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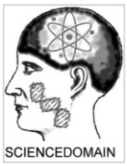

Intercharacter Correlation between Budding Success in *Hevea brasiliensis* Muell. Arg. and Seven Weather Characters

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Authors' contributions

This work was carried out with the collaboration of all authors. Author KOO designed the study and wrote the final manuscript. Author OAE prepared the first manuscript. Author EAI contributed to literature search. All authors read and approved the final manuscript.

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ABSTRACT

Aim: To evaluate the relationship between budding success and weather factors.
Place and Duration of Study: Nursery site of the Rubber Research Institute of Nigeria, Benin City, Nigeria for three years.
Methodology: Seven weather characters were evaluated for correlation with budding success in Rubber Research Institute of Nigeria, Benin City, Nigeria. The seven weather characters were rainfall, relative humidity (RH) at 0900 hrs and 1500 hrs, minimum and maximum temperature, evaporation and radiation. Budding was carried out in the rootstock nursery and data on budding success was recorded over a period of six months for three consecutive years. Data for the corresponding six months was collated and for three years. Intercharacter correlation was calculated for budding success and the seven weather characters. The t-test was applied to test significance of the correlation coefficients.
Results: There was positive correlation between budding success and relative humidity at 0.74 to 0.82, while correlation between budding success was negatively correlated with evaporation at -0.83 to -0.88. Correlation between budding success and radiation was also negative at -0.77. Each significant weather character was significant in correlation with temperature. In this case, relative

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humidity was negatively correlated with temperature at -0.79 to –0.99. Correlation between evaporation and temperature was positive at 0.81 to 0.98 and radiation had significant positive correlation with temperature at 0.81 to 0.98.

Conclusion: The significant correlation coefficients between budding success and three weather characters suggest influence of climate change on budding success for production of planting materials of *Hevea brasiliensis*. This is an indication of appropriate location considerations for nursery facilities in order to enhance budding success. Path analysis to detect direct and indirect effects of the significant weather factors on budding success will be evaluated in further study.

Keywords: Hevea; weather; budding; correlation; nursery; planting materials.

1. INTRODUCTION

Hevea brasiliensis is valued for the natural rubber and it is the major source of natural elastomer world wide. It is an economic crop in many tropical countries such as Nigeria, Cote d'Ivoire, Cameroun and Liberia in West Africa, India, Thailand, Malaysia and China in Asia. *H. brasiliensis* produces viable seeds, yet it is propagated as budded material because of the heterozygosity [1]. The rubber tree is an outcrossing plant and hence undergoes segregation to produce seeds. The implication is that the seeds produced will be different from the mother tree genetically. In order to preserve the genetic integrity of the improved genetic materials, budding is practiced.

Climate change is a common phenomenon all over the world and there is noticeable change in weather pattern affecting a number of agricultural practices and hence models such as ecosystem based management and climate smart agriculture have been recommended [2,3]. Budding success is liable to effect of climate change and this affects the production and availability of planting materials for farmers. This is more relevant as the bulk of farm activities in developing countries is nature dependent. The challenge caused by influence of climate change on budding success is therefore the bases of this study. The objective is to evaluate the response of budding success to six weather characters.

2. MATERIALS AND METHODS

2.1 Study Site and Data Collection

The study was conducted at the nursery of the Rubber Research Institute of Nigeria, Iyanomo, Benin City. Budding was carried out and record of budding success was taken as described by Oghide [4]. Budding was in seven months from April to October each year. There was weather data collection for corresponding months as recorded by the Benin City Station of the Federal Department of Meteorological Services, Nigeria. The weather characters were rainfall, minimum and maximum temperature, relative humidity at 0900 hr and 1500 hr, evaporation and radiation.

The study was conducted in a randomized complete block design consisting of three replications and fifty rootstocks per experimental unit. The test scion clones were PR 107, GT 1 and RRIM 600 and rootstock was raised from unselected seeds in a ground nursery. Budding was carried out by an experienced budder in Rubber Research Institute of Nigeria, Benin City. For the intercharacter analysis, monthly mean budding success was calculated across replications and clones. Rootstock seedling and scion were one year old at the time of budding. The study was carried out in three consecutive years.

2.2 Analysis

Correlation was conducted on the bases of monthly mean values of budding success and respective monthly mean values of the various weather characters. Correlation between budding success and each weather character was calculated in each year and for combined data. The T-test of significant correlation was applied.

3. RESULTS AND DISCUSSION

Intercharacter correlation coefficients among budding success and the six weather characters are presented in Tables 1 - 4 for the various years and combined data. There was significant variation for correlation between budding success and relative humidity, evaporation and radiation (Tables 1 and 4). In a study conducted by Omokhafe and Emuedo [5], relative humidity was a critical factor affecting latex yield in *Hevea*

brasiliensis. There was positive correlation between budding success and relative humidity at 0.74 to 0.82 (Table 1) and this is an indication of high budding success with increasing relative humidity. This justifies concentration of budding activities during the period of high humidity from April to September in many rubber producing countries. Budding during the period of low humidity is often with supplementary water such as irrigation [6].

Table 1. Correlation coefficient of % budding success with weather characters in year I

Weather factor	% budding success	Rainfall	Min. temp.	Max. temp.	Rh 0900 hrs	Rh 1500 hrs	Evaporation
Rainfall	0.39						
Min. Temp	-0.63	-0.41					
Max. Temp	-0.69	-0.58	0.69				
Rh 0900 hrs	0.74*	0.49	-0.90*	-0.91*			
Rh 1500 hrs	0.82*	0.66	-0.85*	-0.91*	0.96*		
Evaporation	-0.88*	-0.59	0.87*	0.84*	0.09	-0.96*	
Radiation	-0.77 *	-0.64	0.85*	0.94*	-0.95*	-0.98*	0.93*

**: Correlation coefficients are significant at P = .05*

Table 2. Correlation coefficient of % budding success with weather characters in year II

Weather factor	% budding success	Rainfall	Min. temp.	Max. temp.	Rh 0900 hrs	Rh 1500 hrs	Evaporation
Rainfall	0.02						
Min. Temp	-0.55	0.07					
Max. Temp	-0.23	-0.1	0.91*				
Rh 0900hrs	0.35	0.26	-0.84*	-0.94*			
Rh 1500hrs	0.16	0.31	-0.83*	-0.97*	0.90*		
Evaporation	-0.29	-0.25	0.87*	0.98*	-0.98*	-0.97*	
Radiation	-0.01	-0.1	0.81*	0.98*	-0.90*	-0.95*	0.94*

**: Correlation coefficients are significant at P = 0.05*

Table 3. Correlation coefficient of % budding success with weather characters in year III

Weather factor	% budding success	Rainfall	Min. temp.	Max. temp.	Rh 0900 hrs	Rh 1500 hrs	Evaporation
Rainfall	-0.12						
Min. Temp	-0.35	-0.25					
Max. Temp	-0.57	0.61	0.78*				
Rh 0900hrs	0.27	-0.65	-0.52	-0.93*			
Rh 1500hrs	0.22	-0.22	-0.79*	-0.98*	0.86*		
Evaporation	-0.71	0.42	0.60	0.81*	-0.76	-0.72	
Radiation	-0.35	0.48	0.59	0.95*	-0.92*	-0.13	0.82*

**: Correlation coefficients are significant at P = 0.05*

Table 4. Correlation coefficient of % budding success with weather characters across the three years

Weather factor	% budding success	Rainfall	Min. temp.	Max. temp.	Rh 0900 hrs	Rh 1500 hrs	Evaporation
Rainfall	0.42						
Min. Temp	-0.69	-0.76*					
Max. Temp	-0.63	-0.69	0.91*				
Rh 0900hrs	0.64	0.64	-0.90*	-0.99*			
Rh 1500hrs	0.59	0.81*	-0.94*	-0.98*	0.96*		
Evaporation	-0.83*	-0.77*	0.96*	0.93*	-0.92*	-0.91*	
Radiation	-0.64	-0.65	0.93*	0.97*	-0.95*	-0.99*	0.89*

**: Correlation coefficients are significant at P = 0.05*

Budding success was negatively correlated with evaporation at -0.83 to -0.88 (Tables 1 and 4). There was significant relationship between evaporation and relative humidity at correlation of -0.91 to -0.98 (Tables 1, 2 and 4). This suggests high evaporation will be accompanied by low relative humidity which can lead to desiccation/dryness of the budding union of scion and rootstock and hence low budding success. This negative impact of evaporation on budding success was reported by Singh et al. [7].

Radiation is a critical primary factor resulting in climate change [8]. According to Hartl-Meier et al. [9], increased radiation induces warmer and dryer ecosystem and this can adversely affect plants especially a grafted system. This is evident in this study with significant negative correlation between budding success and radiation at -0.77 (Table 1). In addition, radiation was negatively correlated with relative humidity at –0.90 to -0.99 (Tables 1 - 4). The relationship between radiation and temperature was positive at 0.81 to 0.98 (Tables 1 - 4). The indirect effects of temperature and relative humidity operating through radiation will be further investigated using path analysis as proposed by Omokhafe and Emuedo [10].

Among other weather factors, relative humidity was negatively correlated with temperature at -0.79 to –0.99 (Tables 1 - 4). The combined effects of temperature and relative humidity have been reported to affect tolerance of the rubber plant to climate change [11,12]. This was further expressed as Temperature-Relative humidity index (THI) described by Mu et al. [13] and Meiyappan et al. [14]. The THI will be applied in subsequent study. Correlation between evaporation and temperature was positive at 0.81 to 0.98 (Tables 1 - 4). Radiation had significant positive correlation with temperature at 0.81 to 0.98 (Tables 1 - 4). The consistent relationship between temperature and the first three weather factors (evaporation, relative humidity and radiation) is a reflection of the position of temperature in climate change. The first concern of climate change is global warming and it is measured as change in temperature [15].

4. CONCLUSION

There was a significant relationship between budding success and each of evaporation, relative humidity and radiation. These three weather characters had significant correlation with temperature. These results suggest appropriate cultural practices to avoid or minimise the hazards of climate change on production of planting materials of *Hevea brasiliensis*. This will be enhanced by better understanding of the indirect effects of temperature either through THI or path analysis.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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