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Temporal Trends and Climatic Determinants of Black Pepper Prices in Meghalaya: A Statistical Investigation

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Abstract

This study examines the fluctuations in black pepper prices in Meghalaya and the impact of weather factors on price movements between 2014 and 2025. Sense slope estimate and the Mann-Kendall test were used and the results showed a marginal trend over time. The correlation between maximum temperature and price of black pepper was found to be significant (p=0.043, r=-0.76) amongst maximum temperature, minimum temperature and rainfall. The negative correlation suggests that the increase in maximum temperature beyond the optimal and average temperature range may lead to a decline in production and its quality, which hampers the stability of price in the market. This leads to an increase in the reliance on cheaper imports and getting low price for their domestic produce. These findings strongly suggest the adoption of climate-resilient measures to protect and boost farmer's income and to stabilize the market prices under adverse climatic conditions.

Keywords: Black pepper, Climate variability, Price volatility, Trend

Introduction

Black pepper (*Piper nigram*), being a humid tropical plant require sufficient humidity and rainfall for proper growth and development. It can thrive in the temperature range of 10-40 °C. An optimum temperature of 26-28 °C is required for root development. It is adapted at an elevation of 1500 m above MSL and requires an annual rainfall of 2000-3000 mm. A relative humidity ranging 60-95% during different growth stages is considered to be ideal for successful cultivation of black pepper.

Prices of agricultural commodities reveal two major features *viz.*, rising trend and many fluctuations. Agricultural prices show wider fluctuations. Shortage in supply as compared to demand and higher per-capita income, contributes to increase in agricultural prices (Ganaraja and Rakesh, 2024). A number of factors, including changes in domestic and international production and consumption dynamics, international prices, exchange rates, trade agreements and export-import policies, have contributed to price fluctuations for black pepper, a commodity that is primarily focused on exports (Sabu and Kuruvila, 2016). The lack of flexibility in planting patterns to market pressures has resulted in income volatility and increased risk for trade-dependent perennial cash crops like black pepper.

Effect of Meteorological Parameters

Rainfall has a significant impact on black pepper productivity and phenological stages. Since it encourages new flush, flower initiation and fruit setting, pre-monsoon rainfall (March-April) has a favorable correlation with productivity (Krishnamurthy *et al.*, 2011). It only needs 70 mm of rain over 20 days in May and June to initiate blossoming. After a dry season, rain causes abundant blossoming; thereafter there must be constant precipitation until the fruit ripens. Flowering is adversely affected by a late arrival of southwest monsoon and yield may be decreased by severe rainfall from early March to late June. There is also a negative relationship between production and rainfall in December.

The fresh yield was correlated with meteorological parameters, *viz.*, maximum temperature (T_{max}) and minimum temperature (T_{min}), maximum relative humidity (RH_{max})

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and minimum relative humidity (RH_{min}), rainfall (RAIN), evaporation (EVPN), wind speed (WIND) and bright sunshine hours (SUNS). The magnitude of the correlation was RH_{max} > RAIN > T_{min} > T_{max} > SUNS > WIND > RH_{min} > EVPN (Kandiannan *et al.*, 2011).

Assessment of Temporal Trends and Statistical Relationships

In this study robust statistical tools, *viz.*, Pearson correlation, Multiple linear regression, Mann-Kendall test and Sen's slope estimate were employed to assess the temporal trend of Black pepper price and their relationships with the climatic variables by using proper statistical procedures. The statistical analysis was performed in RStudio 2025.05.0, IBM SPSS statistics 21.0 and Microsoft excel to see the price dynamics and changing patterns in market price of Black pepper in Meghalaya over 12 years from January, 2014 to May, 2025.

Temporal Variations and Trends in Commodity Prices

The Mann-Kendall trend test is a non-parametric statistical method that can find monotonic trends in time series data. It looks at how the prices of black pepper change over time and whether there are any long-term trends. We made annual observations from monthly price data and drew a line graph to show how prices changed over time. This method makes it possible to find any statistically significant rises or falls in the price series of the commodity.

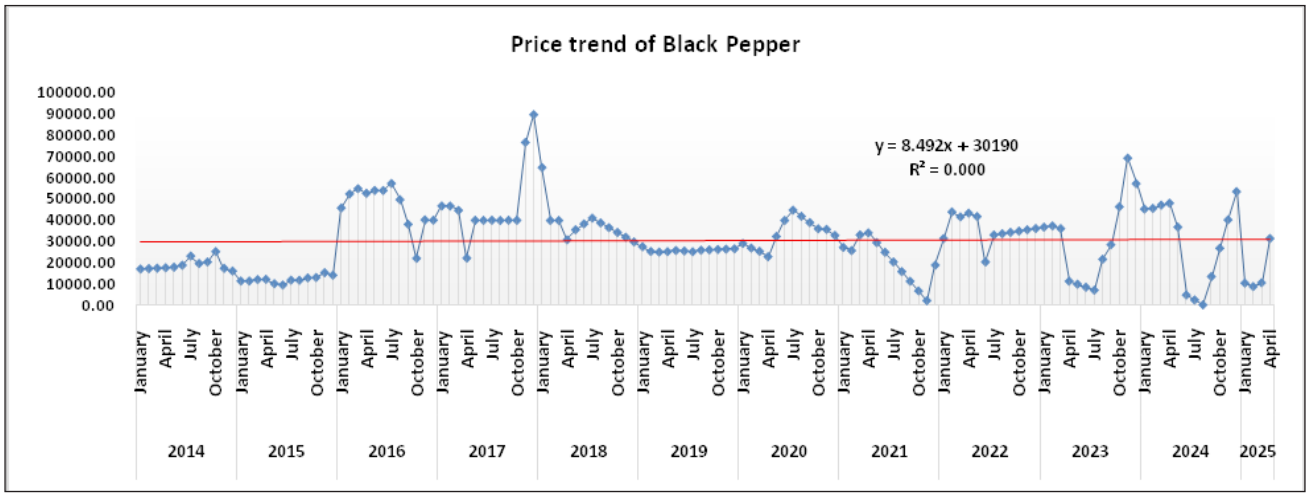

Figure 1: Price trend of black pepper in Meghalaya

Figure 1 shows how the price of black pepper changed in Meghalaya, from January 2014 to April 2025. The equation for the trendline, y = 8.4926x + 30190, has a positive slope, which means that prices have been going up gradually over the time. The price series has a lot of short-term volatility and there isn't a clear pattern of prices going up or down over the decade.

The Mann-Kendall trend test and Sen's Slope estimate were employed to see the presence of a trend over the given period under the study (Table 1). The Mann-Kendall test showed a z-value of 0.4064 (p=0.685) indicating that there exists no significant trend from 2014 to 2025. However, the slightly positive Sen's slope estimate of 18.1594, suggests an increasing pattern for the price of black pepper. But as the trend was statistically not significant, it doesn't provide strong evidence to conclude that the trend is not due to random variation. In conclusion, while the trendline in graph and the Sen's slope estimate demonstrate a marginal trend in price, Mann-Kendall clearly suggests that there exists no significant long-term pattern in black pepper price in Meghalaya.

Table 1: Trend analysis for black pepper prices in Meghalaya

Period	z value	p value	Sen's slope estimate	Lower 95%	Upper 95%
2014-2024	0.4064	0.685	18.1594	-60.5026	100.7833

Relation between Price of Black Pepper and Weather Parameters

Table 2 illustrates that only the maximum temperature has a significant correlation with black pepper prices in Meghalaya (r=--0.76, p=0.043) out of the three climate variables, rainfall, minimum temperature and maximum temperature.

For better growth and development of black pepper the favourable temperature range is between 23 °C and 32 °C, with an average temperature of 28 °C. In Meghalaya, from 2014 to 2025 the average maximum temperature was found to be 29.15 °C, which is slightly higher than the average ideal temperature. As the market price of black pepper is negatively correlated with the maximum temperature, it indicates that; if the temperature rises above this critical value, a significant decline in the price could be witnessed, abruptly affecting on the price dynamics of ginger in the market as well as affecting the livelihood of the farmers in the region. This price instability accounts for different interlinked factors; if the temperature goes up beyond the ideal point, it leads to induction in heat stress which may ultimately affect the production of black pepper massively in the region. Abrupt heat stress during critical stages of growth can alter both its quality and quantity, prompting

Table 2: Correlation analysis of price of black pepper with weather parameters

Particulars	Max. Temp.	Min. Temp.	Rainfall	Lower 95%	Upper 95%
r value	-0.76	-1.22	-0.45	-60.5026	100.7833
p value	0.043*	0.184	0.629		

*Significant at 5% level of significance

to either premature harvesting or increased use of inputs, which can impact market supply and overall price dynamics. However, the price drop is not just attributable to the yield decline; it also includes a number of market responses, such as an upsurge in local imports, an abrupt shift in demand, or reductions in prices subject to product quality.

Regression Analysis of Maximum Temperature, Minimum Temperature and Rainfall Extremes on Price Volatility of Black Pepper in Meghalaya

Table 3 illustrates the multiple linear regressions to see the impact of weather variables on the Price of black pepper. The price of black pepper was considered as a dependent variable and three climatic parameters, *viz.*, minimum temperature, maximum temperature and rainfall were taken as independent variables whose influence was being tested using suitable statistical procedures. The intercept with a coefficient of 44,953.20 was found to be significant (p-value = 0.004), revealing that when all the independent variables (maximum temperature, minimum temperature and rainfall) are assumed to be constant at zero, roughly the estimated price of black pepper will be approximately ₹ 44,953.20.

Table 3: Regression of black pepper price with max temp, min temp and rainfall

Particulars	Coefficients	Standard error	t stat	p-value	Lower 95%	Upper 95%
Intercept	44,953.20	15,112.66	2.97	0.004*	15,020.66	74,885.73
Max. Temp.	-221.53	538.57	-0.41	0.032*	-1,288.23	845.17
Min. Temp.	-410.70	371.13	-1.11	0.271	-1,145.77	324.36
Rainfall	1.72	4.89	0.35	0.725	-7.97	11.42

*Significant at 5% level of significance

Out of the three climatic variables, only maximum temperature was found to be significant (p-value = 0.032) at 5% level of significance, which demonstrates that maximum temperature has a major impact on market price of black pepper. This result derived a negative coefficient of -221.53, which signifies that, increase in one unit in maximum temperature leads to a substantial decline in price and it ultimately tends to instability of price in local market which may enormously affect the market channels in Meghalaya. The coefficient solely lies in the confidence interval between -1,288.23 and 845.17, indicates that the decline in price may vary within a long-range, revealing the uncertainty of the market in Meghalaya. This may be due to the increase in heat stress, which can alter both its quality and quantity, prompting increased use of inputs, which can influence overall price stability in the market. When supply in the local market declines, it results in a rise in local imports, which might result in a reduction of the black pepper price in the market. In the long run, this abrupt shift in the demand supply channel and sudden increase in price instability in the local market may affect farmers' income and livelihood in the region.

In conclusion, regression analysis suggested maximum temperature as a significant factor among all the included meteorological parameters, which strongly influenced the price dynamics and its stability, indicating the sensitivity of black pepper markets to heat stress due to increase in maximum temperature. The findings of this study highlight the importance of temperature management strategies and heat resilient practices in black pepper cultivation, especially under unfavorable shifting weather conditions.

Conclusion

The current research investigates the influence of the temporal price change and climate parameters on the production of black pepper in Meghalaya between 2014 and 2025. Trend analysis showed no significant long-term trend in price because there was some fluctuation but no distinct uptrend or downtrend. Among the three climatic factors considered, the minimum temperature and rainfall did not impact the trends on price. Higher temperature indicates a negative correlation which affects the productivity and quality of black pepper when temperature increases above optimal temperature leading to lower market prices. This gives us a chance to developed climate resilient agriculture techniques and strengthens our irrigation systems that can withstand higher temperature. This also offers a chance for policy makers and stake holders to develop adaptive solutions to weather fluctuations and market actions to protect the farmer's earnings and maintain sustainable black pepper production.

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References

Ganaraja, K., Rakesh, T.S., 2024. Growth and instability analysis of pepper with reference to production and price. *SDMIMD Journal of Management* 15, 55-61.

DOI: https://doi.org/10.18311/sdmimd/2024/42106.

Kandiannan, K., Parthasarathy, U., Krishnamurthy, K.S., Thankamani, C.K., Srinivasan, V., Aipe, K.C., 2011. Modeling the association of weather and black pepper yield. *Indian Journal of Horticulture* 68(1), 96-102.

Krishnamurthy, K.S., Kandiannan, K., Sibin, C., Chempakam, B., Ankegowda, S.J., 2011. Trends in climate and productivity and relationship between climatic variables and productivity in black pepper (*Piper nigrum*). *Indian Journal of Agricultural Sciences* 81(8), 729-733.

Sabu, S.S., Kuruvila, A., 2016. Price instability in black pepper: A comparative analysis of preliberalisation and post-liberalisation periods. *Journal of Tropical Agriculture* 54(1), 41-49.