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CLIMATE CHANGE AND BLACK PEPPER PRODUCTION

K. Kandiannan, K.S. Krishnamurthy, S. J. Anke Gowda and M. Anandaraj*

Black pepper (*Piper nigrum* L.) belongs to botanical family Piperaceae, native to Western Ghats of India and popularly called 'Black gold' and 'King of Spices' is an important commodity of trade along the erstwhile "Spice route". In ancient times it was sourced by the Arabs and sold to the Europeans and subsequently the Europeans themselves found out the production centres and they also spread the crop across the globe, presently it is cultivated in more than 25 countries in Asia, Africa and South America. Area, production and export of important countries are given in Table 1. Out of 0.525 million ha, 41.4 % of the global area under pepper is in India with a production share of 17.9%. Vietnam share to global production and export is the maximum, 28.9% and 40.0%, respectively. On an average 70.1% of the global production is exported, comparatively share of export to production is less from Madagascar (10.6%), China P.R. (18.1%), India (37.6%), Thailand (45.7%) and the remaining countries are exporting above 50.0% of their production (Table1). During 2013-14, India exported 15,363 tonnes of pepper valued Rs. 63,810.29 lakhs to more than 30 countries.

Table 1. Global production and export of black pepper (Mean of 10 years 2001-2010)

Country	Area (ha)	% share by country	Production (MT)	% Share by country	Export (MT)	% Share by country	% share of export to production
Brazil	33000	6.3	43020	12.6	37053	15.5	86.1
India	217738	41.4	61115	17.9	23006	9.6	37.6
Indonesia	154299	29.4	61300	18.0	48236	20.2	78.7
Malaysia	13255	2.5	21750	6.4	17528	7.3	80.6
Sri Lanka	30233	5.8	13194	3.9	7536	3.1	57.1
Vietnam	47691	9.1	98832	28.9	95776	40.0	96.9
China, P.R.	19693	3.7	24630	7.2	4465	1.9	18.1
Madagascar	4000	0.8	9788	2.9	1041	0.4	10.6
Thailand	2818	0.5	2748	0.8	1255	0.5	45.7
Others	2950	0.6	5043	1.5	3469	1.4	68.8
Total	525677	100.0	341419	100.0	239364	100.0	70.1

Source: International Pepper Community, Jakarta.

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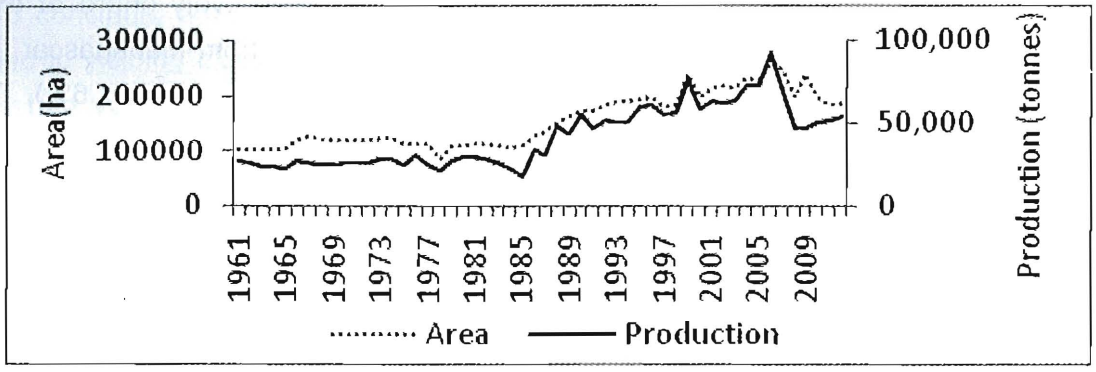
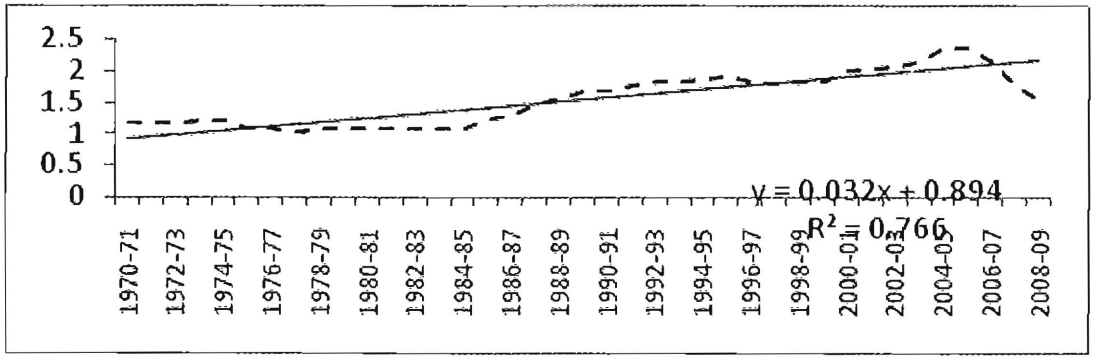
Trend in area, production and yield of pepper

National Horticultural Board's advance estimate indicated that at present (2013-14) pepper has an area of 1,17,770 ha with a production of 45, 000 tonnes in India. Major producers are Kerala, Karnataka and Tamil Nadu and NE States also contribute to some extent. All India area and production trend (Fig 1a) indicated a stagnation between 1961 and 1985, subsequently there is an increasing trend between 1986 and 2005 and afterwards there is a decline. Similar trend in area (Fig 1b), production (Fig 1c) and yield (Fig 1d) has also been noticed in Kerala. These changes could be due to developmental efforts, prevailing market price, climate change, statistical estimation, etc.,

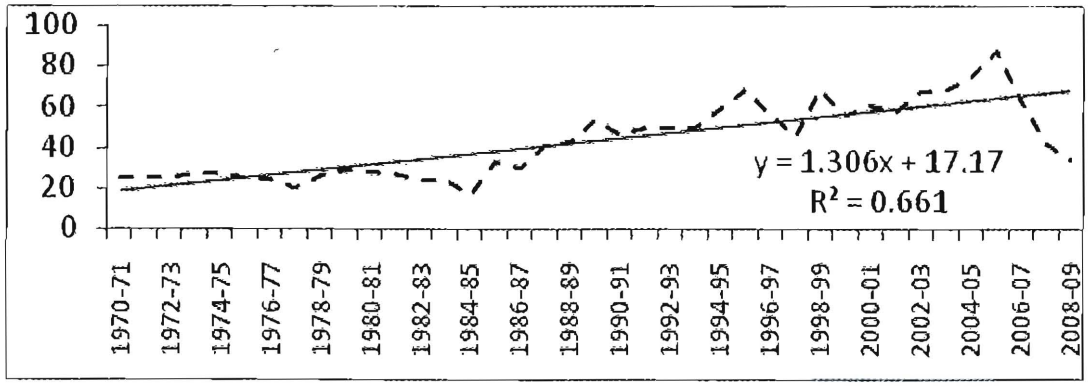
Fig 1. Black pepper



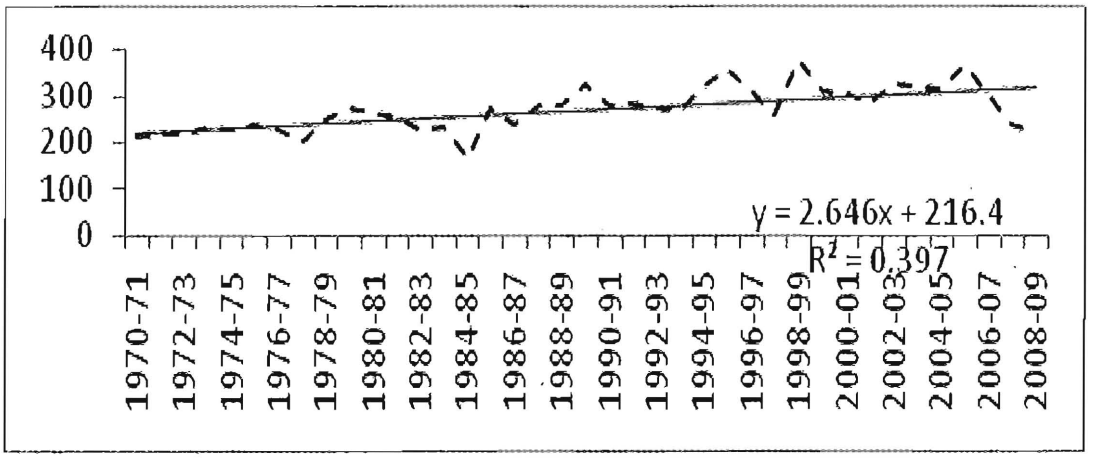
(1a) Trend in all India area (ha) and production (tonnes) (Source: FAO STAT),



(1b) Kerala area (lakh ha)



(1c) Kerala production ('000 tonnes)



(1d) Kerala yield (kg/ha)

(Source: Farm Guide, Govt. of Kerala).

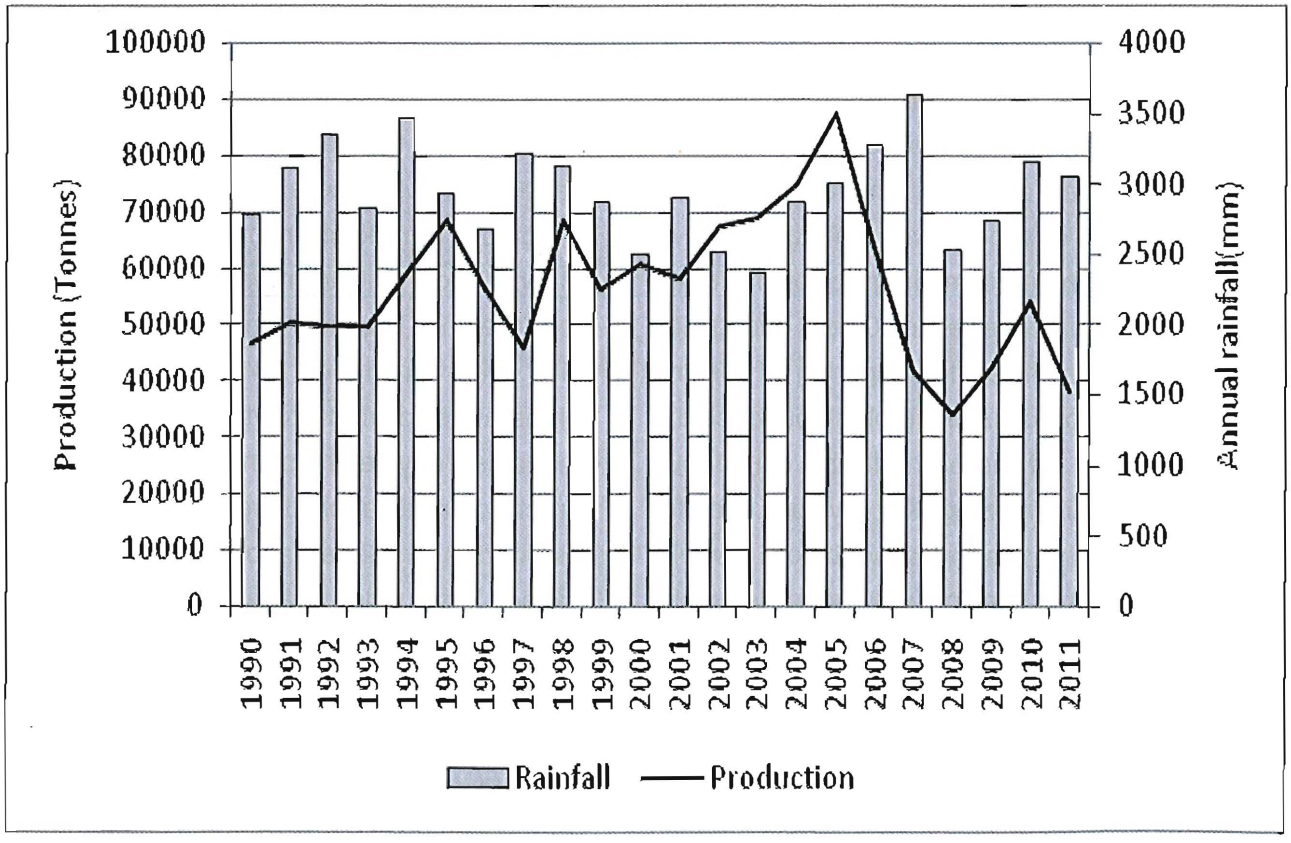
Climate requirement of pepper

Black pepper grows successfully between 20° North to 20° South of equator and from sea level up to 1500 m above MSL. It is a plant of humid tropics, requiring 2000 - 3000 mm of rainfall, tropical temperature and high relative humidity with little variation in day length throughout the year. Pepper does not like excessive heat and dryness. Total rainfall and its distribution play an important role in pepper cultivation and its productivity. Annual rainfall of 2000 mm with uniform distribution is ideal. Rainfall of 70 mm received in 20 days during May - June may be sufficient for triggering off flushing and flowering process in the plant, but once the process is set off there should be continuous shower until fruit ripening. Any dry spell even for a few days, within this critical period of 16 weeks (Flowering to Fruit ripening) will result in low yield. In pepper growing areas of Indonesia and Malaysia (Sarawak) the average annual rainfall is 2300 mm and 3950 mm, respectively. In India pepper growing areas receive 1500 to more than 4000 mm rainfall. Rainfall after stress induced profuse flowering. Heavy rains during flowering reduces the rate of pollination and continuous heavy rainfall promotes vegetative development and limits flowering. Growth of fruit bearing lateral shoots (plagiotropes) and photosynthetic rate were maximum during peak monsoon in India (June - July). A relative humidity of 60 -95 per cent is conducive for optimum growth at various stages of growth. There is not much work on the effect of rainfall characters on production especially on spiking intensity, pollination and beery setting. The ideal temperature is 23-32° C with an average of 28° C. Optimum soil temperature for root growth is 26-28° C. Black pepper is a day neutral plant. Pepper exposed to direct solar radiation developed physiological disorders even under favourable soil moisture. Pepper kept under shade (7 % incident light) remained green and healthy whereas fully exposed to sunlight turned yellow and developed necrotic patches during summer. Illumination above 50, 000 lux (900μ mol $s^{-1}m^{-2}$) decreased carbon fixation in a few varieties of pepper.

Black pepper production in relation to annual rainfall

Black pepper is mainly grown as rainfed crop. It is not irrigated generally except for young vines or when it is grown under the shade trees in tea and coffee plantations. Fig 2 indicates the annual rainfall receipt of Kerala and corresponding year pepper production. Although it is a rainfed crop, we cannot directly attribute the high annual rainfall receipt to enhanced production. It is evident that apart from the quantum of rainfall received, it's uniform distribution is essential to witness higher productivity. The rainfall pattern and pepper yields during two extremely adverse years (1980-81 and 1986-87) when compared to that of a favourable year (1981-82) indicated that during both adverse years, there was a distinct break in the rainfall during critical period following flower initiation. The break was experienced at two different times and therefore at different stages of the crop during the two years, but in both cases, the pepper yields were as low as 24.3% of the normal years' yield. On the contrary, during 1981-82, the favourable year, the precipitation remained steady without any break and the pepper yields were high. It is also reported that rainfall of 70 mm received in 20 days during May-June has been sufficient for triggering off flushing and flowering process in black pepper, but once the process is set off there should be continuous shower until fruit ripening. Any dry spell even for few days, within this critical period of 16 weeks (flowering to fruit ripening) would result in low yield.

Fig. 2. Black pepper production and annual rainfall over the years in Kerala



The change in rainfall pattern during 1999-2000 crop season affected the flowering and yield of black pepper in Idukki, a predominant black pepper growing zone. Similar observation was also noted in Bangka, Indonesia. We found that there is an increasing trend in rainfall during summer month that could affect the flowering pattern of black pepper. *Phytophthora palmivora* infection of black pepper in an arecanut-black pepper mixed cropping system was positively correlated with rainfall, number of rainy days and relative humidity and was negatively correlated with temperature and sunshine hours. A daily rainfall of 15.8-23mm, RH of 81-99%, temperature range of 22.7°C-29.6°C and sunshine hours of 2.8-3.5/day during the peak monsoon period of the year are conducive for the maximum development of the disease.

Climate change and black pepper productivity

It was observed that the long term mean annual rainfall of the Kerala state is 2817 ± 406 mm and it is highly stable and dependable. However, spatial variability is also noticed. For example, in Wayanad, the annual and monsoon rainfall are declining. Rainfall decline and temperature increase are projected over Ambalavayal. Several black pepper gardens were wiped out during summer 2004 due to the non-receipt of summer showers. Spatial and temporal variation in rainfall is common nowadays. Study of long series of climatological data for 140 years over Kerala in the humid tropics of India indicated the cyclic pattern in rainfall with a declining trend in annual and southwest monsoon rainfall during the past 60 years. In contrast, there was an increasing trend in post monsoon rainfall, indicating likely shifts in rainfall patterns. Onset of monsoon over Kerala, the Gateway of monsoon, appears to be little early. If the onset of monsoon is early, i.e. on or before 25th May, the monsoon rainfall is below normal or normal over Kerala. Rise in maximum and minimum temperatures was also noticed since last 49 years over Kerala. The day maxima increase was 0.64° C while the night minimum increase was 0.23°C. Increase in mean annual surface air temperature over Kerala was 0.44°C. Such warming was noticed in the entire West Coast. The difference in maximum and minimum temperatures (temperature range) is widening where thermo-sensitive crops like cardamom, tea, black pepper and cocoa are grown along the high ranges. These changes in thermal and moisture regimes have resulted in climate shifts from B4-B3 to B2-B1, moving Kerala from wetness to dryness within the humid climates. The impact of climate change in the form of climate variability like floods and droughts adversely affected food and plantation crops to a large extent. Climatic trend presented below (Table 2) indicated the declining trend in rainfall in main black pepper producing centers.

Table 2. Trend analysis of climatic variables and black pepper productivity

Place	Rainfall	TMAX	TMIN	Productivity
Ambalavayal (Wynad Dist.)	Decreasing	Increasing	Increasing	Decreasing
Pampadumpara (Idukki Dist.)	Decreasing	-	Increasing	Increasing
Panniyur (Cannanore Dist.)	Decreasing	Increasing	Increasing	Decreasing
Trichur	Decreasing	Decreasing	No trend	Decreasing

Conclusion

Black pepper - The King of Spices is a native of Kerala and its diversified uses demands more production. However, area expansion is not possible. Production bases are shrinking. Spatial and temporal variation in weather particularly rainfall and temperature are a great concern in augmenting the productivity of this rainfed crop. Climate change is evident and it is a great challenge for scientific community to find solutions to mitigate the ill-effect. The work already has been initiated on drought tolerance studies and breeding programme to find better ideotypes and crop management aspects such as water conservation, irrigation, mulching, cropping system etc., to modulate the weather effects. The climate change also would bring new pests and pathogens apart from causing erosion to native gene banks and it is essential to gear-up and set priorities to meet the challenges.

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