

FOLIAR, FLORAL AND ABAXIAL LEAF EPIDERMAL CHARACTERISTICS OF *Piper nigrum* L. & *P. longum* L.

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SUMMARY

The two species, *P. nigrum* and *P. longum* show distinct foliar, floral and anatomical differences. The shape of leaf, type of venation, presence of trichomes, length and nature of spike, its sex composition, shape of bract, length of guard cells, length and breadth of epidermal cells, and stomatal index are the major distinguishing features of these two species. The possibility of using leaf epidermal pattern for the identification of wild and cultivated varieties of pepper has been indicated. The polygamodioecious *P. nigrum* has been found to include plants with only bisexual, bisexual and female, bisexual and male, total female and only male flowers in the spikes. The scope for improving the yield of pepper plantations has been discussed in the light of the above variation in sex composition.

Introduction

The family Piperaceae of the order Piperales is thought to represent a specialized offshoot of the Ranales. Extreme reduction is found in the flower of the genus *Piper* as evident from the absence of perianth parts and the ovary being one celled with one ovule (Franklin *et al*, 1962). The genus *Piper* has about 650 species (Chih & Sim, 1977) of which *P. nigrum*, *P. longum* and *P. betle* are of economic importance. In the case of *P. nigrum* which is one of the most important spice crops, more than 100 varieties are known to be cultivated in India (Mathew, 1957). Great majority of the cultivated varieties are bisexual although few pure female forms are also seen (Jose & Nambiar, 1972). Pure male forms are not generally observed under cultivation, but are common in the wild state. *P. longum* popularly known as "long pepper" cultivated in India is used as a condiment and also in ayurvedic medicine (Mathew, 1957). Though the general morphology of the flowers of *P. nigrum* has been described (Trimen, 1895; Chih & Sim, 1977) no critical information is available on leaf shape, venation, epidermal cell pattern, and floral characteristics of *P. nigrum* & *P. longum* in Sri Lanka. The results of study taken up on these aspects are reported in this paper.

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Materials and Methods

Ten cultivated and wild varieties of *P. nigrum* and *P. longum* collected from Crystal Hill Estate, Rattota, Gammaduwa, Udawatukele Nature Reserve, Illukkumbure, Matale and Muwandeniya of Sri Lanka, India and Malaysia and maintained at the research station of the Department of Minor Export Crops, Matale were used for the sampling of leaves and spikes. Fresh leaves collected from the 5th and 6th nodes below the growing tip were used for the study of leaf shape, venation, and leaf epidermal pattern

Abxial leaf epidermal peels were prepared with a razor blade and stained with cotton blue in lactophenol. Number of epidermal cells and stomata in 3 microscopic fields were counted at a magnification of 10 x 40. Length and width of 75 epidermal cells and length of 30 guard cells were measured at a magnification of 10 x 15. Observations on cell inclusion such as trichomes were also made. Stomatal index was calculated following the method of Salisbury (1928).

Spikes of appropriate maturity were preserved in FAA (formalin, acetic acid & alcohol) to study the floral and spike characteristics. The flowers were dissected and examined under stereo microscope and observations made from a random sample of 15 spikes, the lengths of which was measured,

Results

The shape of leaves of cultivated and wild accessions of *P. nigrum* is ovate oval, usually broad, obtuse or slightly rounded and acuminate with unequal base in some cases. However, for a given variety the leaf shape is more or less constant. There are 3 or 5 main veins arising from the base of the lamina with one pair of prominent secondary veins arising from the middle vein (Fig. A. 1, 2) mostly alternate and rarely opposite. In *P. longum* two types of leaves are found in the same vine. While leaves at the base are broadly ovate, cordate, and acuminate upper ones are oblong, cordate and acuminate. Five or seven main veins arising from the base is characteristic of this species. The last pair however is not prominent (Fig. A. 3, 4).

The length and breadth of epidermal cells, the length of guard cells, and the stomatal index are given in Table 1. It will be observed from the Table that the length of epidermal cells in *P. longum* is almost twice that of *P. nigrum* though their width does not show much variation. In *P. nigrum* the epidermal cells are polygonal (Fig. A. 5) and have straight walls whereas in *P. longum* they are more or less rectangular and wavy

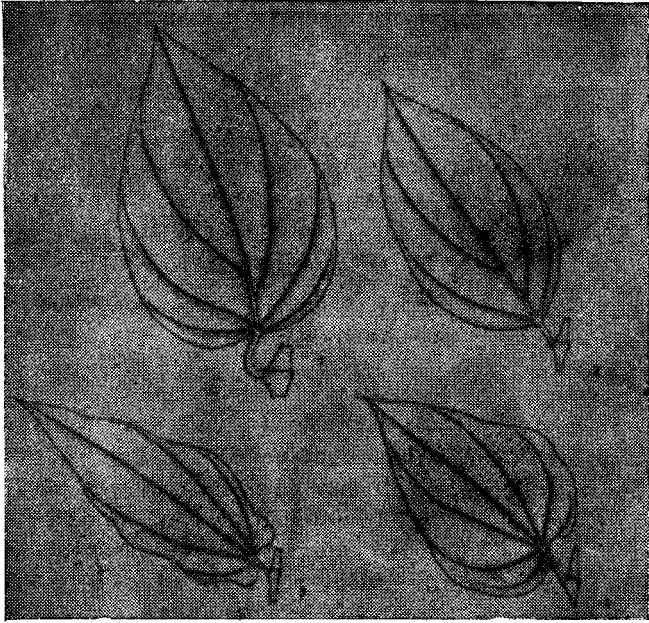


Fig. A. 1—4 x $\frac{1}{2}$

1. *P. nigrum* broadly ovate leaf with 5 main veins and a pair of secondaries
2. *P. nigrum* ovate leaf with 3 main veins and a pair of secondaries
3. *P. longum* oblong leaf with 5 main veins
4. *P. longum* ovate leaf with 7 main veins

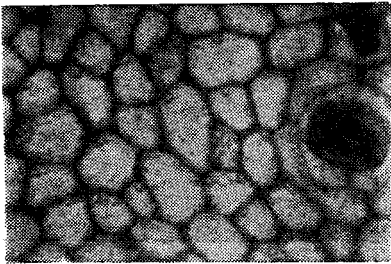


Fig. A. 5
Epidermal pattern of
P. nigrum x 450

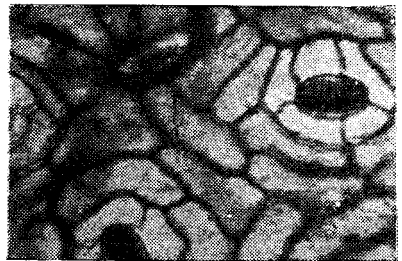


Fig. A. 6
Epidermal pattern of
P. longum x 450 t - trichome



Fig. B. 1—4 x $\frac{1}{2}$

1. Spike with only male flowers
2. Spike with only female flowers
3. Spike with bisexual flowers only
4. Spike with bisexual and male flowers



Fig. B. 5
Spike of *P. nigrum* x 3
b. oblong bract
s. persistent stamens

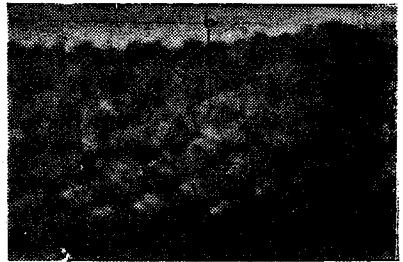


Fig. B. 6
Spike of *P. longum* x 3
b. circular bract

(Fig. A. 6). This species has also unicellular trichomes on the abaxial side. The stomata in both species are anomocytic. However they vary widely in their stomatal index. The index in *P. longum* being more than double of that in *P. nigrum*.

Observations on floral characteristics are given in Table 2. From the data it will be seen that in the case of *P. longum* the spikes are very much short compared to that of *P. nigrum*. The bracts in *P. nigrum* are oblong in shape (Fig. B. 5) while those in *P. longum* are circular (Fig. B. 6). The fruit set in *P. nigrum* also vary widely (Fig. B. 1, 2, 3, 4).

Discussion

The different cultivated and wild varieties of *P. nigrum* do not show any difference in respect of leaf shape and venation. However, there is difference in the epidermal cell length, epidermal cell breadth, and stomatal index are higher in the case of wild varieties. Variation in epidermal cell pattern has been used for identification of varieties at intra-specific level in rubber (Senanayake, 1969), arecanut (Bavappa, 1966). It appears that these characters can be used for identification of wild and cultivated varieties of pepper. At the inter-specific level *P. longum* has larger epidermal cells and a much higher stomatal index (Table 1). In addition, the two species differ in their leaf shape, type of venation, spike length and fleshiness, number of stigmatic lobes, and shape of bracts. *P. longum* is also characterised by the presence of unicellular trichomes on the abaxial surface of the leaf.

The polygamodioecious nature of *P. nigrum* has been observed to include vines with only bisexual, bisexual and female, bisexual and male, total female and only male flowers in the spikes (Fig. A. 1, 2, 3, 4). In pepper where pollination takes place through rain water (Franklyn *et al.*, 1962), bisexual flowers can favour high berry setting. Low berry setting has been recorded in plants having only female flowers (Jose and Nambiar, 1972). Even spikes with female and bisexual flowers have been found to have low setting when the female flowers are at the base of the spike, due to lack of pollination chances. Thus high yielding varieties to be stable yielders have to be those bearing bisexual flowers. As against the earlier report that cultivated varieties are either bisexual or female (Jose & Nambiar, 1972) occurrence of male plants under cultivation has been observed. The belief prevalent amongst some of the pepper planters in Sri Lanka that the presence of male plants is essential to get higher yield requires further study. However, it is possible that where the vines are predominantly females presence of males would have been of advantage.

Since berry setting can get reduced substantially in vines having flowers other than bisexual, one of the methods of up-grading production

Table 1. Size of epidermal and guard cells and stomatal index of *P. nigrum* & *P. longum*.

Species/varieties	Acc. No.	Place of Collection	Mean Guard Cell length (μ)	Mean Epidermal Cell length (μ)	Mean Epidermal Cell breadth (μ)	Stomatal Index
<i>P. nigrum</i>						
Panniyur 1	65	India	26.07 \pm 1.20	22.88 \pm 2.51	15.96 \pm 0.22	3.9 \pm .006
Kuching	66	Malaysia	24.69 \pm 1.05	20.40 \pm 3.54	14.59 \pm 0.22	3.6 \pm .005
Local MB 23	67	Gammaduwe	25.88 \pm 1.72	26.46 \pm 3.01	16.86 \pm 0.33	3.5 \pm .006
Local W ₁ *	39	Udawatukele	28.14 \pm 1.41	26.01 \pm 2.73	18.03 \pm 2.9	3.9 \pm .005
Local W ₂ *	25	Illukkumbura	30.61 \pm 1.54	22.85 \pm 4.78	24.17 \pm 2.91	4.3 \pm .015
Local W ₃ *	16	Muwandeniya	30.16 \pm 1.53	30.82 \pm 2.51	24.14 \pm 0.55	4.4 \pm .001
<i>P. longum</i>	3	Matale	24.51 \pm 1.91	44.0 \pm 4.92	18.72 \pm 0.03	9.1 \pm .006

* Wild type of *P. nigrum*

Table 2. Observations on the floral characteristics of *P. nigrum* & *P. longum*

Species/Varieties	Acc. No.	Place of collection	Spike composition	No. of stamens	Stigmatic lobes	Length of spike
<i>P. nigrum</i>						
Panniyur 1	65	India	Bisexual 100%	2	3 - 4	17.0 cm
Kuching	66	Malaysia	Bisexual 100%	2	3 - 3	10.5 cm
Local H ₁	68	Crystal Hill Estate	Male 100%	2	-	13.15 cm
Local H ₂	69	Crystal Hill Estate	Female 100%	-	3 - 4	15.25 cm
Local H ₃	70	Crystal Hill Estate	Male 12% Bisexual 88%	2	-	14.21 cm
Local W ₁ *	39	Udawatukele	Female 100%	-	3 - 4	7.85 cm
Local W ₂ *	25	Illukkumbura	Female 100%	-	3 - 4	7.9 cm
Local W ₃ *	16	Muwandeniya	Male 100%	2	-	14.8 cm
<i>P. longum</i>	3	Matale	Female 100%	-	3	2.2 cm

* Wild type of *P. nigrum*

in a plantation is by the progressive elimination of such plants. In the bisexual flowers the filament along with a portion of the dry anther lobes persist (Fig. B. 5) even after the berries mature, this could be used as a marker for identifying plants having bisexual flowers. Since there are two flowering seasons in many pepper growing tracts in Sri Lanka and consequently continuous stand of the crop on the vines selection for bisexual flowers can be done with much more ease.

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