the calculation of these indices for the two wind and rain variables is far from the value 3. In fact, in monoculture papaya trees are protected by a fern windbreak belt which marks low exposure. The natural adaptation capacities of these plants are highlighted by the destroyed male papaya trees which have made it possible to observe roots with an average length of 50cm for plants over 1 meter and 5cm in diameter; and this size is 10cm for plants of 1 meter. The root network (Photo 6) is made up of an average of 5 roots per papaya plant. These roots are deep for the main root and spread out for the secondary roots. This robust adaptive system also justifies the low vulnerability of these plants, which are sown in a zone of deep humid clay soil. There will be no major impact on yields during harvest.

These results are different from those of (Diomandé et Al, 2009) who worked on the vulnerability of rain-fed agriculture to changes in rainfall patterns and adaptation of rural communities in "V-Baoulé" in Côte d'Ivoire. They showed that the vulnerability of rain crops to current climatic conditions is variable depending on the type of crop. For cash crops: we have a maintenance of coffee, the appearance of cashew and rubber; and the abandonment of cocoa. For food crops: we have the maintenance of yams, the emergence of groundnuts and cassava and abandonment of rain rice and maize. The risk or vulnerability index to the rainfall regime is very high for rubber and cocoa and high for yam. They have high water requirements. This risk is moderate for other crops that can withstand water stress [9].

This is also the case of (Atidegla et Al, 2017) in their study on climate variability and market gardening production in the floodplain of Ahomey-Gblon in Benin. Which showed that the evolution of average yields that emerge from the trials of the main crops (tomato, pepper and sweet potato) during the years 2014, 2015 and 2016 is over the three years of production of the high season (April-July) on the plain experienced a decline from year to year for the three cultures. From 2014 to 2016, the tomatoes went from 19.25 t/ha to 12 t/ha in 2016, i.e. a 38% regression, chilli from 7 t/ha to 4 t/ha with a regression of 43% and sweet potato from 10.5 t/ha to 8.2 t/ha, i.e. a regression rate of 22%. They thus note the value (-3.34 mm) of the climatic deficit at least in August clearly shows that this month corresponds to the short dry season [10].

V-Conclusion

The purpose of this work was to study the influence of winds and rains on pawpaw cultivation in the locality of Meyomessala in southern Cameroon. At the end of our study, we showed that papaya plants in monoculture have a low vulnerability to the winds and rains in this locality. Five (5) pawpaw plants and four (4) pawpaw plants fell respectively in the 1st and 4th week of August after two months of field cultivation monitoring. In intercropping, no plant fell. These results are confirmed by the calculation of the wind vulnerability indices and the rain vulnerability index which has a value of 6, therefore far from the value 3.Also, by the Spearman correlation coefficient, therefore the values of the indices are close to -1 for the two cases Rs1 and Rs2. This means a negative correlation between wind speed and the number of pawpaw plants that falls and as well as between rainfall and the fall of pawpaw trees. This low vulnerability of pawpaw trees to wind and rain will not have a negative impact on the yield of this crop in this locality and therefore will not disrupt production. However, during the transition period from the long dry season to the long rainy season (February to March), the winds often have a higher speed, this could be harmful for this crop if the phenomenon persists, as in 2009 in the area because they often tear palm twigs and topple adult banana plants.

Acknowledgment

Thanks to Mr MENOH A NGON René Research Assistant Irad station of Nko'olong for translating this paper French to English.

References

[1] Weighing, Y. ''The relationship between agriculture and energy: the windbreak hedge and its multiple roles in modern agriculture''. Quebec Union for the Conservation of Nature – UQCN. FrancVert, Volume 2 number 1, March 2005. pp 2.

[2] World Bank. ''Development of a concept of vulnerability index to climate and environmental change at the regional level''. Analytical support program for Morocco's climate change strategy. p-esw 113768 . Strategy note no. December 2, 2013. pp 17.

[3] IPCC. ''IPCC report on climate change. Level 1 Summary of Part 1 – The Science Basics ". 2013, pp 1-5.

[4] Racotomalada, R. ''Correlation analysis Study of dependencies - Quantitative variables. Version 1.1. Course material for teaching linear models'' . Lumière Lyon 2 University. 27 Dec 2017.pp 50.

[5] Wilfran, M. ''Scientific Basis for Climate Decisions in National Adaptation Plans''. World Meteorological Organization. Communication services related to climate forecasts. 2019, pp 6.

[6] N'guettia, Y, R. ''Vulnerability study of the agricultural sector in the face of climate change in Côte d'Ivoire'' . Final report 2013, pp 24 -26.

[7] Bognini, S. ''Impacts of climate change on market gardening in northern Burkina Faso: the case of Ouahigouya''. National Network of Agro-Sylvo-Pastoralists of Faso (RENAF). International Training Program on Climate Change Mitigation and Adaptation. pp24-27.

[8] Lassourdiere. A.. ''The Papaya, part three''. French Institute for Overseas Fruit Research. Fruits- Vol 24, no 2, 1969. pp106.

[9] Diomandé, M. ''Vulnerability of rain-fed agriculture to the change in rainfall regime and adaptation of rural communities in the "V-Baoulé" region of Côte d'Ivoire'' . 14th international symposium on environmental assessment Niamey-Niger - 26 to 29 May 200. pp10.

[10] Atidegla, SC. ''Climate variability and vegetable production in the floodplain of Ahomey-Gblon in Benin''. International journal of. Biological and chemical sciences. 11(5): 2254-2269, October 2017. pp 2259-2260.

[11] Eriksen, S;H. ''Developing credible vulnerability indicators for climate adaptation policy assessment'' mitigation and adaptation strategies for global changes(2007)12. Spinger 2006. pp 511

[12] Eckstein, D.''Indice mondial des risques climatiques 2019 résumé . qui souffre le plus des événements météorologiques extremes'' GermanwatchV, Kaiserstasse 201. Décembre 2018. pp 2

[13] Sultan, B. ''Risky climate and agriculture in West Africa". IRD Editions. Synthesis collection. Marseilles, 2020.pp 63-65.

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