

REVIEW PAPER

Botany, Diversity, and Distribution of Black Pepper (*Piper nigrum* L.) Cultivars in Malaysia

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ABSTRACT

This paper reviewed general botanical description of black pepper (*Piper nigrum* L.) cultivars by previous botanists, based on uniqueness of Malaysian black pepper cultivars characteristics. Ten important cultivars have been verified, i.e. cv. 'Semongok Aman', cv. 'Kuching', cv. 'Semongok Emas', cv. 'Semongok Perak', cv. 'Semongok 1', cv. 'Nyerigai', cv. 'India', cv. 'Lampung Daun Lebar', cv. 'Sarikei', and cv. 'Yong Petai'. The qualitative and quantitative traits distinctness for each cultivar has been highlighted to assist cultivar identification. Vouchers (dried specimens) for the ten cultivars have also been prepared and deposited at herbarium that located at Universiti Malaysia Sarawak and the duplicates at Malaysian Pepper Board, Kuching. Besides, distribution of each cultivar has also been documented based on information sourced from Malaysian Pepper Board.

Keywords: Black pepper cultivars, botanical description, distribution

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INTRODUCTION

The earliest record of description on *Piper* was in 1678 by Rheede (Rheede, 1678). Linnaeus later included 17 species of *Piper* in his Species Plantarum (Linnaeus, 1753). Subsequently, the taxonomy of *Piper* was studied by Roxburgh (1832), Miquel (1848), Wight (1853), Candolle (1869) and Rama Rao (1914) in later years. However, Rahiman *et al.* (1979), Rahiman (1981), Ravindran *et al.* (1987), Ravindran *et al.* (1990), Ravindran (1991), Ravindran *et al.* (1992), Ravindran and Nirmal Babu (1994), and Ravindran *et al.* (1997) have more comprehensive study, up to taxonomic key level that enable identification of species.

In Malaysia, the earliest study on *Piper* taxonomy was by Sim (1979). In the report, she mentioned that the preliminary identification on the collection was based on Ridley's Floral of the Malay Peninsular (Ridley, 1967). In her study, morphological descriptions were included dioecious and monoecious classification, branching behaviour, leaf, stem, and flower spike. Sim *et al.* (1996) also studied fruit development

of three selected cultivars, cv. 'Kuching', cv. 'Semongok emas', and cv. 'Hybrid 10', while Chen (2011) reported on the floral biology study of *P. nigrum*, and the apomixis study in 2013, with regard to floral morphology. In 2018, a phenetic analysis on important cultivars in Malaysia has been reported by Chen *et al.* (2018). The paper enlightened morphological distinctness of each cultivar based on ANOVA test and Principle Component Analysis. Besides, a guideline for the conduct of tests for distinctness, uniformity and stability on black pepper (*Piper nigrum* L.) has been developed by Sim *et al.* (2009) but no application to date.

The cultivar of black pepper was believed to derived from wild one through domestication or selection in India (Ravindran *et al.*, 2000). Ravindran *et al.* (2000) has described 38 cultivars of black pepper with description focused on leaves shape, spike length, percent fruit set, topography suitability, yield performance and etc. The team also listed important cultivars for others countries, like Malaysia (cv. 'Kuching', cv. 'Sarikei' and cv. 'Miri'), Indonesia (cv. 'Bangka', cv. 'Banjarmasin', cv. 'Belantung', cv. 'Beng Kayang', cv. 'Chunuk',

cv. 'Chunuk Kernuga', cv. 'Djambi', cv. 'Duantebei', cv. 'Kerenci', cv. 'Kernuga', cv. 'Korintji', cv. 'LDK', cv. 'LDL', cv. 'Palulauta', cv. 'Petaling 1', cv. 'Petaling 2', cv. 'Merefin', cv. 'Natar 1', cv. 'Natar 2', cv. 'LDLN 1' and cv. 'LDLN 2'), Sri Lanka (cv. 'Ceylon'), Madagascar (cv. 'Sel. IV. 1' and cv. 'Sel. IV. 2') and Thailand (cv. 'Antique', cv. 'Ban Keow', cv. 'Prang Thi' and cv. 'Prang Thi Bai Vick'). However, these cultivars were only differentiated by yield performance evaluation. The world biggest black pepper producer nowadays, i.e. Vietnam claimed they have five important cultivars called cv. 'Karimunda', cv. 'Panniyur 1', cv. 'Belantoeng', cv. 'Vinh Linh' and cv. 'Tieu Trung' (Nguyen & Bui, 2011). A manual entitled 'Pepper production technology in Malaysia' that was released by Malaysian Pepper Board in 2011, mentioned existence of seven cultivated varieties as common cultivars in Malaysia, including cv. 'Semongok Aman', cv. 'Semongok Emas', cv. 'Kuching', cv. 'Semongok Perak', cv. 'Uthirancotta', cv. 'Nyerigai', and cv. 'PN129' (Paulus, 2011). However, Sim (2007) reported the existence of other cultivars, namely cv. 'Lampung Daun Lebar' and cv. 'Lampung Daun Kecil'. In recent phenetic analysis on black pepper cultivar by Chen *et al.* (2018), ten important cultivars were selected for the study.

Extensive fieldwork was undertaken by the first author since January 2014, to cover all the possible black pepper cultivation areas within Malaysia to come out with a representative botanical description of black pepper cultivar in Malaysia. In this study, description by previous black pepper botanist particularly Ravindran *et al.* (1997) and Sim (1979) were comprehensively reviewed. Meanwhile, a botanical drawing (Figure 1) and photography documentation (Figure 2) were produced as evidence to the description. Besides, vouchers (dried specimens and spirit material) for the ten cultivars (Figure 3) have also been prepared and deposited at herbarium that located at Universiti Malaysia Sarawak and the duplicates at Malaysia Pepper Board, Kuching.

This paper enlightens general botanical description and diversity of important black pepper cultivars in Malaysia, with key diagnosis for each cultivar. Besides, distributions for each black pepper cultivar were revealed.

GENERAL BOTANICAL DESCRIPTION OF CULTIVATED BLACK PEPPER

Habit - Woody perennial climber bearing essential oil, with epiphytic ivy-like root emerge from the nodal region of main stem; root adhere to death or living support pole; shoot growing vertically to develop vigorous vine; branching laterally where flowering and fruiting occur.

Stem - Nodal stem with internode ranged from 8 cm to 13 cm when mature; old stem rough with filiform cracking bark, young stem with thick cuticle dull dark green; nodes commonly multilacunar, single to multiple branching from node; shoot tip purplish green (anthocyanin present) or whitish green (anthocyanin absent).

Leaves - Alternate, petiolate, simple, entire, shape commonly lanceolate-ovate, lanceolate or ovate; size much variable, small to large; base rounded, acute, ovate or oblique; tip commonly obtuse, acute or rounded; leaf margin wavy or even; upper surface dark green to light green, lower surface dull green.

Inflorescence - Catkin type, acropetal, length much variable ranged from 6 cm to 13 cm; green, whitish green or light yellow.

Flower - Minute, bracteates, naked, bisexual or unisexual, hypogynous, protogynous.

Perianth - Absent.

Androecium - Stamens 2; anthers dithecos.

Gynoecium - Carpels 1; ovary spherical; orthotropous ovule, 1 in each locules; style absent; stigma 2-5 lobed, papillate.

Fruits - Drupe; light green when young, dark green at mature, yellow and eventually red on ripening.

Seeds - Shape spherical, some slightly pointed at hilum or remains of style region, seed coat with 10-12 whitish thread-like stripes from hilum to remains of style; small, diameter 3-5 mm; embryo minute, near to hilum.

Floral formula - P0 A3+3(1-10) G1 or (G) 3,4, superior.

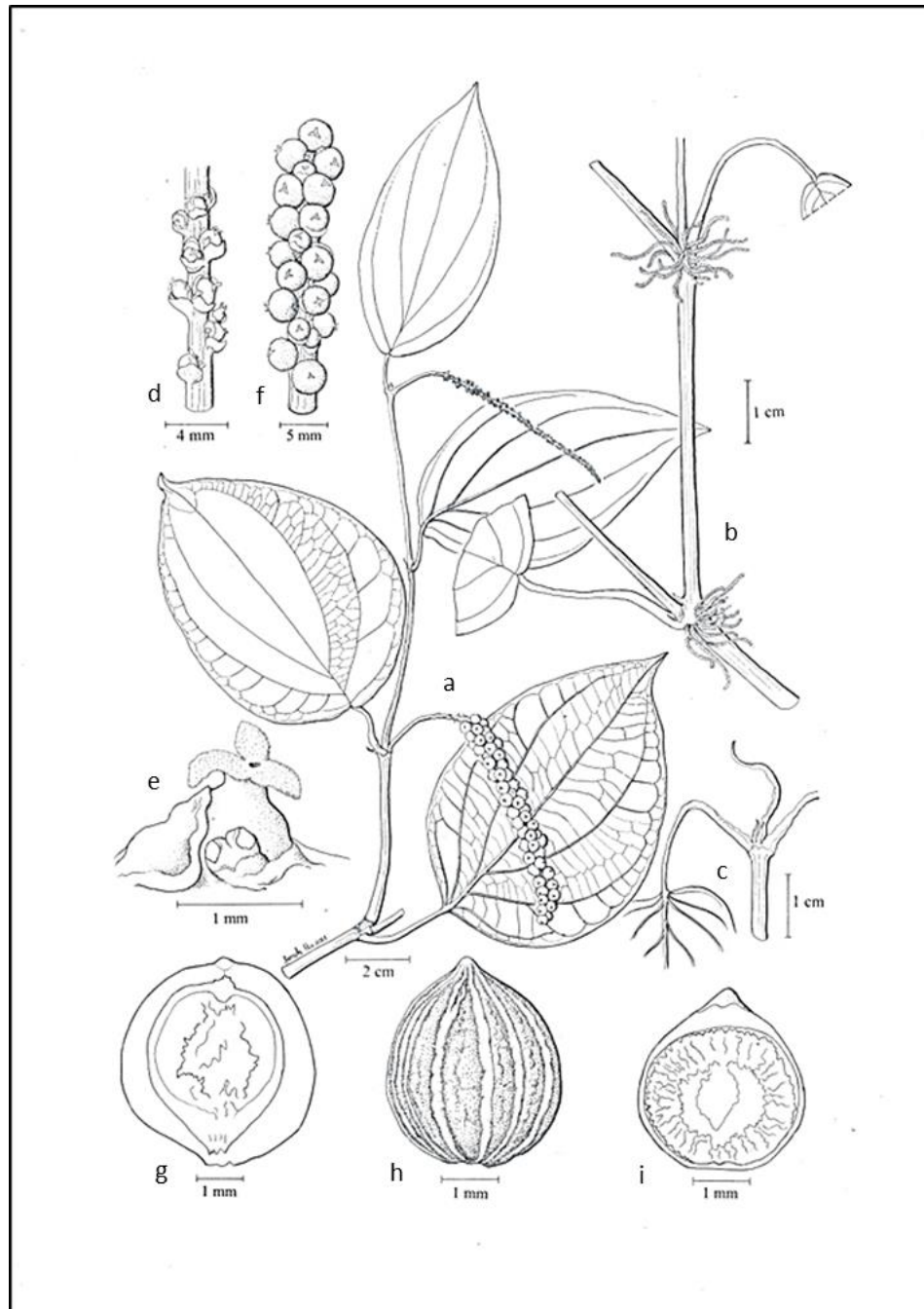


Figure 1. Botanical drawing of cultivated black pepper. (a) Lateral branch; (b) Terminal stem node; (c) Shoot tip; (d) Inflorescence/early stage of fruit development; (e) Single flower; (f) Mature stage of fruit spike; (g) Cross section of fresh berry; (h) Outer surface of peppercorn (pericarp removed); (i) Cross section of pepper seed



Figure 2. Photography documentation of important morphological characteristics of cultivated black pepper. (a) Mature vine; (b) Ivy-like root emerge from node of stem and cling on support pole; (c) Old stem with branches; (d) Single branch; (e) Leaf lower surface; (f) Leaf upper surface; (g) Shoot tips; (h) Ripen fruits; (i) Mature fruits; (j) Inflorescence-Catkin; (k) Bisexual flower; (l) Unisexual flower; (m) Single flower with 3 lobbed stigma and two pairs of anthers (2 stamens); (n) Close up of inflorescence- Minute, bracteates and naked; (o) Dissected fruit- Drupe type; (p) Spherical seed. *St- stamen; Stg- stigma

DOCUMENTATION ON MORPHOLOGICAL CHARACTERISTICS OF THE TEN CULTIVARS

Extensive field work that has been conducted managed to verify ten cultivar of black pepper based on morphological uniqueness. The designations of cultivars were confirmed through germplasm of *Piper* that located at Agricultural Research Center, Semongok Sarawak. The verified cultivars include cv. 'Semongok Aman', cv. 'Kuching', cv. 'Semongok Emas', cv. 'Semongok Perak', cv. 'Semongok 1', cv. 'Nyerigai', cv.

'India', cv. 'Lampung Daun Lebar', cv. 'Sarikei', and cv. 'Yong Petai'. Both qualitative and quantitative traits were included in morphological analysis to enlighten the distinctness and uniqueness of each cultivar. The assessment include leaf part (leaf shape; leaf apex; leaf base; leaf area (cm²); blade width (mm); blade length (mm); blade length-width ratio (Lw⁻¹) and leaf colour), inflorescence part (inflorescence length at stigma withering stage (cm); inflorescence thickness at stigma withering stage (mm); inflorescence colour; number of flower per inflorescence and number of inflorescence per

branch per node), fruit part (fruit spike length (cm); fruit size in diameter (mm); fruit weight (single fresh berry) (g); fruit colour (hard dough stage); percent fruit set (%); conversion rate % (fresh to black pepper); conversion rate % (fresh to white pepper) and pericarp thickness (mm), seed [seed

diameter (mm) and seed weight (g)], vigour (branch column type, internode length (cm) and number of node/feet of stem) and shoot tip part (present or absent of anthocyanin colouration). Table 1 showed result of morphological assessment and key diagnosis for each of the cultivar.

Table 1. Qualitative characteristics, quantitative characteristics and diagnostic characteristics of the ten important cultivars

Cultivars	Diagnostic characteristics
'Semongok Aman'	<p>Qualitative characteristic: Leaf shape elliptical; Leaf apex mucronate; Leaf base acute; Leaf colour- dark yellowish green; Inflorescence colour- strong yellow green; Fruit colour- greyish olive green; Branch column type- horizontal; Anthocyanin present at shoot tip.</p> <p>Quantitative characteristic: Leaf area 45.40 cm²; Blade width <i>ca.</i>6.36 cm; Blade length <i>ca.</i>10.70 cm; Blade length-width ratio, 1.70; Inflorescence length <i>ca.</i>7.84 cm long; Inflorescence thickness <i>ca.</i>3.50 mm; Number of flower per inflorescence <i>ca.</i>88.00; Number of inflorescence per branch per node <i>ca.</i>12.00; Fruit spike length <i>ca.</i>10.00 cm long; Fruit size in diameter <i>ca.</i>6.68 mm; Fruit weight (single berry <i>ca.</i>0.20 g; Percent fruit set <i>ca.</i>70.68%; Conversion rate (Fresh to dried black) <i>ca.</i>37.35%; Conversion rate (Fresh to dried white) <i>ca.</i>30.37%; Pericarp thickness <i>ca.</i>2.00 mm; Seed diameter <i>ca.</i>4.80 mm; Seed weight <i>ca.</i>6.11(x10⁻²) g; Internode length <i>ca.</i>11.42 cm; Number of node/feet of stem <i>ca.</i>3.67.</p> <p>Key diagnosis: Leaf apex mucronate; Percent of fruit set high, <i>ca.</i>71.00%.</p>
'Kuching'	<p>Qualitative characteristic: Leaf shape ovate; Leaf apex acute; Leaf base rounded; Leaf colour- dark yellowish green; Inflorescence colour- strong yellowish green; Fruit colour- greyish olive green; Branch column type- horizontal; Anthocyanin present at shoot tip.</p> <p>Quantitative characteristic: Leaf area <i>ca.</i>37.70 cm²; Blade width <i>ca.</i>5.37 cm; Blade length <i>ca.</i>10.83 cm; Blade length-width ratio <i>ca.</i>2.02; Inflorescence length <i>ca.</i>7.03 cm long; Inflorescence thickness <i>ca.</i>3.56 mm; Number of flower per inflorescence <i>ca.</i>68; Number of inflorescence per branch per node <i>ca.</i>59; Fruit spike length <i>ca.</i>9.37 cm long; Fruit size in diameter <i>ca.</i>6.75 mm; Fruit weight (single berry) <i>ca.</i>0.17g; Percent fruit set <i>ca.</i>61.10%; Conversion rate (Fresh to dried black) <i>ca.</i>41.68%; Conversion rate (Fresh to dried white) <i>ca.</i>31.08%; Pericarp thickness <i>ca.</i>2.20 mm; Seed diameter <i>ca.</i>4.44 mm; Seed weight <i>ca.</i>5.13(x10⁻²) g; Internode length <i>ca.</i>8.33 cm; Number of node/feet of stem <i>ca.</i>4.73.</p> <p>Key diagnosis: Number of inflorescence per branch per node high <i>ca.</i>59; Node /feet of stem, <i>ca.</i>5.</p>
'Semongok Emas'	<p>Qualitative characteristic: Leaf shape elliptical; Leaf apex acute; Leaf base acute; Leaf colour- Moderate olive green; Inflorescence colour- Strong yellowish green; Fruit colour- Deep yellowish green; Branch column type- horizontal; Anthocyanin present at shoot tip.</p> <p>Quantitative characteristic: Leaf area <i>ca.</i>46.60 cm²; Blade width <i>ca.</i>5.67 cm; Blade length <i>ca.</i>13.31 cm; Blade length-width ratio <i>ca.</i>2.35; Inflorescence length <i>ca.</i>7.95 cm long; Inflorescence thickness <i>ca.</i>3.47 mm; Number of flower per inflorescence <i>ca.</i>86; Number of inflorescence per branch per node <i>ca.</i>20; Fruit spike length <i>ca.</i>10.62 cm long; Fruit size in diameter <i>ca.</i>6.76 mm; Fruit weight (single berry) <i>ca.</i>0.17 g; Percent fruit set <i>ca.</i>68.75%; Conversion rate (Fresh to dried black) <i>ca.</i>42.24%; Conversion rate (Fresh to dried white) <i>ca.</i>31.68%; Pericarp thickness <i>ca.</i>2.16 mm; Seed diameter <i>ca.</i>4.60 mm; Seed weight <i>ca.</i>5.40(x10⁻²) g; Internode length <i>ca.</i>11.40 cm; Number of node/feet of stem <i>ca.</i>3.33.</p> <p>Key diagnosis: Leaf colour, moderate olive green (Green group 137 series of RHS code); Mature fruit colour, deep yellowish green (Green group 141 series of RHS code); Conversion rate (from fresh to dried berry) high, 42.24% for black (pericarp remain) and 31.68% for white (pericarp removed).</p>

Continued Table 1

Cultivars	Diagnostic characteristics
'Semongok Perak'	<p>Qualitative characteristic: Leaf shape elliptical; Leaf apex acute; Leaf base oblique; Leaf colour- Greyish olive green; Inflorescence colour- Strong yellowish green; Fruit colour- Greyish olive green; Branch column type- horizontal; Anthocyanin present at shoot tip.</p> <p>Quantitative characteristic: Leaf area <i>ca.</i>62.80 cm²; Blade width <i>ca.</i>7.47 cm; Blade length <i>ca.</i>13.20 cm; Blade length-width ratio <i>ca.</i>1.77; Inflorescence length <i>ca.</i>6.93 cm long; Inflorescence thickness <i>ca.</i>3.73 mm; Number of flower per inflorescence <i>ca.</i>73; Number of inflorescence per branch per node <i>ca.</i>22; Fruit spike length <i>ca.</i>9.27 cm long; Fruit size in diameter <i>ca.</i>6.86 mm; Fruit weight (single berry) <i>ca.</i>0.19 g; Percent fruit set <i>ca.</i>61.51%; Conversion rate (Fresh to dried black) <i>ca.</i>36.12%; Conversion rate (Fresh to dried white) <i>ca.</i>24.21%; Pericarp thickness <i>ca.</i>2.22 mm; Seed diameter <i>ca.</i>4.60 mm; Seed weight <i>ca.</i>4.85(x10⁻²) g; Internode length <i>ca.</i>10.10 cm; Number of node/feet of stem <i>ca.</i>4.13.</p> <p>Key diagnosis: Leaf colour greyish olive green; Conversion rate (from fresh to dried berry) low, 36.12% for black (pericarp remain) and 24.21% for white (pericarp removed).</p>
'Semongok 1'	<p>Qualitative characteristic: Leaf shape cordate; Leaf apex acute; Leaf base cordate; Leaf colour- Dark yellowish green; Inflorescence colour- Strong yellowish green; Fruit colour- Greyish olive green; Branch column type- horizontal; Anthocyanin absent at shoot tip.</p> <p>Quantitative characteristic: Leaf area <i>ca.</i>132.60 cm²; Blade width <i>ca.</i>11.87 cm; Blade length <i>ca.</i>16.67 cm; Blade length-width ratio <i>ca.</i>1.41; Inflorescence length <i>ca.</i>12.40 cm long; Inflorescence thickness <i>ca.</i>3.85 mm; Number of flower per inflorescence <i>ca.</i>128; Number of inflorescence per branch per node <i>ca.</i>18; Fruit spike length <i>ca.</i>16.48 cm long; Fruit size in diameter <i>ca.</i>7.27 mm; Fruit weight (single berry) <i>ca.</i>0.20 g; Percent fruit set <i>ca.</i>64.24%; Conversion rate (Fresh to dried black) <i>ca.</i>42.36%; Conversion rate (Fresh to dried white) <i>ca.</i>27.70%; Pericarp thickness <i>ca.</i>2.46 mm; Seed diameter <i>ca.</i>4.82 mm; Seed weight <i>ca.</i>5.46(x10⁻²) g; Internode length <i>ca.</i>8.73 cm; Number of node/feet of stem <i>ca.</i>4.17.</p> <p>Key diagnosis: Leaf shape cordate; Anthocyanin free shoot tip (whitish green colour); Blade length-width ratio (Lw⁻¹) low, <i>ca.</i>1.41</p>
'Nyerigai'	<p>Qualitative characteristic: Leaf shape elliptical; Leaf apex acute; Leaf base oblique; Leaf colour- Dark yellowish green; Inflorescence colour- Strong yellowish green; Fruit colour- Greyish olive green; Branch column type- horizontal; Anthocyanin present at shoot tip.</p> <p>Quantitative characteristic: Leaf area <i>ca.</i>53.60 cm²; Blade width <i>ca.</i>6.49 cm; Blade length <i>ca.</i>12.07 cm; Blade length-width ratio <i>ca.</i>1.86; Inflorescence length <i>ca.</i>7.06 cm long; Inflorescence thickness <i>ca.</i>3.10 mm; Number of flower per inflorescence <i>ca.</i>74; Number of inflorescence per branch per node <i>ca.</i>36; Fruit spike length <i>ca.</i>9.39 cm long; Fruit size in diameter <i>ca.</i>6.48 mm; Fruit weight (single berry) <i>ca.</i>0.14 g; Percent fruit set <i>ca.</i>66.93%; Conversion rate (Fresh to dried black) <i>ca.</i>41.06%; Conversion rate (Fresh to dried white) <i>ca.</i>31.89%; Pericarp thickness <i>ca.</i>2.25 mm; Seed diameter <i>ca.</i>4.44 mm; Seed weight <i>ca.</i>4.91(x10⁻²) g; Internode length <i>ca.</i>9.77 cm; Number of node/feet of stem <i>ca.</i>3.83.</p> <p>Key diagnosis: Vine branching behaviour erect type; Fruit (single fresh berry) weight light, <i>ca.</i>0.14g.</p>
'India'	<p>Qualitative characteristic: Leaf shape lanceolate; Leaf apex acuminate; Leaf base rounded; Leaf colour- Dark yellowish green; Inflorescence colour- Strong yellowish green; Fruit colour- Greyish olive green; Branch column type- horizontal; Anthocyanin present at shoot tip.</p> <p>Quantitative characteristic: Leaf area <i>ca.</i>50.90 cm²; Blade width <i>ca.</i>5.75 cm; Blade length <i>ca.</i>13.63 cm; Blade length-width ratio <i>ca.</i>2.39; Inflorescence length <i>ca.</i>7.80 cm long; Inflorescence thickness <i>ca.</i>3.00 mm; Number of flower per inflorescence <i>ca.</i>80; Number of inflorescence per branch per node <i>ca.</i>27; Fruit spike length <i>ca.</i>9.39 cm long; Fruit size in diameter <i>ca.</i>6.02 mm; Fruit weight (single berry) <i>ca.</i>0.14 g; Percent fruit set <i>ca.</i>65.76%; Conversion rate (Fresh to dried black) <i>ca.</i>40.51%; Conversion rate (Fresh to dried white) <i>ca.</i>28.16%; Pericarp thickness <i>ca.</i>1.94 mm; Seed diameter <i>ca.</i>3.90 mm; Seed weight <i>ca.</i>4.07(x10⁻²) g; Internode length <i>ca.</i>9.57 cm; Number of node/feet of stem <i>ca.</i>4.30.</p> <p>Key diagnosis: Leaf shape lanceolate; Seed weight light, <i>ca.</i>4.07(x 10⁻²) g.</p>

Continued Table 1

Cultivars	Diagnostic characteristics
'Lampung Daun Lebar'	<p>Qualitative characteristic: Leaf shape ovate; Leaf apex acute; Leaf base oblique; Leaf colour- Greyish olive green; Inflorescence colour- Strong yellow green; Fruit colour- Dark yellowish green; Branch column type- drooping; Anthocyanin present at shoot tip.</p> <p>Quantitative characteristic: Leaf area <i>ca.</i>81.40 cm²; Blade width <i>ca.</i>8.85 cm; Blade length <i>ca.</i>13.50 cm; Blade length-width ratio <i>ca.</i>1.52; Inflorescence length <i>ca.</i>7.68 cm long; Inflorescence thickness <i>ca.</i>3.75 mm; Number of flower per inflorescence <i>ca.</i>101; Number of inflorescence per branch per node <i>ca.</i>21; Fruit spike length <i>ca.</i>10.22 cm long; Fruit size in diameter <i>ca.</i>6.30 mm; Fruit weight (single berry) <i>ca.</i>0.15 g; Percent fruit set <i>ca.</i>55.10%; Conversion rate (Fresh to dried black) <i>ca.</i>38.31%; Conversion rate (Fresh to dried white) <i>ca.</i>29.62%; Pericarp thickness <i>ca.</i>2.06mm; Seed diameter <i>ca.</i>4.32 mm; Seed weight <i>ca.</i>4.30(x10⁻²) g; Internode length <i>ca.</i>11.23 cm; Number of node/feet of stem <i>ca.</i>4.43.</p> <p>Key diagnosis: Leaf base oblique; Blade length-width ratio (Lw⁻¹) low, <i>ca.</i>1.52; Vine branching behaviour drooping type.</p>
'Sarikei'	<p>Qualitative characteristic: Leaf shape elliptical; Leaf apex acute; Leaf base acute; Leaf colour- Dark yellowish green; Inflorescence colour- Strong yellowish green; Fruit colour- Greyish olive green; Branch column type- horizontal; Anthocyanin present at shoot tip.</p> <p>Quantitative characteristic: Leaf area <i>ca.</i>36.90 cm²; Blade width <i>ca.</i>5.26 cm; Blade length <i>ca.</i>10.93 cm; Blade length-width ratio <i>ca.</i>2.10; Inflorescence length <i>ca.</i>6.06 cm long; Inflorescence thickness <i>ca.</i>3.54 mm; Number of flower per inflorescence <i>ca.</i>65; Number of inflorescence per branch per node <i>ca.</i>35; Fruit spike length <i>ca.</i>8.07 cm long; Fruit size in diameter <i>ca.</i>5.78 mm; Fruit weight (single berry) <i>ca.</i>0.17 g; Percent fruit set <i>ca.</i>64.28%; Conversion rate (Fresh to dried black) <i>ca.</i>39.55%; Conversion rate (Fresh to dried white) <i>ca.</i>29.69%; Pericarp thickness <i>ca.</i>1.73 mm; Seed diameter <i>ca.</i>3.84 mm; Seed weight <i>ca.</i>4.56(x10⁻²)g; Internode length <i>ca.</i>9.83 cm; Number of node/feet of stem <i>ca.</i>3.97.</p> <p>Key diagnosis: Leaf area small, <i>ca.</i>36.90 cm²; Inflorescence short, <i>ca.</i>6.06 cm; Fruit size small, <i>ca.</i>5.78 mm (diameter); Pericarp thickness thin, <i>ca.</i>1.73 mm.</p>
'Yong Petai'	<p>Qualitative characteristic: Leaf shape elliptical; Leaf apex acute; Leaf base acute; Leaf colour- Dark yellowish green; Inflorescence colour- Strong yellow green; Fruit colour- Greyish olive green; Branch column type- horizontal; Anthocyanin present at shoot tip.</p> <p>Quantitative characteristic: Leaf area <i>ca.</i>66.50 cm²; Blade width <i>ca.</i>6.62 cm; Blade length <i>ca.</i>14.75 cm; Blade length-width ratio <i>ca.</i>2.24; Inflorescence length <i>ca.</i>12.75 cm long; Inflorescence thickness <i>ca.</i>2.90 mm; Number of flower per inflorescence <i>ca.</i>94; Number of inflorescence per branch per node <i>ca.</i>16; Fruit spike length <i>ca.</i>17.07 cm long; Fruit size in diameter <i>ca.</i>7.27 mm; Fruit weight (single berry) <i>ca.</i>0.19 g; Percent fruit set <i>ca.</i>56.26%; Conversion rate (Fresh to dried black) <i>ca.</i>36.25%; Conversion rate (Fresh to dried white) <i>ca.</i>25.70%; Pericarp thickness <i>ca.</i>2.69 mm; Seed diameter <i>ca.</i>4.45 mm; Seed weight <i>ca.</i>4.98(x10⁻²) g; Internode length <i>ca.</i>12.70 cm; Number of node/feet of stem <i>ca.</i>3.33.</p> <p>Key diagnosis: Inflorescence long, <i>ca.</i>13 cm; Fruit spike thickness thin, <i>ca.</i>2.90 mm.</p>

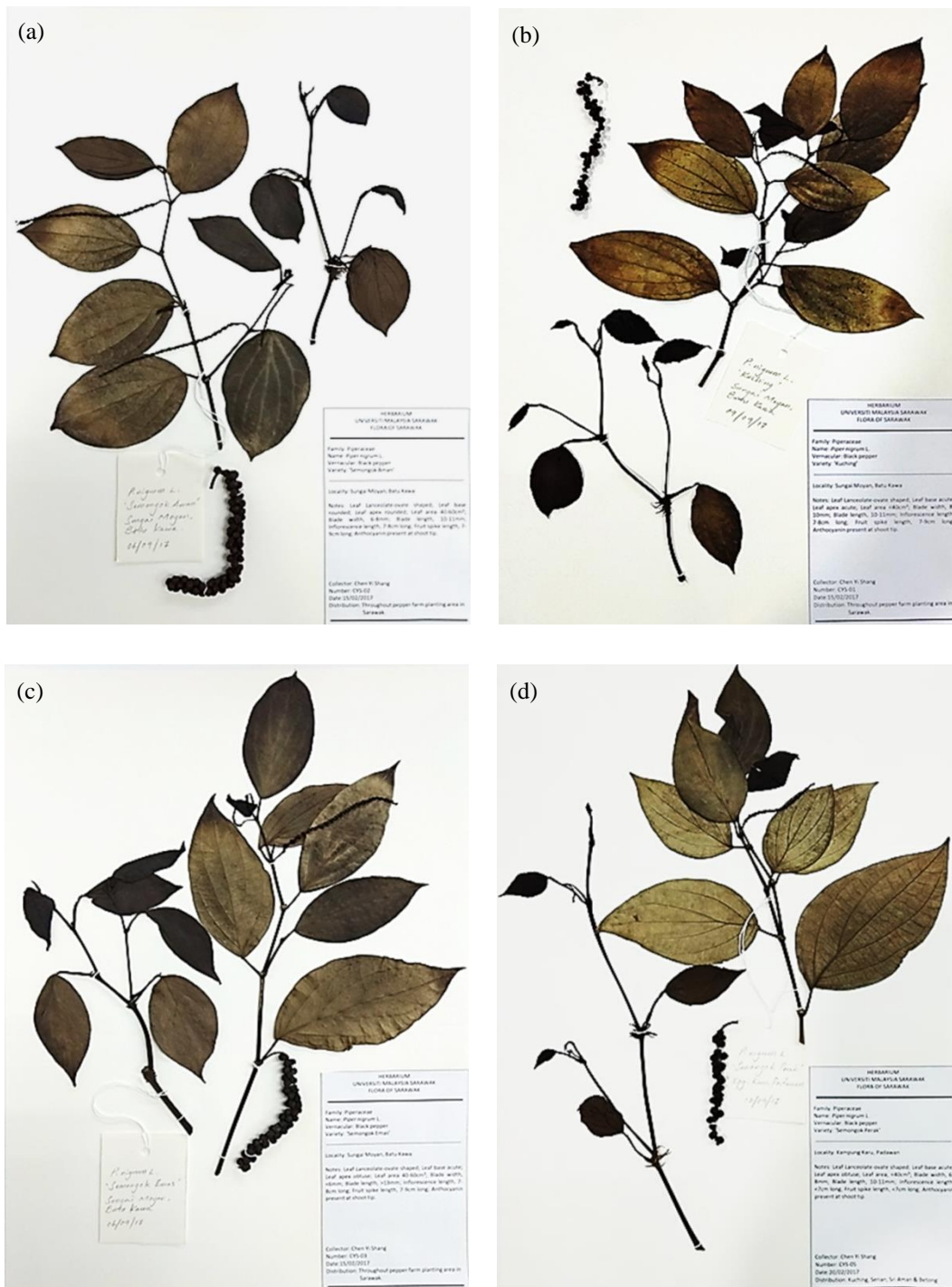


Figure 3. Dried specimen of black pepper cultivars. (a) cv. ‘Semongok Aman’- Voucher no. CYS-01; (b) cv. ‘Kuching’- Voucher no. CYS-02; (c) cv. ‘Semongok Emas’- Voucher no. CYS-03; (d) cv. ‘Semongok Perak’- Voucher no. CYS-04

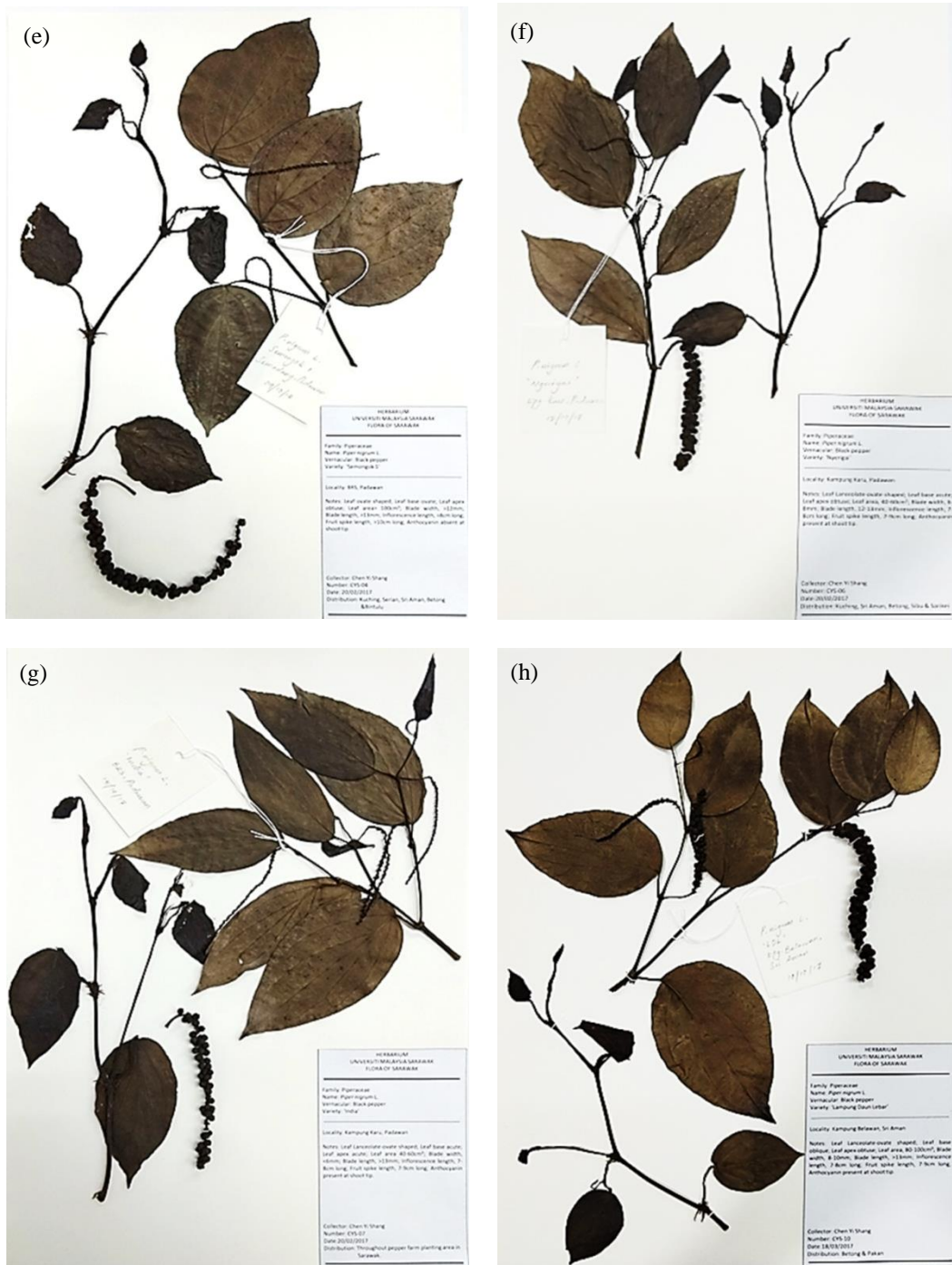


Figure 3. (continued) Dried specimen of black pepper cultivars. (e) cv. ‘Semongok 1’- Voucher no. CYS-05; (f) cv. ‘Nyerigai’- Voucher no. CYS-06; (g) cv. ‘India’- Voucher no. CYS-07; (h) cv. ‘Lampung Daun Lebar’- Voucher no. CYS-08

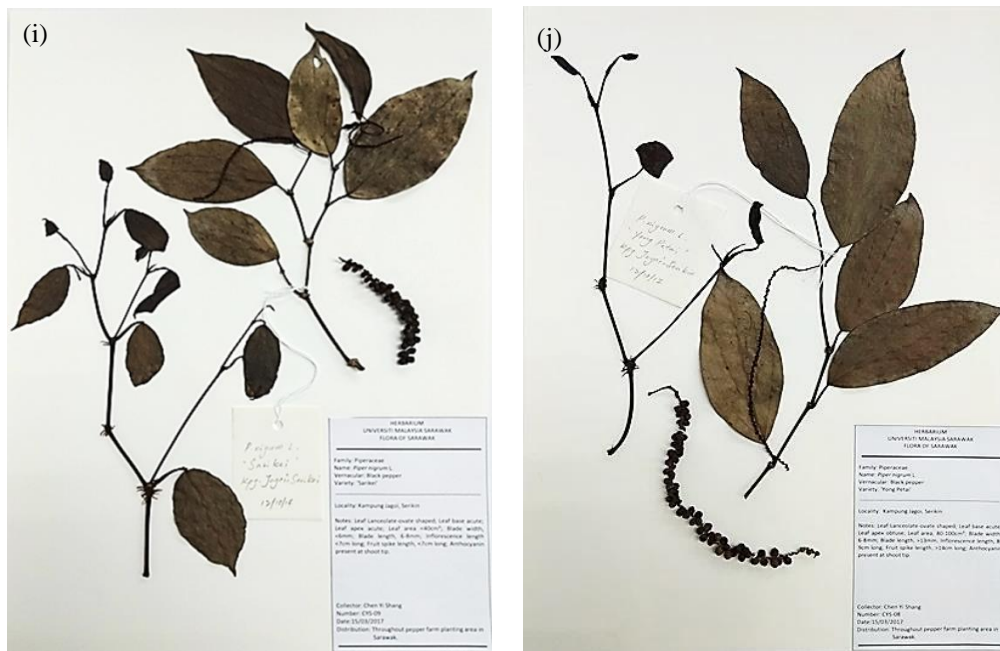


Figure 3. (continued) Dried specimen of black pepper cultivars. (i) cv. ‘Sarikei’- Voucher no. CYS-09; (j) cv. ‘Yong Petai’- Voucher no. CYS-10

DISTRIBUTION

In Malaysia, 95% of pepper planting areas are in the state of Sarawak, mainly distributed in rural area in Division of Kuching, Serian, Sri Aman, Betong, Sarikei and Sibul (Figure 4 and Table 2) while 5% from Peninsular Malaysia that consist of Johor, Pahang, Negeri Sembilan, Selangor Terengganu, Kelantan, Perak, Pulau Pinang and Kedah (Figure 5 and Table 2). Pepper cultivation has been initiated in Sabah (Figure 5 and Table 2) however distribution and population is limited. Distribution and population of cultivar ‘Kuching’ and ‘Semongok Emas’ was found most diverse among all the cultivars, made up of estimated 50% and 20% of total planting area, respectively. This is followed by cultivar ‘Semongok Aman’ and ‘India’, with estimated 10% of planting area coverage each, however the distribution restricted to Sarawak only. Cultivar ‘Nyerigai’ was common in Sri Aman and Betong Division, with population estimated 5%, however dissemination of this cultivar is limited. ‘Semongok Perak’, ‘Yong Petai’ and ‘Semongok 1’ were considered rare cultivar, with total planting area estimated less than 5% and distribution only limited to Sarawak

region. The least common cultivars were ‘Lampung Daun Lebar’ and ‘Sarikei’, with less than 10 farms reported the existence of this cultivar.

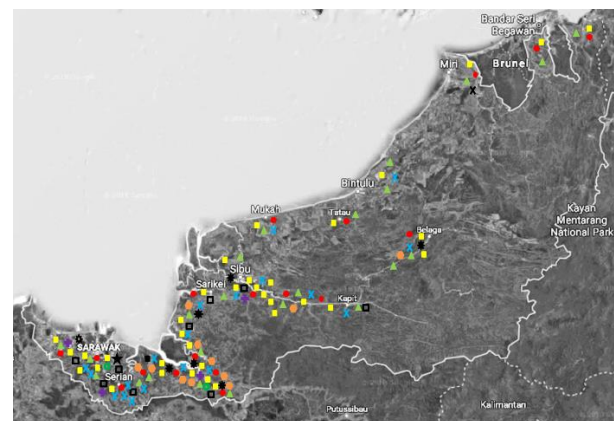


Figure 4. Distribution of cultivated pepper in Sarawak

Legend:

- ‘Kuching’
- ‘Semongok Emas’
- ▲ ‘Semongok Aman’
- ‘Semongok Perak’
- ‘Nyerigai’
- ✕ ‘India’
- ✚ ‘Semongok 1’
- ‘Lampung Daun Lebar’
- ★ ‘Sarikei’
- ✿ ‘Yong Petai’

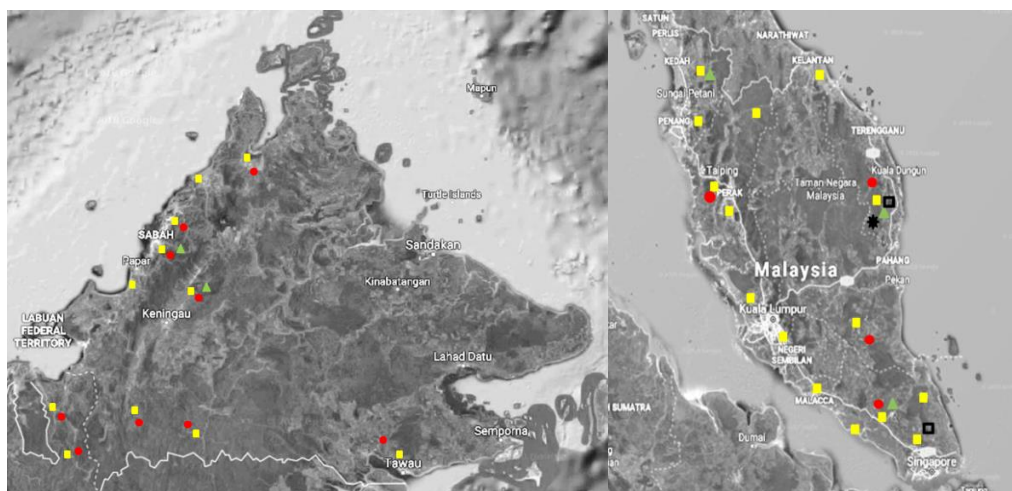


Figure 5. Distribution of cultivated pepper in Sabah and Peninsular Malaysia

Legend:

- 'Kuching'
- 'Semongok Emas'
- ▲ 'Semongok Aman'
- 'Semongok Perak'
- ★ 'Yong Petai'

Table 2. Distribution of pepper cultivar.

Cultivars	Locality
'Semongok Aman'	<p>State: Sarawak Area: Kuching Division- Bau, Sematan, Padawan, Mambong, Tarat, Matang; Samarahan Division- Muara Tuang, Simunjan and Batang Sadong; Serian Division- Tarat, Tebakang, Kedup, Bukit Semuja, Tedebu and Gedong; Sri Aman Division- Balai Ringin, Lachau, Lubok Antu, Bukit Begunan and Batang Lupar; Betong Division- Saratok, Layar, Saribas and Bukit Saban; Bintulu Division- Niah and Subis; Miri Division- Marudi and Sibuti; Sibiu Division- Dalat, Selangau, Kanowit and Lanang; Sarikei Division- Julau and Repok; Limbang Division- Lawas, Batu Danau and Bukit Kota; Bintulu Division- Tatau; Mukah Division- Dalat; Limbang Division- Lawas and Ba'Kelalan; Kapit Division- Song, Bukit Goram and Belaga; Miri Division- Marudi</p> <p>State: Sabah Area: Inanam; Pensiangan; Kimanis; Tuaran; Kota Marudu; Tawau; Kota Belud; Panampang; Tenom</p> <p>State: Terengganu Area: Ajil and Marang</p>
'Kuching'	<p>State: Sarawak Area: Kuching Division- Bau, Lundu, Sematan, Tanjung Datu, Padawan, Mambong, Tarat, Matang, Batu Kawa and Bako; Samarahan Division- Muara Tuang, Asajaya, Simunjan and Batang Sadong; Serian Division- Tarat, Tebakang, Kedup, Bukit Semuja, Tedebu and Gedong; Sri Aman Division- Balai Ringin, Lachau, Lubok Antu, Bukit Begunan and Batang Lupar; Betong Division- Saratok, Layar, Saribas and Bukit Saban; Bintulu Division- Niah, Subis and Samalaju; Miri Division- Marudi and Sibuti; Sibiu Division- Dalat, Selangau, Kanowit, Lanang, Bawang Assan and Nangka; Sarikei Division- Julau, Pakan and Tanjong Manis; Limbang Division- Lawas, Batu Danau and Bukit Kota, Batu Danau, Bukit Kota and Ba'Kelalan; Bintulu Division- Niah, Tatau, Subis and Samalaju; Mukah Division- Dalat and Balingian; Kapit Division- Song, Bukit Goram, Hulu Rajang and Belaga; Miri Division- Marudi and Sibuti</p> <p>State: Sabah Area: Kota Kinabalu Division- Inanam; Keningau Division- Pensiangan; Papar Division- Kimanis; Ranau Division- Keranaan</p> <p>State: Negeri Sembilan Area: Mambau; Seremban and Jelevu</p> <p>State: Pahang Area: Lipis and Rompin</p> <p>State: Selangor Area: Subang Jaya</p>

Continued Table 2

Cultivars	Locality
'Kuching'	State: Johor Area: Kukup, Pontian, Kulai, Kluang, Batu Pahat; Tebrau; Parit Sulong; Kota Tinggi; Yong Peng, Bakri and Lok Heng State: Perak Area: Gopeng; Canning; Batu Gajah; Kampar; Sungai Siput and Tambun State: Terengganu Division: Ajil, Dungun and Marang State: Kelantan Division: Jeli and Pasir Puteh State: Kedah Division: Kulim, Belantok, Baling, Jerai and Sik State: Pulau Pinang Division: Bukit Mertajam
'Semongok Emas'	State: Sarawak Area: Kuching Division- Bau, Sematan, Padawan, Mambong, Tarat, Matang; Samarahan Division- Muara Tuang, Simunjan and Batang Sadong; Serian Division- Tarat, Tebakang, Kedup, Bukit Semuja, Tedebu and Gedong; Sri Aman Division- Balai Ringin, Lachau, Lubok Antu, Bukit Begunan and Batang Lupar; Betong Division- Saratok, Layar, Saribas and Bukit Saban; Bintulu Division- Niah and Subis; Miri Division- Marudi and Sibuti; Sibu Division- Dalat, Selangau, Kanowit and Lanang; Sarikei Division- Julau and Repok; Limbang Division- Lawas, Batu Danau and Bukit Kota; Bintulu Division- Tatau; Mukah Division- Dalat; Limbang Division- Lawas and Ba'Kelalan; Kapit Division- Song, Bukit Goram and Belaga; Miri Division- Marudi State: Terengganu Area: Ajil
'Semongok Perak'	State: Sarawak Area: Kuching Division- Padawan, Mambong; Serian Division- Kedup and Tebedu; Sri Aman Division- Lachau and Lubok Antu; Sarikei Division- Julau; Betong Division- Saratok, Layar and Bukit Saban; Kapit Division- Song State: Terengganu Area: Ajil
'Semongok 1'	State: Sarawak Area: Kuching Division- Bau, Padawan, Mambong; Samarahan Division- Simunjan; Serian Division- Tarat, Tebakang, Kedup, Tedebu and Gedong; Sri Aman Division- Balai Ringin, Lachau, Lubok Antu; Betong Division- Layar and Bukit Saban; Sibu Division- Selangau, Kanowit and Lanang; Sarikei Division- Julau; Bintulu Division- Tatau; Kapit Division- Song and Belaga
'Nyerigai'	State: Sarawak Kuching Division- Padawan; Serian Division- Tebakang, Kedup and Gedong; Samarahan Division- Simunjan and Batang Sadong; Sri Aman Division- Balai Ringin, Lachau, Lubok Antu, Bukit Begunan and Batang Lupar; Betong Division- Saratok, Layar, Saribas and Bukit Saban
'India'	State: Sarawak Area: Kuching Division- Bau, Padawan, Mambong, Tarat; Samarahan Division- Simunjan and Batang Sadong; Serian Division- Tarat, Tebakang, Kedup, Bukit Semuja, Tedebu and Gedong; Sri Aman Division- Balai Ringin, Lachau, Lubok Antu, Bukit Begunan and Batang Lupar; Betong Division- Saratok, Layar, Saribas and Bukit Saban; Sibu Division- Selangau, Kanowit and Lanang; Sarikei Division- Julau and Repok; Kapit Division- Song
'Lampung Daun Lebar'	State: Sarawak Area: Kuching Division- Padawan; Sri Aman Division- Layar
'Sarikei'	State: Sarawak Area: Kuching Division- Bau; Sarikei Division- Julau and Repok
'Yong Petai'	State: Sarawak Area: Kuching Division- Bau, Padawan, Mambong; Serian Division- Tarat, Tebakang, Kedup, Bukit Semuja, Tedebu and Gedong; Sri Aman Division- Balai Ringin, Lachau, Lubok Antu, Bukit Begunan and Batang Lupar; Betong Division- Saratok, Layar, Saribas and Bukit Saban; Sibu Division- Selangau, Kanowit and Lanang; Sarikei Division- Julau, Pakan and Tanjong Manis State: Terengganu Area: Ajil

Source: E-Pekebun (Sistem Maklumat Pekebun Lada), by Malaysian Pepper Board.

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