



Kodoth Prabhakaran Nair

The Geography of Black Pepper (*Piper nigrum*)

The “King” of Spices

Volume 1

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To Pankajam, my wife, who is all to me

Preface

This book is about the world's most important spice crop, black pepper, known as the “King” of spices.

Black pepper has a checkered history, dating back to the times of Queen Sheeba and King Solomon (B.C. 1015–B.C. 66), which has influenced the destiny of nations and their people across the world, both economically and culturally. Today, black pepper commands the leading position among different spices as one of immense commercial importance in world trade, and is finding its way onto dining tables of millions around the world, even in Europe, North America, and Japan. Pepper use ranges from a simple dietary constituent to that of immense pharmacological benefit. Though beset with many problems, both agronomic and economic, it is a safe bet that pepper will emerge as the world's most sought-after spice; its global demand is predicted to escalate colossally to about 280,000 metric tons by the year 2020, which will further climb to 360,000 metric tons by 2050.

This book's exhaustive review details the various constraints in enhancing pepper productivity and charts contours of a new course of action. Among the primary constraints in pepper production is the absence of an ideal ideotype that combines many positive traits to boost production potential while, at the same time, resisting the ravages of nature—such as the dreaded disease foot rot, caused by the *Phytophthora* fungi. The book also includes an exclusive chapter on a revolutionary soil management concept, developed by the author over three decades of research in Europe, Africa, and Asia, now globally known as the “nutrient buffer power concept,” which has challenged the conventional wisdom of industrial agriculture, euphemistically known as the “green revolution.” The book specifically details the work of the author on pepper nutrition with zinc, the most important micronutrient, which is suspected to be an intermediary in causing the *Phytophthora* onslaught in the quick wilt disease.

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Chapter 1

Introduction



Abstract The chapter traces the history of black pepper starting from the time of Queen of Sheba and King Solomon (BC 1015–BC 66) up to recent times. It lays stress on the fact that what the East India Company started as a trade in spices in India finally led to the colonization of the country. The chapter provides details of the spread of black pepper in the world, the acreage, the production, and the productivity. Among the Indian States, Kerala tops in black pepper production.

Keywords “King” of spices · British East India Company · Global distribution

Known as the “King” of spices, black pepper (*Piper nigrum*), a perennial crop of the tropics, is economically the most important and the most widely used spice crop of the world. The history of spices is very much entwined with the history of mankind. But, within the family of spices, black pepper predominates. In ancient Egypt, when the mummified body of the Pharaoh was laid to rest in the Pyramids, it was black pepper (along with gold and silver) that was kept adjacent to the body, in the belief that even in the afterlife this very important spice would be of use. The ancient scriptures, Bible, Koran, and the Vedas mention the use of spices. According to the Bible, it was during the royal visit of Queen Sheba to King Solomon (BC 1015–BC 66) that a caravan load of spices, primarily pepper, was presented by the former to the latter. Nearly 3000 years before the birth of Christ, both Babylonians and Assyrians were trading in spices, primarily black pepper, with the people of the Malabar Coast in the state of Kerala on the Indian subcontinent. Also, the ancient Indian medical texts, such as *Ashtangahridaya* and *Samhitas*, mention the use of pepper in rare and unique medical formulations. That spices, and in particular, pepper, had such a lasting impact on the economic prosperity of places is revealed by the fact that cities like Alexandria, Genoa, and Venice can trace their economic prosperity back to the vigorous trade in spices (Rosengarten 1973). Parry (1969) observed that due to the increased demand and consumption of pepper in England and Europe, a guild known as “Pepperers”—the wealthiest of the merchants—was established in London. The high price of pepper made it the exclusive commodity in

use by the rich for culinary purposes. But, it is interesting to note that with the arrival of pepper, the Western kitchen transformed when “dishes took on a fullness of flavor previously unknown, beverages glowed with a redolent tang, and life experienced a new sense of warmth and satisfaction” (Parry 1969). King Solomon of Israel and the Phoenician King, Hiram of Tyre, obtained their spices from the coast of Malabar (Rosengarten 1973). Though the Jews and Arabs were well into the spice trade by this time, it was the latter who had a domineering role, which was later usurped by the Romans. However, the Arabs were privy to the knowledge of the country of origin of pepper and even secretly kept the sea route knowledge to themselves. But, the onslaught of the Roman Empire changed all that during the first century A.D. when Rome captured Egypt. It was around A.D. 40, during the reign of Roman Emperor Claudius that the enterprising Greek merchant mariner Hippalus, who—after discovering the full power and velocity of wind movement of the Indian ocean, a secret guarded by the Arabs—let it become known that a round trip to Egypt via India could be completed in less than 1 year (Rosengarten 1973). A consequence of the great economic scale of this discovery was that when the sea route came to be known, the dependence on the overland trade routes declined substantially; several wealthy cities on the overland trade route went into economic penury (Ummer 1989). Hippalus and many others reached the coast of Malabar and returned to Rome with loads of pepper and other spices. The Roman dominance on the spice trade completely eclipsed the Arabs. Interestingly, among all the spices, it was pepper that the Romans fancied most, despite its “obnoxious pungency” as noted by Pliny the Elder in his *Natural History* compiled between A.D. 23 and A.D. 79. It is also interesting to note that just about the time Arabs were getting involved in the spice trade with the Malabar Coast, the Chinese also entered the fray. As early as the first century A.D., a royal messenger reached the Malabar Coast in search of spices, and the trade relationship between China and the Malabar Coast began to flourish as recorded by travelers, such as Sulaiman, who reached the Malabar Coast in A.D. 851 (Ummer 1989). It was the Chinese who played an important part in spreading pepper to Southeast Asia and Far East Asia, and it was during the voyages of Zheng He (1405–1433) that China imported as much pepper as the total quantity imported into Europe during the first half of the tenth century (T’ien 1981). The Chinese trade was an imperial monopoly. In the fifteenth century, soldiers in China were partly paid in pepper, as were government officials, as observed by T’ien (1981). The fabulous Chinese ships that carried pepper were greatly praised by the venerable explorer Marco Polo (Mahindru 1982).

The colonization of the Indian subcontinent had much to do with the pepper trade. It was the lure of the spice trade that led Vasco de Gama, the great Portuguese explorer, to discover the sea route to India, and he landed on the Malabar Coast at the Kappad beach near the presently named city of Kozhikode (Calicut) on 20 May 1498. Vasco de Gama and his men returned to Portugal immensely rich, but in the process also put an end to the Arab trade. The Portuguese King, Dom Manuel, was so greatly impressed with the pepper bounty that Gama brought back home that he sent a naval contingent with a fleet of 13 battle ships to India under the command of Pedro Alvares Cabral in A.D. 1500; he went further to declare sovereignty over

India, along with other countries such as Ethiopia and Arabia (Rosengarten 1973). The Portuguese domination of Kerala through pepper production and trade was so complete that this tiny state of India turned out to be the cradle of world pepper. The Portuguese rulers were ruthless, and their only aim was to make the most out of the pepper trade. However, the scene changed in the first quarter of the seventeenth century with the arrival of the Dutch. The Dutch were temporarily successful in elbowing out the Portuguese until the British came on the scene in A.D. 1600. In hindsight, what is most astonishing is how a trade war in pepper between the Dutch and the British led to the establishment of the British Empire on the Indian subcontinent.

The historians Collins and Lapierre, in their monumental work *Freedom at Midnight* (1976), make a remarkable observation as follows.

Sometimes history's most grandiose accomplishments have the most banal of origins. Great Britain was set on the road to the great colonial adventure for five miserable shillings. They represented the increase in price of a pound of pepper proclaimed by the Dutch privateers who then controlled the spice trade. Incensed at what they considered a wholly unwarranted gesture, 24 merchants of the city of London gathered on the afternoon of 24 September 1599 A.D. in a decrepit building on Leadenhall Street. Their purpose was to find a modest trading firm with an initial capital of £72,000 subscribed by 125 shareholders. Only the simplest of concerns, that is, profit, inspired their enterprise, which expanded and transformed, would ultimately become the most noteworthy creation of the age of imperialism—the British Raj.

The British East India Company came into being on 31 December 1600 (with the stamp of approval by Queen Elizabeth I). Just 36 years later (1636), when the 500-ton ship *Hector* landed in the Surat port, north of Bombay, the Company laid the long and tortuous road to the subjugation of the vast millions of Indians through the pepper trade. In more than one sense, pepper was the cause of India losing its sovereignty.

It was only in the last quarter of the eighteenth century that the Americans entered the pepper trade. The first sponsored trip to the East Indies was organized by Capt. Jonathan Carnes in 1795. Though the American pepper trade flourished until 1810, it later declined, coinciding with the American Civil War in 1861. Compared with the Portuguese, Dutch, and British, the impact of Americans on the pepper trade was only marginal. The Americans traveled to Sumatra to fetch pepper. By 1933, pepper was introduced to Brazil, and in 1938, it reached the Republic of Malagasy. By 1954, pepper was introduced to the African continent.

Within the Indian Republic, the tiny state of Kerala can pride itself as the home of pepper, in particular, the coastal region of Malabar, in the state of Kerala, which accounts for 95% of the country's area and production (Anon. 1997). Besides Kerala, two other states in the southern region—namely, Tamil Nadu and Karnataka—contribute the remainder. The first research station of pepper in the world was established in Kerala in a small town named Panniyur on the Malabar Coast during 1952 and 1953. In addition, the first hybrid pepper—Panniyur-1—in the world was released by this station in 1966 (Fig. 1.1). Following research at



Fig. 1.1 Panniyur-1, the first pepper hybrid developed in the world at the Panniyur Pepper Research Station, in Kerala State, India

Panniyur, pepper research began in Sarawak (Malaysia) in 1955. Following the success of the “green revolution” in India, several coordinated research projects catering to the specific needs of individual crops were established by the Indian Council of Agricultural Research, headquartered in New Delhi. Thus, the All India Coordinated Research Project on Spices, with an intense focus on pepper, was established in 1971. More than 30 years later, the project has included other spice crops as well, yet pepper continues to receive the most attention against the background of the current liberalization and globalization process, and the World Trade Organization (WTO) mandated changes. The future of pepper is most crucial to the economy of India vis-à-vis the economy of the state of Kerala, where it is the economic mainstay.

Many other tropical countries have made concerted efforts to grow pepper in view of its global economic importance, the most important being Indonesia, where the International Pepper Community (IPC) is headquartered in Jakarta. Indonesia is second to India as a pepper-growing country. It was either through the Polynesian seafarers or through the Babylonian-Chinese sea route linking the Malabar Coast and southeast and Far East Asia that pepper reached Indonesia. Indonesia, known as the Dutch East Indies during the pre-World War II period, was the largest pepper producer. It was during the Japanese occupation during the war that many plantations were abandoned and production declined sharply. During the prewar period, Indonesia had close to 30,000 ha of pepper (Lawrence 1981). Malaysia and Sri Lanka are the other two major pepper producers. It was the European settlers who introduced pepper to Malaysia, while in Sri Lanka, pepper was grown as a mixed crop with other crops like cocoa. The foreign occupation of Sri Lanka helped pepper cultivation expand in the country. In the Southeast Asian countries such as Thailand, Vietnam, Cambodia, South Korea, and parts of South China, pepper cultivation took

Table 1.1 Acreage, production, and productivity of major pepper-growing countries in the last decade of the twentieth century

Country	Area (ha)	Production (metric tons)	Productivity (kg ha ⁻¹)
Brazil	26,500	23,400	883
China	13,170	11,045	839
India	191,426	56,200	294
Indonesia	110,580	45,240	409
Madagascar	4228	2160	511
Malaysia	8960	16,920	1888
Mexico	1294	1112	859
Sri Lanka	12,080	5058	419
Thailand	2808	10,091	3594
Vietnam	15,700	17,266	1100

hold in the postwar years. Within the Southeast Asian countries, Vietnam is beginning to emerge as a major pepper grower. Within the South Pacific islands, Fiji is the most important pepper-growing country. In South America, Brazil is the leader, followed by Mexico, Guatemala, Honduras, Saint Lucia, Costa Rica, and Puerto Rico. Within the African continent, Madagascar leads the pack followed by Malawi, Zimbabwe, Benin, Kenya, Nigeria, Cameroon, Congo, and Ethiopia.

Within Asia, where pepper production is concentrated, Malaysia takes third place next to Indonesia, with an Agricultural Research Station in Kutching, Sarawak. Indonesia, which takes second place, has the Research Institute for Spice and Medicinal Plants in Bogor. Though India tops the list among the producers in acreage, with a total area of 191,426 ha and a production of 56,200 metric tons, its productivity is the lowest in the world with just 294 kg ha⁻¹, while Thailand, with a total area of only 2808 ha, tops the list with a productivity of 3594 kg ha⁻¹ (Table 1.1). The International Trade Center (ITC) in Geneva, Switzerland, estimates the current trade in spices at 400,000–450,000 metric tons with a total value of US \$1.5–\$2 billion annually. With an annual growth rate of 3.6% in quantity and 8.4% in value in spices, pepper contributes 34% of total trade in spices. Within the industrialized west, Denmark tops the list in pepper consumption, followed closely by Germany and Belgium. The USA is a sizable consumer, while Canada and Switzerland tail the list.

Post-Doha (World Trade Organization (WTO) held an important meeting in Doha, Qatar, on global trade regulations, including agriculture) negotiations, agriculture will increasingly play a crucial role in the world economy. Among the spices, pepper will play a major role. By 2010, projected world consumption will reach 230,000 metric tons, which scales up to 280,000 metric tons by 2020, which means an annual increase of 5000 metric tons. Present production is close to 200,000 metric tons. For the next two decades, close to 100,000 metric tons will be needed to balance the projected demand and consumption. Worldwide, especially in the industrialized countries, there is a growing demand for premium organically grown pepper. The potential for the organic food market is close to US \$8 billion

now in the USA, which is followed by Germany and Japan, each with a market share of close to US \$2.5 billion. A substantial part of this market will be for pepper. This would imply that future production strategies would need to increasingly focus on clean pepper production, which has to withstand both biotic and abiotic stresses without recourse to high input chemical technology—the hallmark of the so-called green revolution.

There are areas of pepper production that simultaneously pose great challenges while opening up new avenues. One of the most daunting in the former category is the evolution of a pepper variety that is totally resistant to “foot rot,” caused by the fungus *Phytophthora*, which has wiped out many pepper plantations. Also, pepper nutrition is still far from being thoroughly understood. The fact that it is a perennial crop adds to the lack of thorough understanding. Despite the complexity of soil science and emergent soil management practices, the basic concept of soil as a medium of plant growth can be expected to persist for an indefinite length of time (Nair 1996). But it is becoming clearer that the earlier views on soil as merely a “supportive medium” for plant growth is giving place to new ones on managerial concepts of this supportive medium. This is amply illustrated by the shift in focus from the green revolution phase of the 1960s to mid-1970s—where application of increasing quantities of soil inputs, such as fertilizers and pesticides, was emphasized—to the sustainable agriculture phase of the early 1980s continuing to the present; sustainable agriculture places more reliance on biological processes by adopting genotypes to adverse soil conditions, enhancing soil biological activity, and optimizing nutrient cycling to minimize external inputs (such as fertilizers) and maximize their efficiency of use. In fact, the paradigm of the earlier phase has given way to an emergent new paradigm (Sanchez 1994), and this is clearly reflected in the dialogue of the world leaders during the Earth Summit in 1991 in Rio de Janeiro, Brazil, where Agenda 21 incorporated six chapters on soil management (Keating 1993). This review on pepper, while discussing its overall production profile in the world, will place a special emphasis on the second paradigm inasmuch as prescriptive soil management for pepper production is concerned with regard to understanding the soil nutrient bioavailability and its efficient management in the pepper production. On account of the paucity of published literature on this aspect, the focus will only be with regard to specific nutrients, such as zinc, which is becoming increasingly important in pepper production.

References

- Anon (1997) Spice export grows to an all time record. *Spice India* 10:2–4
Collins L, Lapieree D (1976) *Freedom at midnight*. Vikas Publication House, New Delhi
Keating M (1993) The Earth Summit’s agenda for change. In: *A plain language version of Agenda 21 and the other Rio Agreements*. Centre for our common future, Geneva