LUKENYA UNIVERSITY

ISSN 2663-3183 MULTIDISCIPLINARY JOURNAL (LUMJ)

Vol 3, (3), p. 98- 105

The Effects of Temperature Variation on Mango Production in Kibwezi Sub County, Makueni County in Kenya

Justus Kimolo

justus.kimolo@gmail.com

Article history
Received: June 29, 2023
Received in revised form: November 1, 2023
Accepted: November 15, 2023
Available online: https://research.lukenyauniversity.ac.ke/

Abstract

Mango (Mangifera indica) is the second most popular fruit within the tropics after banana. It is grown commercially in more than 90 countries globally and consumed in both processed and fresh forms (Mujuka et al., 2020). However, its productivity is adversely affected by severe climatic conditions caused by climate change. Change in rainfall patterns, extreme weather conditions such as drought and floods have become more frequent. This change in climatic conditions is projected to continue in the future. This research project sought to establish the effects of temperature variation on mango production in Kibwezi sub county, Makueni County in Kenya the objective of the study was to assess the effects of temperature variation on mango production in Kibwezi sub county, Makueni County in Kenya. The study utilized a descriptive research design to investigate the effects of climate change in Mango production in Kibwezi East Sub County -Makueni County. The research utilized the questionnaire as the main research instrument to collect data from 398 respondents selected through stratified random sampling. Quantitative data was analyzed using descriptive statistics and presented using frequency distribution tables and bar charts while qualitative data was analyzed thematically based on the objectives and research questions and presented in form of narrative. The findings revealed that there exists a strong and positive correlation between temperature variation and mango production ($r = 0.752$, $p= 0.000$). And that a unit increase in temperature variation will lead to a 0.195 increase in mango production. The study recommends that the national government in conjunction with the county government focus more resources and into mitigating climate change effects so as to maximize mango production.

Key Terms: Arid and Semi-Arid Lands; Temperature; Mango; Mango production; Climatic conditions

1.0 BACKGROUND INFORMATION

Mango production is one of the main agricultural activities in Africa, with the

continent producing over 50% of the world's mangoes. Mangoes are produced in more than 40 African countries. Mangoes form a staple food for many indigenous people in Africa and are also an important export horticultural fruit crop. Mostly, the mangoes are exported to Europe, North America, among other parts of the globe. The main mango varieties grown in Mali are Kent, Tommy Atkins, Keitt, and Haden. These varieties are common due to their sweet, juicy flavor and large size. Mango fruits are an important source of food for many citizens in Mali. They are consumed fresh, dried, or processed into various products, such as juice, nectar, and jams. Johnson, (2013) contends that mango sector will continue to grow in the coming years. This is because of favorable factors, including the increasing demand for mangoes both locally and internationally, the government's support for the sector, and the availability of skilled work force and resources.

Climatic and weather conditions play a major role in the success or failure of commercial mango production (Subedi et al., 2008). Temperature and rainfall amount influence vegetative and phenological phases in mango growth and development. These are two of the most important climatic factors determining suitability of an area for mango production. Climate-related phenomena have already brought varied changes in flowering and fruiting patterns of mango (whiley, et al., 1989). Olesen, (2011) opined that this has adversely affected fruit production in some areas. Normad, (2015) noted that rising temperatures in areas that were previously cold for mango production are making them more suitable for mango production. He further notes that, increase in temperatures during cold months has made mango production possible in the valley areas of Himchal Pradesh and Utarkhand.

Unpredictable rains during pre- flowering and flowering periods may lead to poor fruit set and low pollination activities in mango trees. In the changing climatic scenario, a major portion of the harvest may be wiped out by storms during later fruit development stage (Ploez, 2003). Unpredictable changes in rainfall patterns can have a negative effect on the quality and form of ripe mango fruits. Unseasonal rains provide optimum conditions for pests, this lowers fruit yield. Mangoes grow well in climates that have low rainfall distribution and low relative humidity at flowering, fruit setting and harvesting, and that are warm to hot during fruiting (Sauco, 2000). Although mangoes can withstand a wide range of climates from warm temperate to tropical, anthracnose is a serious problem for mango cultivation in humid and high rainfall environments (Cook 1975; Lim and Khoo 1985; Ploez 2003).

1.1 Statement of the problem

Change in rainfall patterns, extreme weather conditions such as drought and floods have become more frequent. This change in climatic conditions is projected to continue in the future. Kenya will experience an increase in temperature by between 1^0C and 5^0 C by year 2050 while mean annual rainfall is also going to increase particularly in the short rain season in the high to medium potential areas. (Downing C et al.., 2008). Arid and semi-arid areas will likely experience depressed rainfall thereby exacerbating the drought conditions being experienced in those regions. Studies conducted on the impact of climate change on agricultural sector in Kenya have analyzed the impact of climate on general agriculture, (Mati et al., 2002) and (Karanja 2006) attempted to analyze the impact of climate change on maize production. However, results by Mati (2002) were inadequate as they only addressed two ecological zones, yet maize is grown in nearly all seven agro-ecological zones. The study by Karanja

(2006) mainly focused on what? It is important to analyze the impact of climate change at individual crop or animal level so as to enhance a better understanding of how climatic changes continue to affect agricultural production in Kenya. It is in light of this discourse, that this study sought to address and provide some insights on how climate change affects mango production in Makueni County.

Objective

The general objective was to assess the effects of temperature variation on mango production in Kibwezi sub county, Makueni County in Kenya.

2.0 LITERATURE REVIEW

1.1.1. Effects of temperature change on mango production

An increase in temperature changes plant morphology, anatomy and functioning, having advanced effects on seed germination, plant development, flower formation, growth and shedding, pollen viability, gamete fertilization, fruit setting, fruit weight, size and fruit quality (Gora et al., 2019). Most fruit crops are severely affected by hot and cold waves (Malhotra, 2017). In perennial tropical fruit trees such as mango, temperature variation affects flowering. Mango has a vegetative tendency and when temperature rises it bears more number of leaves thus impacting the phenology of flowering. Studies have shown that the hermaphrodite flowers (having both stamen and carpel) percentage in late emerging panicles was higher which also coincided with extreme temperatures (Balogoun et al., 2016; Singh et al., 1966). In bearing or non-bearing trees of mango, scorching of leaves and the dying of twigs are the main symptoms of heat stroke. In mango, the major effects observed during climate change were multiplication of reproductive flushes, early flowering or of of delayed flowering, poor fruit set, reproductive buds transformation into vegetative ones, changes in the fruit maturity etc (Rajan et al., 2011).

In hot & humid situation, the incidence of insect- pests and diseases are more in fruit crops, the attack of Fruit fly is more in such conditions, Papaya Leaf curl virus attack is more prevalent whereas low chilling temperature results to decline in productivity due to extreme temperatures (Hazarika, 2013). In general, higher temperature of 31-32 ºC increases the maturity rate thus shortens the period of fruit development (Turner et al., 2007).

1.1.1 Temperature records from the Kenya Meteorological Department over the last fifty years provide clear evidence of climate change in Kenya, with temperatures generally showing increasing trends in many parts of the country starting from the early 1960s. This evidence is also provided in the State of the Environment Reports published by the National Environment Management Authority (2022).

1.1.2 Earth receives energy from the sun as radiations. About half of this is energy absorbed by the Earth's surface while the rest is re-radiated back into the atmosphere as thermal infrared radiation. Atmospheric greenhouse gases (water vapor, carbon dioxide, methane, nitrous oxide and ozone) absorbs the re-radiated energy and partly redirects the energy back to the Earth's surface resulting to elevated temperatures, above what would be in the absence of the greenhouse gases. (IPCC, 2007). The process is natural and vital as the total absence of the greenhouse gases will result to drastic reduction in of temperature on the Earth's surface to -18°C instead of the current 15°C (Karl and Trenberth, 2003).

Temperature is an important factor affecting photosynthesis and therefore increase in temperature would have a positive effect on photosynthesis. However higher temperature of above 45°C would affect the rate of photosynthesis negatively. This is because it will promote damage to the photosynthesis and respiration machinery. Extremely low

temperature also is counterproductive as it also lowers the rate of photosynthesis. The floral induction of mango tree is mainly driven by cool temperatures. Consequently, increase in temperature would have negative effect on floral induction thus affecting mango production. Whiley et.al (1991) reported that for vegetative induction day temperature of 30°C and night temperature of 25°C is required. For floral induction at 15°C day and 10°C night temperatures are critical in mono and polyembryonic cultivars. The most suitable temperature for the growth of mango is 22°C to 27°C. Therefore, temperature variations affect mango tree growth eventually affecting mango production.

3.0 RESEARCH METHODOLOGY

The research design used was descriptive research design. The target population was farmers growing mango in Kibwezi east Makueni County, Kenya. 398 mango farmers were selected through stratified random sampling. Questionnaires were used to collect data. Quantitative data was analyzed using descriptive statistics and presented using frequency distribution tables and bar charts while qualitative data was analyzed thematically based on the objectives and research questions and presented in form of narrative.

DATA PRESENTATION AND INTERPRETATION

Response rate

200 copies of the questionnaire were wholly filled and returned. This translates to a 50.25% response rate. This response rate was deemed adequate for the study, as Wu et al. (2022) contends that superior statistical research requires a return rate of 50% and above.

1.1.2. Effects of Temperature Variation on Mango Production

1.1.2.1.1 Table 4.9. Respondents' Perception Effects of Temperature Variation on Mango Production

Construct	Mean	Std. Deviation
I have noted increase/ decrease in temperature in the recent past.	4.25	0.770
The temperature variations have impacted positively/ negatively on my mango trees	4.16	0.818
The temperature variations are a great concern to my mango farming	3.98	0.910
I belief human activities are the main cause for temperature variations	4.42	0.629
I belief temperature variations will continue in the near future.	4.51	0.448

The statement that sought to assess on whether respondents have noted increase/ decrease in temperature in the recent past recorded a high mean of 4.25. This is an indication that most of the respondents agreed to this statement. On the other hand, the statement recorded a moderate standard deviation of 0.770, implying that there was a moderate /disparity in the respondents' responses.

A high mean of 4.16 was recorded when respondents were asked whether the temperature variations have impacted positively/ negatively on my mango trees.

This implies that most respondents strongly agree with the statement. A high standard deviation of .818 was recorded for the same statement, an indication that the respondents' responses varied to a large extent.

Most respondents agreed to the statement that sought to know whether the temperature variations are a great concern to my mango farming as indicated by the large mean of 3.98. On the other hand, a moderate standard deviation of 0.910 was recorded on the same statement, an indication that the respondents' responses varied to a high extent.

The statement on whether the respondents believe human activities are the main cause for temperature variations recorded a high mean of 4.42, implying that most of the respondents agreed with the statement. A moderate standard deviation of 0.629 was recorded on the same statement, implying that there was a moderate disparity in the responses given by the respondents.

The statement on whether the respondent's belief temperature variations will continue in the near future recorded a very high mean of 4.51, implying that most of the respondents strongly agreed with the statement. A low standard deviation of 0.448 was recorded on the same statement, implying that there was a low disparity in the responses given by the respondents.

1.1.3. Temperature Variation

1.1.3.1.1 Table 4.13 Correlation Analysis Results for Temperature Variation

		Mango Production	Temperature Variation
Mango Production	Persian Correlation	1.00	
	Sig. (2-tailed)		
Temperature Variation	Persian Correlation	.752**	1.00
	Sig. (2-tailed)	0.00	

** Correlation is significant at the 0.01 level (2-tailed).

Table 4.13 above presents the correlation analysis results between temperature variation and mango production. From the table, it is revealed that there exists a strong and positive correlation between temperature variation and mango production (r = 0.752, p= 0.000). This means that both temperature variation and mango production change in the same direction. Further, the correlation coefficient of 0.752 reveals a strong association between temperature variation and mango production in the study area.

According to the regression model established, taking all factors (temperature variation, rainfall, pests & diseases, phenological aspects) constant at zero, mango production will be 0.530. The data findings analyzed also shows that holding all other variables at zero, a unit increase in temperature variation will lead to a 0.195 increase in mango production.

5.0 CONCLUSION

The study findings clearly indicate that there is a positive correlation between temperature variation affects mango production. More particularly the study findings indicate that: Farmers have noted increase/ decrease in temperature in the recent past (M= 4.25, SD= 0.770); the temperature variations have impacted positively/ negatively on the respondents' mango trees (M= 4.16, SD= 0.818); the temperature variations are a great concern to my mango farming (M= 3.98, SD= 0.910); farmers belief human activities are the main cause for temperature variations (M= 4.42, SD= 0.629); respondents belief temperature variations will continue in the near future. (M= 4.51, SD= 0.448).

6.0 RECOMMANDATION

From the study findings, it is justified to conclude that climate change adversely affects mango production in Kibwezi East sub county Makueni County-Kenya. The study therefore recommends that the national government of Kenya, in conjunction with County Governments should Channel more resources and attention into mitigating climate change so as to maximize on mango production.

6.1 Suggestion of Areas for Further Studies

With the guide of a descriptive research design, this study generally sought determine the effects of climate change on mango production in Kibwezi East sub county Makueni County-Kenya. Specifically, the research was guided by the following research objectives: to evaluate the effects of temperature variation on mango production in Kibwezi sub county, Makueni County in Kenya; to measure the effects of rainfall patterns on mango production in Kibwezi sub county in Makueni County, Kenya; to determine the impact of phenological aspects on mango production in Kibwezi sub county in Makueni County, Kenya; to examine the effects of pests and disease prevalence on mango production in Kibwezi sub-county, Makueni county, Kenya. Based on this context, the study suggests the following as areas for further studies:

1) A similar study should be carried out using different study area, say Kitui County, as a case study, in order to allow comparison and generalization of results.
2) A similar study should be carried out using more independent variables apart from the ones used in this study, so as to allow us to tap into a deeper comprehension of the research topic.

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