Black Pepper in Malaysia: An Overview and Future Prospects

A.H. Izzah, W.Y. Wan Asrina

ABSTRACT

Cultivating black pepper in Malaysia started in early 10\textsuperscript{th} to the 11\textsuperscript{th} century when the South Indian Kings began to extend their empire. The crop was brought to East Malaysia in 1840 by Chinese settlers, actively planted until it was hit by the massive flood, fluctuation of the price and outbreak of foot rot. High yielding cultivars such as Kuching, Semenggok Emas and Semenggok Aman provided promise for better production, but resulted in increased soil degradation and reduced crop growth in Sarawak. The paper aims to discuss the black pepper industry in Sarawak and present scenario of its cultivation including future prospects. Cultivating on hilly topography with coarse textured dominant soil becomes one of the limiting factors. This factor is observed due to high rainfall intensity and steeper slopes. Neglected soil conservation also affects crop production and lead to a lower return on investments. Technologies such as land conservation and practising precision agriculture need to be adopted to reduce the impact of soil degradation and better production.

Key words: Black pepper, Cultivars, Erosion, Sarawak, Topography.

Black pepper has been used enormously in the world to flavour a dish, pharmaceutical and even cosmetics. It originated from the south western region of India which is now known as Malabar Coast (Ravindran, 2000). The history of black pepper cultivation in Malaya (known as Malaysia) started in early 10\textsuperscript{th} to 11\textsuperscript{th} century when the powerful South Indian kings, Raja Raja Chola and his sons extended their empire to the Malay archipelago and Java-Bali Islands (Ravindran, 2000). East Malaysia (now known as Sabah and Sarawak) under the reign of King Brooke has been reported to start in 1840 where the Chinese settlers actively grew black pepper in Bau, Baram, Trusan and Limbang, in the state of Sarawak. As the crop steadily grew during the time, a disease outbreak and massive flood diminished the crop (1918 to 1919) with later troubled by the fluctuation of black pepper price causing a serious problem to the farmers (in 1928) and alternatively start to shift their black pepper to other more profitable crops such as cocoa, oil palm and rubber.

The crop is more suitable to humid, tropical with relatively 2,000 to 3,000 mm of rainfall (Sivaraman et al., 1999). Malaysia is among the top seventh world producer accounted to 23,500 metric ton of black pepper in year 2017 (Malaysian Pepper Board, 2018a). This is beneficially caused by profitable world market which provides more competitive price for pepper growers and income.

The cultivation in Peninsular Malaysia is majorly planted on flat land with lower rainfall (~1,800 to 3,000 mm) while in Sabah and Sarawak, the crop was planted on hilly topography with higher rainfall (~2,800 to 4,700 mm). The differences between these two areas (Peninsular Malaysia and Sabah and Sarawak) were mainly due to their land topography and weather characteristics. According to Paulus et al. (2011a) and Ravindran (2000), the area with higher rainfall needs to be closely monitored due to the sensitivity of the crops to excessive moisture which increases the severity of the infection by foot rot. Meanwhile, a continuous drought season may reduce the flowering potential which also affects potential yields (Paulus et al., 2011a).

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How to cite this article: Izzah, A.H. and Wan Asrina, W.Y. (2019). Black Pepper in Malaysia: An Overview and Future Prospects. Agricultural Reviews, 40(4): 296-302.

Source of support: Nil

Conflict of support: None

Submitted: 15-06-2019 Accepted: 11-10-2019 Published: 06-12-2019

Due to this geoclimatic difference, the scenario in each area was according to its own nature. For that reason, the objective of this paper is to give an overview of the black pepper industry in Malaysia with the scenario of black pepper in Sarawak.

THE BLACK PEPPER INDUSTRY IN SARAWAK

Sarawak is known as a major producer which cover 17,134 ha area in 2018 (Malaysian Pepper Board, 2018b). The fraction of area is showing Serian contributing most than other areas (Fig 1). This industry is monitored and supported by Malaysian Pepper Board (MPB) and local universities helps in black pepper production, marketing and others.

Till now, Sarawak leads the production of black and white pepper in Malaysia, which about 23,780 tonnes of black pepper and 6,794 tonnes of white pepper in 2018 (Malaysia’s Open Data Portal, 2019). The black pepper trends are increasing since 2009, while fluctuation of white pepper production was recorded since 2017 due to hard to produce. Production of pepper has indicated 30,433 tonnes in 2017 which far behind other leading production countries such as Vietnam (200,000 tonnes), Indonesia (70,000 tonnes), Brazil (65,000 tonnes) and India (57,000 tonnes) (Malaysia’s Open Data Portal, 2019).
The emergence of Vietnam as leader in this industry was due to good support from local government by providing some initiatives to sustain black pepper production through training, media and good agricultural practice have embarked USD 1,119,729,000 profit in 2017 with only 110,000 ha compared to their competitors. Use of traditional breeding such as trunk and vines cutting is another successful cultivation here compared to India, which uses a pre-rooted cutting from runner shoot (Prabhakaran Nair, 2011). In Malaysia, support by MPB has a remarkable effect on the growth of black pepper; however, juggling with market price has diversified the crop even abundant availability of cutting.

CROP AND FEATURES IN SARAWAK REGION

Black pepper or *Piper nigrum* L. belong to family Piperaceae which is easily classified as climbing crops that need a support to keep growing. It is a perennial crop and may grow up to 15 years depending on crop management practices applied by farmers. The crop can grow well in humid tropics with 2,000 to 3,000 mm rainfall per year and require a proper drainage system to avoid foot rot (Paulus *et al.*, 2011b; Prabhakaran Nair, 2011). Excessive drainage during the flowering period has been reported to affect flower pollination and thus reducing berries production. The crop can be cultivated in a wide range of soil topography including slopes of less than 10° (Tanaka *et al.*, 2009). In the case of Sarawak where certain divisions in parts of Sarawak received heavy rainfall per annum and geographically it is more hilly than Peninsular Malaysia (Sa’adi *et al.*, 2017), farmers were indirectly tend to cultivate black pepper on hilly steeps with the slope ranging from 25 to 30°. Another reason caused the farmer in Sarawak to grow in hilly area is to reduce soil-borne diseases caused by *Fusarium* spp. and *Phytophthora* spp. that favoured water logged condition (Kifelew and Adugna, 2018; Nguyen, 2015).

This crop has two types of vine namely orthotropic and plagiotropic classified according to its growth. Orthotropic grow vertically, monopodium and has adventitious root. This root provides climbing internodes which support crop growth. This vine is used to produce new cutting for new crops either for personal or commercial use. Plagiotropic have lateral, sympodium and hold flower inflorescence which lead to production of black pepper within internode.

Table 1 lists major characteristic of Malaysian peppers as recommended by Malaysian Pepper Board for commercial farming and recent cultivars. Leaf shape, apex, base, inflorescences, branch and flowers of black pepper highlights the potential of the conversion ratio for black pepper production. This will be highly useful for the farmers’ and researchers to do field classification of recommended cultivars.

RECOMMENDED VARIETY AND ITS FEATURES

| Cultivar | Shape | Base | Number of flowers per inflorescence | Number of spikes per branch | Conversion rate fresh pepper (％) | Black pepper | White pepper |
|----------|-------|------|-------------------------------------|----------------------------|---------------------------------|--------------|--------------|
| Kuching  | Lancelolate-ovate | Rounded | >40 | 40-50 | 20-30 |
| Semenggok Emas | Lancelolate-ovate | Acute | <20 | >30 | 40-50 |
| Semenggok Aman | Lancelolate-ovate | Acute | <40 | 20-30 | 40-50 | 20-30 |
| Semenggok Perak | Lancelolate-ovate | Acute | >30 | 40-50 | 20-30 |
| Kuala Terengganu | Lancelolate-ovate | Acute | <30 | 20-30 | 40-50 |
| Sarawak | Lancelolate-ovate | Acute | >40 | 40-50 | 20-30 |
| Yong Petai | Lancelolate-ovate | Acute | <80 | 20-30 | 40-50 |
| Lampung Daun Lebar | Lancelolate-ovate | Acute | <80 | 20-30 | 40-50 |

* Adapted from *Chen et al.* (2018).
Kuching, Semenggok Emas and Semenggok Aman (Paulus et al., 2011a). These three cultivars become familiar due to its characteristics inherited from their parent materials. Semenggok Emas was produced through hybrid cross-breeding between Uthirancotta and Kuching and made its debut in 1991 (Paulus et al., 2011a). Meanwhile Semenggok Aman was released from clonal germplasm from Costa Rica and was first announced in 2006.

To date, only three known cultivars are recommended by the Malaysian Pepper Board (MPB) to be cultivated in Malaysia based on berries productivity, disease resistance, piperine and oleoresin content, and the percentage of conversion to black or white pepper (Chen et al., 2018; Sruthi et al., 2013). Their composition and characteristic is presented in Table 2. These characteristics were finalised by the MPB and widely cited to explain the importance of these cultivars to the farmers.

**NUTRIENT REQUIREMENT**

The consumption of nutrients in black pepper increased over the years. However, early fertilisation was practised to supply equivalent nutrient to support all crop growths such as root, leaves and stem elongation. Once the crop reaches 24 months, significant increase of fertiliser to support growth and preparation for the mature phase is applied. This phase was optimum once it reaches 36 months when the entire crop is fully developed and black pepper berries production starts (Ann, 2012).

The differences between varieties and types of soil have highlighted different nutrient requirement to satisfy their growth. A cultivar such as Semenggok Aman needs greater nutrient uptake due to its characteristic yielding longer fruit spike (Ann, 2012). Guajarina also exhibits similar nutrients consumption like Semenggok Aman (Partelli, 2009). In order to maximise crop growth, a large amount of N and K were used to satisfy nutrient uptake. This is according to research conducted on Semenggok Aman and Indian variety which recorded nutrient removal of 293.08 and 138 kg ha⁻¹, 264.95 and 189 on N and K, respectively (Ann, 2012; Ravindran, 2000).

**Nitrogen**

Large N quantities need to support fruit development, especially after 24 months. Research by Ann (2012) on cultivating Semenggok Aman on clay loam has indicated increasing N application for three constitutive cropping years yielded 62, 237 and 390 kg ha⁻¹. However, N supply in India only limited to 34, 68 and 100 kg ha⁻¹ for three cropping years, respectively (Satyagopal et al., 2014). The differences between variety cultivated in Malaysia and India has close relationship to the crop variety and soil characteristics present in an area (Shamshuddin et al., 2014). Moreover, critical management on soil fertility and soil N have gained serious consideration among researchers to boost crop productivity (Niranjana et al., 2018; Singh, 2018).

**Phosphorus**

Supplementation of P fertiliser in black pepper was proposed according to soil texture. Ann (2012) demonstrates about 10, 22 and 62 kg ha⁻¹ of P on three cultivated years on clay to clay loam texture in compared to sandy soil. George et al. (2005) in his research on sandy soil has concluded at the rate of 70, 140 and 140 kg ha⁻¹ for three constitutive years. Accordingly, the second and third year in sandy soil was fixed to 140 kg ha⁻¹ attributed to limited adsorption surface and promoted leaching from the soil profile (Fujii et al., 2017; Yanai et al., 2007).

**Potassium**

The uptake of K is often related to fruit formation in black pepper (Ann, 2012; Paulus et al., 2011a). The importance of K is comparable to N which about 0.72 g kg⁻¹ is recorded as early crop cultivation in nursery level (Thankamani et al., 2007). The amount of K fertiliser was applied at 62, 246 and 352 kg ha⁻¹ K for three constitutive years, respectively (Ann, 2012). However, in shale soils, the amount of K was about 80, 160 and 400 kg ha⁻¹ for three conservative years. Interestingly, both soil either in clay loam or shale showed an increasing trend of K on the third year which highlights the importance of this nutrient for berries production.

**Calcium**

Amendment of Ca in soil from liming based often practised by the farmer to alleviate acidity and prevent leach of cations. The importance of this element due to behaviour on regulating crop growth and development. About 1 kg dolomite was applied per vine prior to cultivation and 0.5 kg may apply subsequent year. Increasing accumulation of Ca in black pepper tissue sample up to 22 months after plating has reported by Ann (2012). A remarkable effect on adequate

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**Table 2:** Characteristics of recommended black pepper in Malaysia for cultivation.

| Characteristics                                      | Kuching | Semenggok Emas | Semenggok Aman |
|------------------------------------------------------|---------|----------------|----------------|
| Green berry yield (kg/vine/year)                     | 6-8     | 6-8            | 6-8            |
| Length of fruit spike (cm)                           | 9.7     | 9.9            | 10.1           |
| Piperine (%)                                         | 3.5     | 3.4            | 5.4            |
| Oleoresin (%)                                        | 11.0    | 11.0           | 15.5           |
| Volatile oil (%)                                     | 2.8     | 3.0            | 3.8            |
| Non-volatile (%)                                     | 7.9     | 8.0            | 11.5           |
| Harvesting rounds per season                         | 4-6     | 2-3*           | 2-3*           |
| Susceptible to Phytophthora foot rot disease         | Highly susceptible | Susceptible | Less susceptible |
| Susceptible to black berry disease                    | Highly susceptible | Tolerant     | Tolerant       |

*more uniform ripening compared to Kuching.
**adapted from Paulus et al. (2011a)
Ca also reported in bean plants, which increase the dry mass of the shoot and root, thus lead to high grain yield (Domingues et al., 2016).

**Magnesium**

Deficiency of Mg occurs on mature vine compared to the immature caused by low pH value. Excessive application of K fertiliser provides antagonism effect which inhibits the absorption of Mg. This tendency has indicated a common Mg deficiency which may correct exactly supplementation of 1 kg of dolomite and 0.5 kg in a subsequent year (Paulus et al., 2011a). A sufficient Mg concentration in black pepper soil may promote photosynthesis activity through the production of chlorophyll. Moreover, insufficient Mg to a crop provides significant reduction of root/shoot ratio, thus lead to poor crop canopy and abilities to produce fruit (Farhat et al., 2016).

**Iron**

Cultivating black pepper on a coarse-textured hastened deficiency of Fe including over liming activity. The primary function of Fe is regulating photosynthesis and lead to plant growth and development, and insufficient affect length of internode, especially terminal shoots and lateral branches (Zhang et al., 2019). Deficiency of Fe mainly occurred on the immature vine and corrected slowly as the crop growth older. Formation of a more extensive root system with increasing the age of crop help in absorbing the ion in soil colloids.

**Manganese**

Application of excessive animal manure, which contains an element of Ca affect the availability of Mn. This element recommended for black pepper was 215 mg kg$^{-1}$ to sustain the growth. Important of Mn was illustrated in various crops on chlorophyll production, which essential on photosynthesis activity (Mousavi et al., 2011). Increasing yield of corn and wheat also reported, which affect its dry matter and yield (Asad and Rafique, 2000).

**Zinc**

Supplementation of Zn to black pepper has a remarkable effect on the yield of black pepper. Moreover, sufficient application of Zn at 2.5 mg Zn kg$^{-1}$ soil has increasing content of oleoresin (22.83%) and piperine (7.57%), however applying 0.1% Zn EDTA as foliar has a greater yield of black pepper for about 89 g bush$^{-1}$ of dry pepper (Hamza and Sadanandan, 2005b). The remarkable effect on yield also reported in other crops such as onion (Goyal et al., 2017), jojoba (Attaya et al., 2018) and chickpea (Pooja and Sarawad, 2019).

**Molybdenum**

Application of organic matter as a source of micronutrient, especially Mo practised by the farmers to affect the growth and N utilisation on protein and amino acid synthesis. An increase in yield of black pepper, especially on application rate at 0.5 mg kg$^{-1}$ soil (Hamza and Sadanandan, 2005a). This application of Mo also enhances the quality of black pepper, especially their oleoresin and piperine contents.

**TOPOGRAPHY AND CULTIVATION PRACTICES IN SARAWAK**

Growing black pepper in a hilly area with multiple slope orientations has been practised in Sarawak as attributed to the natural formation of its topography. This has formed new guidelines proposed by the Malaysian Pepper Board (MPB) to construct terracing along the slopes and intercropping with the selected cover crop which benefit the black pepper, for example, *Centrosema pubescens* and *Arachis pintoi* (Paulus et al., 2011b). Promoting land conservation techniques has close relationship to reduce land degradation, improve soil fertility and crop productivity (Tanaka et al., 2009).

Even though guidelines were provided to the farmer, it is still unfollowed due to the high cost of constructing terraces and the level of awareness on the benefits of cover crop is still weak among farmers especially those who live in rural area. A traditional approach used by farmers is usually clearing secondary forest through slashing and burning its residue, direct cultivation without any visible terracing, using non-living pole (e.g. *Eusideroxylon zwageri*, *Commersonia bartramia* and others) and bare soil surface through clearing...
any other crops than black pepper. All the traditional practices indeed promote higher crop productivity in the first year, however, the deterioration of crop and land will be seen on wet seasons (Prabhakaran Nair, 2011; Tanaka et al., 2009). The loss of topsoil from this area with high rainfall, especially in Sarawak (e.g. 2,800 to 4,700 mm/year) has hastened this process. Due to the higher rainfall, massive soil loss occurs and the farmer practically applying wood plank around black pepper mound to control soil movement. This has disturbed crop growth by exposing black pepper root, reduce nutrient uptake and affecting the development of the crops (Izzah and Wan Asrina, 2018; Ravindran, 2000).

Cultivating black pepper in flatland is hardly to find in Sarawak because preventive to infection by foot rot disease. However, cultivating on flatland is a common in Peninsular Malaysia which drier season and equipped with drip irrigation. There also significant different cultivation practices in Sarawak and Peninsular Malaysia, especially, using a different type of support either living or non-living, fertiliser scheme, water availability and management.

HILLY TOPOGRAPHY

The cultivated black pepper on hilly topography has documented the loss of 62.7 t ha⁻¹ soil in the first year of cultivation on a slope of 25° (Frenken, 2012; Hatch, 1981). Every slope has their effect on the amount of soil loss for example from a ridge, up-slope, mid-slope, down-slope, valley and flat land was about 17.15, 16.90, 21.88, 17.54, 21.48 and 3.24 t ha⁻¹, respectively (Sun et al., 2014). However, the amount will be elevated if the steepness of the area increases.

For black pepper, the application of fertiliser needs to also consider the slope of the area. This consideration is particularly attributed to the nutrient transportation and accumulation whereas N found greater in middle and slope position, P in footslope and K in upper slope (Uzoho et al., 2016; Samndi and Mahmud, 2014). One of the ways to increase fertiliser efficiency and reduce soil pollution derived from fertiliser application for pepper planted at the steep area is growing a barrier crop nearby the surface water (Yulnafatmawita et al., 2017; Tun et al., 2014). Moreover, several techniques on fertiliser application has been introduced such as split fertiliser according to microclimate and semi terracing area (Sarker et al., 2015).

SANDY SOIL TEXTURE

Coarse textured soil has been reported to cause lower crop productivity which is related to its incapability to hold water, lower cation exchange capacity (CEC), lower pH and lower nutrient retention (Izzah and Wan Asrina, 2018; Pal and Marschner, 2016). This will promote the leaching of nutrients caused by high soil permeability (Tahir and Marschner, 2017; Nalina et al., 2016). To alleviate this problem, mixing clay with sandy fraction may increase CEC and promote the absorption of NH₄⁺ by eight to 20 folds and P by two folds (Tahir and Marschner, 2016). However, with appropriate management practices such as cover crop and, organic matter amendment proposed on BRIS soil in Malaysia which has been used in sweet potato, tobacco and maize cultivation, therefore, may provide a significant improvement on black pepper productivity (Laha et al., 2011; Choudhury and Khanif, 2003). This may slowly improve the crop and sustain the soil health for long term production.

Black pepper cultivated on sandy soil with higher rainfall intensities is often practised to avoid waterlogged condition and preventing disease incidence, the foot rot disease (Ravindran, 2000). However, the problem in retaining cations become an issue because it causes leaching and intensifies soil acidity. Retaining nutrient and improvement in soil pH on sandy soil can be achieved through mixing manure with chemical fertiliser (Zingore et al., 2008). Generally, the improvement of P on signal grass has been achieved by supplying with 15 mg ha⁻¹ poultry manure (Gerola et al., 2014). In a tropical country, the monitoring season may enhance flower pollination and production of flower spike (Rao et al., 2016). Moreover, with appropriate management practices such as establishing cover crop, amendment of soil with organic matter practices by other researchers on sweet potato, maize and kenaf cultivation eventually may be practised on black pepper (Ishaq et al., 2014; Roslan et al., 2011). This may increase the black pepper productivity when cultivating on sandy soil texture thus sustaining soil health for long term production.

CONCLUSION

The black pepper industry in Malaysia emerges accordingly to the current demand from other countries. Since the crop was successfully grown in humid tropical, it becomes the most important characteristic that influences other farmers to join in. The lucrative price and multiple schemes offered by the Malaysian Pepper Board facilitated this trend. Moreover, successful cultivars namely Kuching, Semenggok Emas and Semenggok Aman as high yielding berries become another promising growth in this industry.

Cultivating black pepper on hilly topography in Sarawak is one of the most important characteristics as the natural land formation occurred. This practice alleviates water retention which otherwise may enhance the infection by the foot rot disease. However, improper farm management practices among rural farmers could lead to extreme soil erosion and becoming one of the limiting factors to support black pepper growth. Thus, good agricultural practices which are affordable, accessible, effective and easy such as cover crop (e.g. Centrosema pubescens and Arachis pintoi) and providing mulch at slope area should be well explained to rural farmers that will eventually protect the farm sustainability in the long term.

ACKNOWLEDGEMENT

This research was supported by the project number GP-IPB/2018/9557605 from Universiti Putra Malaysia.

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