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***Myzus (Nectarosiphon) persicae* (Sulzer, 1776) (Homoptera: Aphididae): Updated Check List of Host Plants in India**

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Abstract: *Myzus (Nectarosiphon) persicae* (Sulzer) (Homoptera: Aphididae) is a highly polyphagous aphid species and is now considered to consist of distinct phenotypes and genotypes, both holocyclic and anholocyclic, that vary with respect to their ability to reproduce and food preferences on different host plants. The diversity of its host range in India includes plants belonging to 293 species under 64 plant families. Plants belonging to following families are highly infested: Asteraceae, Brassicaceae, Fabaceae, Malvaceae, Rosaceae and Solanaceae. There are 14 plant families where more than 5 species of plants were infested with *Myzus persicae* in India upto March, 2015, viz. Asteraceae (44 plant species), Solanaceae (37 plant species), Brassicaceae (27 plant species), Fabaceae (18 plant species), Rosaceae (13 plant species), Malvaceae (11 plant species), Convolvulaceae (11 plant species), Amaranthaceae (10 plant species), Polygonaceae (8 plant species), Caryophyllaceae, Plantaginaceae, Poaceae (7 plant species each), Cucurbitaceae (6 plant species), and Euphorbiaceae (5 plant species).

Keywords: *Myzus persicae*, economic importance, distribution, host plants.

Introduction

Passerini (1860) described the genus *Myzus* with *Aphis cerasi* Fabricius, 1775 as the type species and probably is Asian in origin. *Myzus* is one of the large aphid genus in the world containing 68 species out of which several species are the most injurious aphid pests. Four subgenera were recognised: *Galiobium* Börner 1933, *Myzus* sensu stricto, *Nectarosiphon* Schouteden 1901 and *Sciomyzus* Stroyan 1954 (Remaudiere and Remaudiere 1997). The species *Myzus persicae* was described by Sulzer in 1776

(Type species: *Aphis persicae* Sulzer, 1776) and was kept under subgenus *Nectarosiphon*.

For very long time populations of *Myzus persicae* on tobacco, *Nicotiana tabacum* L., have been considered to be different from populations on other plants (Blackman and Eastop 2007). Multivariate morphometric analysis has revealed that populations of *Myzus persicae* feeding on tobacco are morphologically distinct from those on other host-plants, and the tobacco feeding form has been given the name *Myzus nicotianae* Blackman (Blackman 1987).

However, several studies using molecular methods have provided evidence that the aphids on tobacco are not distinct at the species level from other populations of *Myzus persicae* (Field et al. 1994, Margaritopoulos et al. 1998, Clements et al. 2000a, b). Also, it was considered that *Myzus nicotianae* populations were permanently parthenogenetic until holocyclic populations were found in Greece on peach (Margaritopoulos et al. 2002). These data suggest that tobacco-feeding aphids cannot be considered a valid species, and Eastop and Blackman (2005) proposed that the tobacco-adapted form should be called *Myzus persicae* ssp. *nicotianae* Blackman 1987.

Some described species are comprised of complexes of morphologically closely related species, biotypes, host-races or subspecies (Clements et al. 2000a, Jensen and Holman 2000, Poulios et al. 2007, Vučetić et al. 2010). Lack of distinguishable morphological characters, the presence of sibling species and intraspecific variation among members of this group makes their identification and separation based on morphological characters alone very difficult (Margaritopoulos et al. 2000, 2006). These difficulties have made it necessary for taxonomists to look for other techniques such as morphometrics in order to delimit species and populations (Madjzadeh et al. 2009).

A. Synonyms: Sixty synonyms of *Myzus persicae* were observed in the literature (Börner 1952, Remaudiere and Remaudiere 1997, <http://www.cabi.org/isc/datasheet/35642>). These are following:

- = *Aphis consors* Walker, 1848
- = *Aphis convolvuli* (Kaltenbach, 1843)
- = *Aphis cynoglossi* Williams, 1891
- = *Aphis cymbalariae* Schouteden, 1900
- = *Aphis cynoglossi* Walker, 1848

- = *Aphis cynoglossi* Williams, 1911
- = *Aphis deposita* Walker, 1848
- = *Aphis derelicta* Walker, 1849
- = *Aphis dianthi* Schrank, 1801
- = *Aphis dubia* Curtis, 1842
- = *Aphis egressa* Walker, 1849
- = *Aphis intirrhini* Macchiati
- = *Aphis malvae* Mosley, 1841
- = *Aphis particeps* Walker, 1848
- = *Aphis persicae* Morren, 1836
- = *Aphis persicophila* Rondani "in scheda" (=sur fiche") ex Passerini, 1860
- = *Aphis persola* Walker, 1848 ?
- = *Aphis rapae* Curtis, 1842 partim
- = *Aphis rapae laevigata* Riley, 1875
- = *Aphis redundans* Walker, 1849
- = *Aphis suffragans* Walker, 1848
- = *Aphis tuberoscellae* Theobald, 1922
- = *Aphis vastator* Smee, 1846
- = *Aphis vulgaris* Kyber, 1815
- = *Aulacorthum convolvuli* (Cooke)
- = *Macrosiphum lophospermum* Theobald, 1914
- = *Macrosiphum lycopersicella* Theobald, 1914
- = *Myzodes tabaci* Mordvilko, 1914
- = *Myzodes persicae* (Sulzer, 1776)
- = *Myzus asterophaga* Zhang, Chen, Zhong and Li, in Zhang 1999 partim
- = *Myzus callae* Koch, 1854
- = *Myzus dianthi* (Schrank, 1801)
- = *Myzus lagerstroemiae* Zhang, Chen, Zhong and Li, in Zhang 1999
- = *Myzus malvae* Oestlund, 1886
- = *Myzus nicotianae* Blackman, 1987
- = *Myzus papaverisucta* Zhang, Chen, Zhong and Li, in Zhang 1999
- = *Myzus pergandii* Sanderson, 1901
- = *Myzus persicae* ssp. *dyslycialis* F.P.Müller
- = *Myzus persicae* var. *cerastii* Theobald, 1926
- = *Myzus persicae* var. *portulacella* Theobald, 1926

- = *Myzus persicae* var. *sanguisorbiella* Theobald, 1926
- = *Myzus persicae* var. *tuberosellae* Theobald, 1922
- = *Myzus tuberosellae* Mason, 1940
- = *Nectarosiphon persicae* (Sulzer, 1776)
- = *Phorodon cynoglossi* Williams, 1891 sec. Davis, 1911
- = *Phorodon persicae* (Sulzer, 1776)
- = *Rhopalosiphum betae* Theobald, 1913
- = *Rhopalosiphum calthae* Koch, 1854
- = *Rhopalosiphum dianthi* (Schrank, 1801)
- = *Rhopalosiphum galeactitis* Macchiati, 1883
- = *Rhopalosiphum lactucellum* Theobald, 1915
- = *Rhopalosiphum persicae* (Sulzer, 1776) : Essig (1917).
- = *Rhopalosiphum solani* Theobald, 1912 nonKalt, 1843
- = *Rhopalosiphum trilineatum* del Guercio, 1920 (1921)
- = *Rhopalosiphum tuberosellae* Theobald, 1922
- = *Rhopalosiphum tulipae* Thomas, 1879
- = *Siphonophora achyrantes* Monell, 1879
- = *Siphonophora calenduella* Williams, 1891
- = *Siphonophora calendulella* Monell, 1879
- = *Siphonophora nasturtii* Koch, 1855

B. Preferred Common Name: Green peach aphid.

C. Other common names: Cabbage aphid, green sesame aphid, peach aphid, peach curl aphid, peach-potato aphid, potato aphid, tobacco aphid.

In India, *Myzus persicae* was first reported by George (1927) and Krishnamoorthi (1929) on *Nicotiana tabacum* L. (Solanaceae) from south India. Later on, Krishnamoorthi (1930) reported the species on another host plant, *Phaseolus vulgaris* L. (Fabaceae). Thereafter, several

workers reported *Myzus persicae* from different parts of the country. There exists a considerable proportion of literature that deals with mainly its geographical distribution, host plants, bionomics, host plant relations and chemical and biological control (Zimmerman 1948, Toba 1963, 1964, van Emden et al. 1969, Burbutis et al. 1972, Mackauer and Way 1976, Taylor 1977, Agarwala et al. 1981, Raychaudhuri 1983, Flint 1985, Verma et al. 1985, Jansson and Smilowitz 1986, French-Constant et al. 1988, Flanders et al. 1991, Verma and Parihar 1996a, b, El-Arnaouty et al. 2000, Laskar and Ghimiray 2004, Musa et al. 2004, Agrawal and Singh 2005, Malik and Khajuria 2005, Agrawal et al. 2006, Devi and Singh 2007, Joshi and Poorani 2007, van Emden and Harrington 2007, Sathe and Jadhav 2008, Pelletier et al. 2010, Vučetić et al. 2010; Duarte et al. 2011, Prado and Frank 2013, Bass et al. 2014; Elzinga et al. 2014).

DISTRIBUTION OF *MYZUS PERSICAE* IN INDIA

Myzus persicae is a remarkable species in terms of geographical distribution and host plant range. It is a cosmopolitan and is reported from 144 countries of the world (<http://www.cabi.org/isc/datasheet/35642>) and is a highly polyphagous species infesting about 1600 plant species in tropics, subtropics, and temperate regions (Blackman and Eastop, 1994, 2000, 2006, Holman, 2009). In India, it is a major pest of several crops particularly potato and brassica crops. The aphid has become a serious pest of field and glasshouse crops, especially *Abelmoschus esculentus* (L.) Moench, *Beta vulgaris* L., *Brassica juncea* L. Czern., *Brassica napus* L., *Brassica nigra* (L.) W.D.J. Koch, *Brassica oleracea* var. *botrytis* L., *Brassica oleracea* var. *capitata* L., *Brassica oleracea* var. *gongyloides* L., *Brassica rapa* L.,

Brassica rapa subsp. *campestris* (L.) A.R. Clapham, *Capsicum frutescens* L., *Coriandrum sativum* L., *Helianthus annuus* L., *Ipomoea batatas* (L.) Lam., *Lycopersicon esculentum* Mill., *Malva sylvestris* L., *Nicotiana tabacum* L., *Pisum sativum* L., *Prunus persica* (L.) Batsch, *Raphanus sativus* L., *Sesamum indicum* L., *Solanum melongena* L., *Solanum tuberosum* L. etc. (Verma 1976, Verma and Parihar 1996a, Sathe and Jadhav 2008).

In India, it has been reported from almost all the states infesting nearly 300 plant species as follows (only selected references are given):

1. Andhra Pradesh (Joshi et al. 1979)
2. Andman and Nicobar (Biswas et al. 1992)
3. Arunachal Pradesh (Dubey et al. 2013, Ali et al. 2014)
4. Assam (Ghosh and Raychaudhuri 1962a, 1963)
5. Bihar (Ahmed and Singh 1996)
6. Chhattisgarh (Patel and Thakur 2005, Kulkarni et al. 2008)
7. Delhi (Ghosh and Raychaudhuri 1962b, Ghulam-Ullah 1940)
8. Gujarat (Shah 1996, Trivedi et al. 2002)
9. Haryana (Verma et al. 1975, Lakra 2004)
10. Himachal Pradesh (Bhalla 1971, Sharma and Bhalla 1964)
11. Jammu and Kashmir (Verma 1971, Verma and Das 1992)
12. Kerala (George 1927)
13. Jharkhand (Jha 1998)
14. Karnataka (Krishnamurthi 1929, 1930, Joshi and Poorani 2007)
15. Kerala (Varghese and Mathew 2012)
16. Madhya Pradesh (Veda et al. 1994, Patel et al. 2005)
17. Maharashtra (Despande 1938, Raj and Verma 1989)
18. Manipur (Agarwala and Raychaudhuri 1980, Agarwala et al. 1980)
19. Meghalaya (Ali et al. 2013)
20. Mizoram (Boopathi and Pathak 2012)
21. Nagaland (Raha 1979, Ali et al. 2013)
22. Odisha (Sengupta et al. 1962, Mandal and Patnaik 2006)
23. Punjab (Singh et al. 1987)
24. Rajasthan (Raychaudhuri and Ghosh 1959, Ghosh and Raychaudhuri 1962c)
25. Sikkim (Agarwala 1979, Ghosh and Raychaudhuri 1968)
26. Tamil Nadu (Basha and Balasubramanian 1980)
27. Telangana (Jagadeeshwar et al. 2005)
28. Tripura (Ganguli and Ghosh 1965)
29. Uttar Pradesh (Ghosh 1969, Singh et al. 1999)
30. Uttarakhand (Chakrabarti 1972, Kumar et al. 2009)
31. West Bengal (Banerjee and Basu 1955, Agarwala et al. 1982).

ECONOMIC SIGNIFICANCE OF *MYZUS PERSICAE*

The peach potato or green peach aphid, *Myzus persicae* is the most economically important aphid crop pest worldwide (van Emden and Harrington 2007). It is one among those aphids which is more diverse in cooler temperate regions and reproduce through sexual reproduction for one generation per year (holocycle), but in summer it reproduce parthenogenetically, i.e. clonal reproduction (anholocycle) through many generations by alternating its lifecycle between primary host and alternative hosts. But, in warmer tropics, the lifecycle is strictly anholocyclic (Blackman 1971). However, in India, sexual morphs were reported by Verma and Ghosh (1990) from northern part of the country such as Nainital (Uttarakhand) and Shillong

(Meghalaya), but also from plains like Modipuram and Meerut (Uttar Pradesh). Hence, it is presumed that it enjoys both asexual and sexual life cycle in northern India (Singh and Ghosh 2012). Thus, it appears that the species has heteroecious holocycle in the Indian conditions.

Myzus persicae causes damage to its host by direct feeding, the transmission of plant viruses and the production of honeydew. It can attain very high densities on young plant tissue, causing water stress, wilting, and reduced growth rate of the plant. Prolonged aphid infestation can cause appreciable reduction in yield of root crops and foliage crops. Early season infestation is particularly damaging to potato, even if the aphids are subsequently removed (Verma 1976, Petitt and Smilowitz 1982). Contamination of harvestable plant material with aphids, or with aphid honeydew, also causes loss (Elmer and Brawner 1975). However, green peach aphid does not seem to produce the high volume of honeydew observed with some other species of aphids. Blemishes to the plant tissue, usually in the form of yellow spots, may result from aphid feeding. Leaf distortions are not common except on the primary host. Contamination of vegetables by aphids sometimes presents quarantine problems (Stewart et al. 1980).

The major damage caused by green peach aphid is through transmission of plant viruses (Chan et al. 1991). Indeed, this aphid is considered by many to be the most important vector of plant viruses throughout the world (Sigvald 1984, Hooker 1986, Romancer et al. 1994, Ali et al. 2014). Nymphs and adults are equally capable of virus transmission (Namba and Sylvester 1981), but adults particularly alates, by virtue of being so mobile, probably have greater opportunity for transmission. Both persistent viruses, which move through the

feeding secretions of the aphid, and non-persistent viruses, which are only temporary contaminants of aphid mouthparts, are effectively transmitted. Kennedy et al. (1962) listed over 100 viruses transmitted by this species. Later on, Chan et al. (1991) estimated 182 plant viruses transmitted by *Myzus persicae*. Some of the particularly damaging diseases include potato leafroll virus and potato virus Y to Solanaceae, beet western yellows and beet yellows viruses to Chenopodiaceae, lettuce mosaic virus to Asteraceae, cauliflower mosaic and turnip mosaic viruses to Brassicaceae, and cucumber mosaic and watermelon mosaic viruses to Cucurbitaceae. A discoloration in potato tubers, called net necrosis, occurs in some potato varieties following transmission of potato leafroll.

On brassica crops, *Myzus persicae* and *Lipaphis pseudobrassicae* both infest simultaneously in the field crops. Srivastava et al. (1996) estimated that *Myzus persicae* along with *Lipaphis pseudobrassicae* cause yield loss of 46.1% to yellow sarson cultivar (YST-841) in Himachal Pradesh, India followed by brown sarson (BSH-1, 43.58%), *Brassica juncea* (Varuna, 30.9%), *Brassica napus* (HPN-1, 36.0% and *Brassica carinata* (HPC-1, 22.84%). Similarly, Sharma and Kashyap (1998) estimated the losses in three different brassica oilseed brassica crops due to *Myzus persicae* and reported that it along with *Lipaphis pseudobrassicae* damage 67.6, 62.5 and 50.0% on toria (cv. DK-1), sarson (cv. BSH-1) and *Brassica juncea* (cv. Varuna), respectively. Most of the losses occurred when the infestation was prevalent during the flowering stage. For *Myzus persicae*, the potato (*Solanum tuberosum* L.) is one of the preferred host crops and it causes a yield loss upto 85% (Nagaich 1975).

FOOD PLANTS OF *MYZUS PERSICAE* IN INDIA

Myzus persicae is highly polyphagous and consist of distinct phenotypes and genotypes (Peppe and Lomônaco 2003), both holocyclic and anholocyclic (Blackman 1991). These populations vary with respect to their reproductive ability and preferences for host plants for food. The diversity of its host range in India includes plants belonging to 293 species under 64 plant families.

The following records of food plants of *Myzus persicae* are based on the survey of literature. In the literature, names of the plants were erroneously mentioned even in the recent publications. In the present compilation, attempts were made to provide the valid scientific name of the plants following updated taxonomic informations provided by <http://www.ars-grin.gov> and <http://www.theplantlist.org>. At several places, their synonymy was also mentioned. Following is the list of familiwise food plants of *Myzus persicae* recorded in India upto March, 2015.

1. Acanthaceae :

Hemigraphis indicus (?) (Agrawal et al. 2006)

2. Acanthaceae :

Strobilanthes sp. (Raychaudhuri 1973)

3. Adoxaceae :

Sambucus javanica Reinw. ex Blume (Raychaudhuri 1973)

4. Amaranthaceae :

Achyranthes sp. (Raychaudhuri 1973)

Alternanthera philoxeroides (Mart.) Griseb. (Raychaudhuri 1973)

Amaranthus sp. (Ghosh and Agarwala 1980)

Amaranthus spinosus L. (Raychaudhuri 1973)

Amaranthus viridis L. (Raychaudhuri 1973)

Beta vulgaris L. (Ghulam-Ullah 1940, Ghosh and Raychaudhuri 1962b, Behura 1963b, Verma et al. 1975, Agarwala 1979, Raychaudhuri 1980, Agrawal et al. 2006)

Beta vulgaris var. *bengalensis* L. (Behura 1963b)

Chenopodium album L. (Ghosh and Agarwala 1985)

Chenopodium sp. (Banerjee and Basu 1956, 1958, Raychaudhuri 1973) Ghosh and Agarwala 1980)

Spinacia oleracea L. (Chakrabarti 1972)

5. Amaryllidaceae (=Alliaceae) :

Allium ascalonicum L. (=Allium *hierochuntinum* Boiss.) (Raychaudhuri 1973)

6. Araceae :

Amorphophallus paeoniifolius (Dennst.) Nicolson (Babu et al. 2011)

7. Apiaceae :

Anethum graveolens L. (=Peucedanum *graveolens* (L.)) (Behura 1963a)

Coriandrum sativum L. (Basu and Banerjee 1958, Behura 1963b, Agrawal et al. 2006)

Daucus carota L. (Behura 1963b, Rao 1969, Chakrabarti 1972)

8. Apocynaceae :

Calotropis gigantea (L.) W.T. Aiton (Raychaudhuri 1973)

Calotropis procera (Aiton) W.T. Aiton (Singh et al. 1999, Agrawal et al. 2006)

Catharanthus roseus (L.) G. Don (=Vinca *rosea* L.) (Raha 1979)

9. Asteraceae :

Ageratum conyzoides L. (Raychaudhuri 1973, Ghosh and Agarwala 1980, Agrawal et al. 2006)

Ageratum sp. (Chakrabarti 1972)

Amberboa moschata (L.) DC. (=Centaurea *moschata* L.) (Ghosh and Raychaudhuri 1962a, Behura 1963)

- Arctotis arctotoides* (L. f.) O. Hoffm. (= *Venidium arctotoides* L. f.) (Verma et al. 1975)
- Artemisia* sp. (Agarwala 1979)
- Artemisia vulgaris* L. (Ghosh and Agarwala 1985)
- Aster trinervius* Roxb. ex D. Don (Verma et al. 1975)
- Bidens pilosa* L. (Agarwala 1979, Maity and Chakrabarti 1979, Ghosh and Agarwala 1980)
- Blainvillea acmella* (L.) Philipson (= *Spilanthes acmella* (L.) L.) (Agarwala 1979)
- Blumea lacera* (Burm.f.) DC. (Raychaudhuri 1973)
- Carthamus tinctorius* L. (Ghulam-Ullah 1940, Behura 1963b, Verma et al. 1975)
- Chrysanthemum indicum* L. (Kar et al. 1990)
- Chrysanthemum* sp. (Behura 1963b, Raychaudhuri 1973)
- Chrysanthemum xmorifolium* Ramat. (= *Chrysanthemum sinense* Sabine ex Sweet) (David 1958b)
- Cineraria* sp. (Behura 1963b)
- Cosmos* sp. (Ghosh and Agarwala 1980)
- Crassocephalum crepidioides* (Bent.) S. Moore (= *Gynura crepidioides* Benth.) (Ghosh and Agarwala 1985)
- Dahlia* sp. (Agarwala 1979)
- Dichrocephala integrifolia* (L.f.) Kuntze (= *Dichrocephala latifolia* (Pers.) DC.) (Raychaudhuri 1973)
- Echinops echinatus* Roxb. (Behura 1963b)
- Erechtites* sp. (Agarwala 1979)
- Erigeron* sp. (Ghosh and Agarwala 1980)
- Eupatorium odoratum* L. (Ghosh and Agarwala 1980)
- Eupatorium riparium* Rigel. (Ghosh and Agarwala 1985)
- Eupatorium wallichii* DC. (Raychaudhuri 1973)
- Galinsoga parviflora* Cav. (Ghosh and Agarwala 1980)
- Gynura cusimbua* (D. Don) S. Moore (= *Gynura angulosa* DC.) (Agarwala 1979)
- Gynura nepalensis* DC. (Raychaudhuri 1973)
- Gynura* sp. (Ghosh and Agarwala 1980)
- Helianthus annuus* L. (Raychaudhuri 1978, Agrawal et al. 2006)
- Helianthus* sp. (Ahmed and Singh 1996)
- Hypochoeris radicata* L. (Raychaudhuri 1973)
- Inula cappa* (Buch.-Ham. Ex D. Don) DC. (Raychaudhuri 1973)
- Lactuca sativa* L. (Ghosh and Agarwala 1980)
- Launaea sarmentosa* (Willd.) Sch. Bip. ex Kuntze (= *Launaea pinnatifida* Cass.) (Agarwala 1979)
- Pseudognaphalium luteoalbum* (L.) Hill. & Burt. (= *Gnaphalium luteoalbum* L.) (Agarwala 1979, Ghosh and Agarwala 1980)
- Sonchus arvensis* L. (Raha 1979, Ghosh and Agarwala 1980, Ghosh and Agarwala 1985)
- Sonchus asper* (L.) Hill (Mall et al. 2010)
- Sonchus* sp. (Singh et al. 1999)
- Spilanthes acuminata* (?) (Agarwala 1979)
- Spilanthes corymbosus* Sessé & Moc. (= *Sonchus corymbosa* auct. nonn.) (Ghosh and Agarwala 1985)
- Tagetes patula* L. (Raychaudhuri 1973, 1978)
- Tridax procumbens* L. (Bhanotar and Ghosh 1969b, Chakrabarti 1972, Agrawal et al. 2006)
- Zinnia* sp. (Chakrabarti 1972)
- 10. Balsaminaceae :**
- Impatiens balsamina* L. (Ghosh and Agarwala 1985)
- 11. Basellaceae :**

- Basella alba* L. (= *Basella rubra* (L.) (Singh et al. 1999, Agrawal et al. 2006)
- 12. Berberidaceae :**
Berberis lycium Royle (Bhalla and Pawar 1980)
- 13. Bignoniaceae :**
Jacaranda mimosifolia D. Don (Raychaudhuri 1973)
- 14. Brassicaceae :**
Brassica juncea L. Czern. (Behura 1963b, Raha 1979, Agrawal et al. 2006)
Brassica napus L. (Agarwala 1979, Agarwala and Raychaudhuri 1980)
Brassica nigra (L.) W.D.J. Koch (Raha 1979, Agrawal et al. 2006)
Brassica oleracea L. (Ghulam-Ullah 1940, Banerjee and Basu 1956)
Brassica oleracea L. var. *viridis* (= *Brassica oleracea* var. *acephala*) DC.) (Verma et al. 1975)
Brassica oleracea var. *botrytis* L. (= *Brassica oleracea* var. *cauliflora* misnomen.) (Despande 1938, David 1958b, Ramaseshiah and Dharmadhikari 1969, Raychaudhuri 1978, Agrawal et al. 2006)
Brassica oleracea var. *capitata* L. (Ghosh and Raychaudhuri 1962b, Chakrabarti 1972, Agrawal et al. 2006)
Brassica oleracea var. *gongylodes* L. (= *Brassica oleracea* var. *caulorapa* DC.) (Behura 1963b, Rao 1969, Agrawal et al. 2006)
Brassica pekinensis (Lour.) Rupr. (Devi and Singh 2007)
Brassica rapa L. (Behura 1963b, Rao 1969)
Brassica rapa subsp. *campestris* (L.) A.R. Clapham (= *Brassica campestris* L.) (Banerjee and Basu 1955, Banerjee and Basu 1956, Basu and Banerjee 1958, Behura 1963b, Bhalla and Pawar 1980, Agrawal et al. 2006)
- Brassica* sp. (Basu and Banerjee 1958, Agarwala 1979)
Capsella bursa-pastoris (L.) Medik (Behura 1963b)
Cardamine debilis Banks ex DC. (Singh and Singh 1986)
Cardamine impatiens L. (Chakrabarti 1972)
Eruca vesicaria (L.) Cav. (= *Eruca sativa* Miller) (Behura 1963b)
Erysimum cheiri (L.) Crantz (= *Cheiranthus cheiri* L.) (Behura 1963b)
Iberis amara L. (Chakrabarti 1972)
Iberis sp. (Behura 1963)
Lepidium didymum L. (= *Coronopus didymus* (L.) Sm.) (Behura 1963b)
Lepidium sativum L. (Behura 1963b)
Nasturtium sp. (Behura 1963b)
Raphanus sativus L. (Banerjee and Basu 1955, Behura 1963b, Bhalla and Pawar 1980)
Rorippa indica (L.) Hiern (= *Nasturtium indicum* (L.) DC.) (Raychaudhuri 1973)
Senebiera pinnatifida DC. (Raychaudhuri 1973)
Sinapis alba L. (= *Brassica alba* (L.) Rabenh.) (Raychaudhuri 1973)
Sisymbrium irio L. (Behura 1963b, Ghosh 1970d)
- 15. Cannaceae :**
Canna indica L. (= *Canna orientalis* Bouche) (Raychaudhuri 1973, Ghosh and Agarwala 1980)
- 16. Capparidaceae :**
Crataeva religiosa Forst.f. (Raychaudhuri 1973)
- 17. Caricaceae :**
Carica papaya L. (David 1958b, Rao 1969, Raychaudhuri 1978)
- 18. Caryophyllaceae :**
Cerastium fontanum ssp. *vulgare* Hartm. Greuter & Burdet (= *Cerastium vulgatum* auct.) (Chakrabarti 1972)

- Cerastium holosteoides* Fries em Hyle. (Chakrabarti 1972)
Dianthus caryophyllus L. (Behura 1963b, Raychaudhuri 1973, Sengupta et al. 1962)
Dianthus sp. (Banerjee and Basu 1956, Ghosh and Agarwala 1985)
Drymaria cordata (L.) Willd. ex Schult. (Agarwala 1979)
Silene conoidea L. (Chakrabarti 1972, Basu and Raychaudhuri 1980)
Stellaria media (L.) Vill. (Behura 1963b, Raychaudhuri 1973)
- 19. Cleomaceae :**
Cleome gyandra L. (= *Cleome pentaphylla* L., = *Gynandropsis pentaphylla* (L.) DC) (Behura 1963b, Raychaudhuri 1973)
Cleome sp. (Behura 1963b)
- 20. Convolvulaceae :**
Convolvulus arvensis L. (Verma et al. 1975)
Convolvulus major J. Ray (Behura 1963b)
Convolvulus sp. (Ghulam-Ullah 1940)
Cuscuta reflexa Roxb. (Raychaudhuri 1973)
Ipomoea batatas (L.) Lam. (Banerjee and Basu 1956, Behura 1963b, Rao 1969, Raychaudhuri 1978)
Ipomoea bullata Oliver (Behura 1963b)
Ipomoea crispa (Thunb.) Haill. f. (Behura 1963b)
Ipomoea floribunda Moric. (Agarwala 1979)
Ipomoea hederacea Jacq. (Raychaudhuri 1973)
Ipomoea purpurea (L.) Roth (= *Ipomoea mexicana* A. Gray) (Behura 1963b)
Ipomoea sp. (Rao 1969, Raychaudhuri 1978)
- 21. Crassulaceae :**
Bryophyllum sp. (Behura 1963b, Raychaudhuri 1973)
- Bryophyllum pinnatum* (Lam.) Oken (= *Kalanchoe pinnata* (Lam.) Pers. (Singh et al. 1999, Agrawal et al. 2006)
- 22. Cucurbitaceae :**
Cucumis sativus L. (Agarwala et al. 1982)
Cucurbita maxima Duchesne (Raychaudhuri 1973)
Cucurbita sp. (Behura 1963b)
Lagenaria siceraria (Molino) Standl. (= *Lagenaria leucantha* Duches.) (Raychaudhuri 1973)
Momordica charantia L. (Raychaudhuri 1973, Agrawal et al. 2006)
Sechium edule (Jacq.) Sw. (Agarwala and Raychaudhuri 1980)
- 23. Ericaceae :**
Lyonia ovalifolia (Wall.) Drude (Raychaudhuri 1973)
Rhododendron campylocarpum Hook.f. (Basu and Raychaudhuri 1980)
- 24. Euphorbiaceae :**
Croton bonplandianus Baill. (Raychaudhuri 1973)
Euphorbia helioscopia L. (Behura 1963b)
Euphorbia hirta L. (Raychaudhuri 1973)
Euphorbia pulcherrima Willd. ex Klotzsch (Raychaudhuri 1973)
Ricinus communis L. (Behura 1963b)
- 25. Fabaceae :**
Cajanus cajan (L.) Millsp. (Raychaudhuri 1973, Agrawal et al. 2006)
Cassia fistula L. (Raychaudhuri 1973)
Cassia sp. (Ghosh and Agarwala 1980)
Crotalaria sp. (Agrawal et al. 2005, 2006)
Dalbergia sissoo Roxb. ex DC. (Behura 1963b)
Glycine max (L.) Merr. (Laskar and Ghimiray 2004)
Lablab purpureus (L.) Sweet ssp. *purpureus* (= *Dolichos lablab* L.) (Raychaudhuri 1973)
Lupinus sp. (Behura 1963)
Medicago lupulina L. (Behura 1963)

- Phaseolus vulgaris* L. (Krishnamoorthi 1931, Behura 1963b)
- Pisum sativum* L. (Behura 1963b, Raychaudhuri 1973, Ghosh and Agarwala 1985, Agrawal et al. 2006)
- Senna sophera* (L.) Roxb. (= *Cassia sophera* L.) (Raychaudhuri 1973)
- Tamarindus indica* L. (Sath and Jadhav 2008)
- Trifolium praetutianum* Guss. (= *Trifolium prulentianum* auct. nonn.) (Chakrabarti 1972)
- Trifolium* sp. (Rao 1969)
- Trigonella foenum-graecum* L. (Verma et al. 1975)
- Vicia faba* L. (Raychaudhuri 1973, Agrawal et al. 2006)
- Vicia sativa* L. (Mall et al. 2010)
- 26.** Gentianaceae (=Portaliaceae) :
- Potalia* sp. (Chakrabarti 1972, Raychaudhuri 1973)
- 27.** Geraniaceae :
- Pelargonium zonale* (L.) L'Hér. ex Aiton (Agarwala and Hameed 1972)
- 28.** Gesneriaceae :
- Gesneria* sp. (Behura 1963b)
- 29.** Hydrangeaceae :
- Deutzia corymbosa* R. Br. ex G. Don (Chakrabarti and Sarkar 2001)
- Hydrangea* sp. (Bhalla and Pawar 1980)
- 30.** Lamiaceae (=Labiatae) :
- Callicarpa* sp. (Raychaudhuri 1973)
- Dysophylla* sp. (Raychaudhuri 1973)
- Mentha* sp. (Raychaudhuri 1973)
- Salvia* sp. (Bhalla and Pawar 1980)
- 31.** Lauraceae :
- Cinnamomum tamala* (Buch.-Ham.) T. Nees & Eberm. (Raychaudhuri 1973)
- 32.** Lythraceae :
- Punica granatum* L. (Verma et al. 1975)
- 33.** Malvaceae :
- Abelmoschus esculentus* (L.) Moench (= *Hibiscus esculentus* L.) (Behura 1963b, Raychaudhuri 1978, Agrawal et al. 2006)
- Alcea rosea* L. (Banerjee and Basu 1956, Basu and Banerjee 1958, Sengupta et al. 1962)
- Gossypium* sp. (Behura 1963b)
- Grewia asiatica* L. (Verma et al. 1975)
- Hibiscus mutabilis* L. (Raychaudhuri 1973)
- Hibiscus rosa-sinensis* L. (Ghosh and Raychaudhuri 1962b, Behura 1963, Raha 1979, Agrawal et al. 2006)
- Malache grandiflora* (A.St.-Hil.) Kuntze (Behura 1963b)
- Malva sylvestris* L. (Behura 1963b, Maity and Chakrabarti 1979)
- Malvaviscus conzattii* Grenm. (= *Malvaviscus conzonthiae* auct.) (Rao 1969)
- Urena lobata* L. (Raychaudhuri 1973)
- Urena* sp. (Ghosh and Raychaudhuri 1959, Raychaudhuri and Ghosh 1958)
- 34.** Marantaceae :
- Maranta leuconeura* E. Morren (Mall et al. 2010)
- 35.** Melastomaceae :
- Osbeckia capitata* Benth. Ex Naudin (Raychaudhuri 1973)
- Osbeckia chinensis* L. (= *Osbeckia sinensis* auct. nonn.) (Ghosh and Agarwala 1980)
- Osbeckia crinata* Benth. (Agarwala et al. 1980)
- Tibouchina semidecandra* (Schrank & Mart. Ex DC.) Cogn. (Raychaudhuri 1973)
- 36.** Moraceae :
- Ficus religiosa* L. (Mall et al. 2010)
- Ficus* sp. (Raychaudhuri 1973)
- Morus alba* L. (Singh et al. 1999, Agrawal et al. 2006)
- 37.** Musaceae :
- Musa *paradisiaca* L. (Raychaudhuri 1973)
- 38.** Myrtaceae :
- Psidium guajava* L. (Raha 1979, Ghosh and Agarwala 1985)
- 39.** Nyctaginaceae :

- Boerhavia diffusa* L. (Agarwala 1979)
Bougainvillea spectabilis Willd. (Raychaudhuri 1973)
Mirabilis jalapa L. (Raychaudhuri 1973, 1980, Ghosh and Agarwala 1980)
- 40. Oleaceae :**
Jasminum sp. (Agarwala 1979)
Nyctanthes arbor-tristis L. (Mall et al. 2010)
- 41. Onagraceae :**
Oenothera biennis L. (Verma et al. 1975)
- 42. Oxalidaceae :**
Oxalis corniculata L. (Raychaudhuri 1973)
Oxalis latifolia Kunth (Raychaudhuri 1973)
Oxalis triflora (?) (Ghosh and Raychaudhuri 1962b, Behura 1963, Raychaudhuri 1973)
- 43. Papaveraceae :**
Argemone mexicana L. (Ghosh and Agarwala 1985)
Eschscholzia californica Cham. (Kumar 2013)
Papaver somniferum L. (Verma et al. 1975)
- 44. Passifloraceae :**
Passiflora sp. (Raychaudhuri 1973)
- 45. Pedaliaceae :**
Sesamum indicum L. (Banerjee and Basu 1956, Basu and Banerjee 1958, Behura 1963b, Raychaudhuri 1978)
- 46. Phrymaceae (=Scrophulariaceae) :**
Mazus sp. (Behura 1963b)
- 47. Plantaginaceae (=Scrophulariaceae) :**
Antirrhinum majus L. (Ghosh and Agarwala 1985, Kar et al. 1990)
Antirrhinum sp. (Behura 1963b, Agrawal et al. 2006)
Cymbalaria muralis P. Gaerth. et al. (Ghosh 1977a)
Digitalis lanata Ehrh. (Chakrabarti 1972)
Digitalis sp. (Raychaudhuri 1973)
Linaria sp. (Behura 1963b)
- Lindenbergia* sp. (Ghosh 1986)
- 48. Poaceae :**
Avena sativa L. (Verma et al. 1975)
Cynodon dactylon (L.) Pers. (Agarwala 1979)
Dactylus sp. (Chakrabarti 1972)
Panicum miliaceum L. (Raychaudhuri 1978)
Triticum aestivum aestivum L. (= *Triticum vulgare* Vill.) (Behura 1963b)
Triticum aestivum L. (Singh et al. 1999)
Triticum sp. (Ghosh and Agarwala 1985)
- 49. Polemoniaceae :**
Phlox drummondii Hook. (Behura 1963)
Phlox sp. (Behura 1963b, Agrawal et al. 2006)
- 50. Polygonaceae :**
Antigonon leptopus Hook. & Arn. (Raychaudhuri 1973)
Fagopyrum sp. (Ghosh and Agarwala 1980)
Persicaria perfoliata (L.) H. Gross (= *Polygonum perfoliatum* L.) (Ghosh and Agarwala 1985)
Polygonum alatum Buch.-Ham. ex D. Don (Raychaudhuri 1973)
Polygonum sp. (Ghosh and Agarwala 1980, 1985)
Rumex acetosella L. (Bhalla and Pawar 1980)
Rumex dentatus L. (Behura 1963b, Rao 1969)
Rumex nepalensis Spreng. (Raychaudhuri 1978)
- 51. Pteridaceae (=Adiantaceae) :**
Adiantum cordatum Maxon (Agarwala 1979)
- 52. Ranunculaceae :**
Delphinium sp. (Singh et al. 1999, Agrawal et al. 2006)
- 53. Rosaceae :**
Malus domestica Borkh. (= *Pyrus malus* (L.) (Behura 1963)

- Prunus armeniaca* L. (Behura 1963b, Raychaudhuri 1978)
- Prunus cerasoides* D. Don (= *Prunus puddum* Rox. Ex Ser.) (Raychaudhuri 1973)
- Prunus cerasus* L. (Raychaudhuri 1978)
- Prunus domestica* L. (Raychaudhuri 1978)
- Prunus dulcis* (Mill.) D.A. Webb. (= *Prunus communis* (L.) Arcang., = *Prunus amygdalus* Batsch) (Behura 1963b, Ghosh and Agarwala 1985)
- Prunus napaulensis* (Ser.) Steud. (Raychaudhuri 1973)
- Prunus persica* (L.) Batsch (Rizvi and Paul Khurana 1970, Basu and Raychaudhuri 1980)
- Pyrus communis* L. (Behura 1963b)
- Rosa* sp. (Singh et al. 1999)
- Rubus ellipticus* Sm. (Rao 1969, Raychaudhuri 1973, Ghosh and Agarwala 1980)
- Rubus rosifolius* Sm. (= *Rubus rosaefolius* auct. non.) (Ghosh and Agarwala 1985)
- Spiraea oleracea* (Raychaudhuri 1973)
- 54. Rubiaceae :**
- Galium* sp. (Behura 1963b)
- Mussaenda* sp. (Raychaudhuri 1973)
- 55. Rutaceae :**
- Citrus limon* (L.) Burm.f. (Raychaudhuri 1973)
- Citrus reticulata* Blanco (Ghosh and Raychaudhuri 1963)
- Citrus* sp. (Raychaudhuri 1973)
- Ruta graveolens* L. (Joshi and Poorani 2007)
- 56. Scrophulariaceae :**
- Buddleja* sp. (Raychaudhuri et al. 1980)
- 57. Solanaceae :**
- Atropa acuminata* Royle ex Lindl. (Chakrabarti 1972, Raychaudhuri 1973)
- Atropa belladonna* L. (Chakrabarti 1972, Raychaudhuri 1973)
- Brugmansia suaveolens* (Humb. & Bonpl. ex Willd.) Bercht. & Presl. (= *Datura suaveolens* Humb. & Bonpl. ex Willd.) (Rao 1969)
- Capsicum annuum* L. (Bhalla and Pawar 1980)
- Capsicum frutescens* L. (Rao 1969, Rizvi and Paul Khurana 1970, Agrawal et al. 2006)
- Capsicum* sp. (Despande 1938, Rao 1969)
- Cestrum diurnum* L. (Raychaudhuri 1973)
- Cestrum fasciculatum* (Schltdl.) Miers (Rao 1969, Raychaudhuri 1973)
- Cestrum nocturnum* L. (Raychaudhuri 1973)
- Datura metel* L. (= *Datura fastuosa* (L.) (Behura 1963b, Chakrabarti 1972, Raychaudhuri 1973, Agrawal et al. 2006)
- Datura* sp. (Agarwala 1979)
- Datura stramonium* L. (Behura 1963b)
- Hyoscyamus niger* L. (Chakrabarti 1972)
- Lycopersicon esculentum* Mill. var. *esculentum* (= *Solanum lycopersicum* (L.) (Behura 1963b, Rao 1969)
- Lycopersicon esculentum* Mill. (Banerjee and Basu 1955, 1956, Behura 1963b, Rao 1969, Verma et al. 1975)
- Nicotiana glauca* Graham (Behura 1963b)
- Nicotiana glutinosa* L. (Behura 1963b)
- Nicotiana plumbaginifolia* Viv. (Behura 1963b, Chakrabarti 1972)
- Nicotiana rustica* L. (Behura 1963b, Rizvi and Paul Khurana 1970, Chakrabarti 1972)
- Nicotiana* sp. (Ghulam-Ullah (1940)
- Nicotiana tabacum* L. (George 1927, Banerjee and Basu 1955, Banerjee and Basu 1956, Behura 1963b, Chakrabarti 1972, Raha 1979, Agarwala 1979)
- Petunia alba* Hort. Ex Ferg. & Ottl. (Ghosh and Raychaudhuri 1962a, Behura 1963)
- Petunia axillaris* (Lam.) Britton et al. (Verma et al. 1975)

- Petunia* sp. (Behura 1963, Raychaudhuri 1973)
Solanum aculeatissimum Jack. (= *Solanum khasianum* Clarke) (Ghosh and Agarwala 1985)
Solanum betaceum Cav. (= *Cyphomandra betacea* Cav.) Sendtn.) (Rao 1969, Agarwala 1979, Agarwala et al. 1982)
Solanum clavatum Rusby (Raychaudhuri 1973)
Solanum dulcamara L. (Chakrabarti 1972)
Solanum erianthum D. Don (= *Solanum verbascifolium* (L.) (Raychaudhuri 1973)
Solanum lasiocarpum Dunal (= *Solanum indicum* (L.) (Ghulam-Ullah 1940, Behura 1963b)
Solanum melongena L. (Despande 1938, Banerjee and Basu 1956, Basu and Banerjee 1958, Behura 1963b, Rao 1969, Raychaudhuri 1978, Raha 1979, Agarwala 1979, Agarwala et al. 1982)
Solanum nigrum L. (Behura 1963b, Raychaudhuri 1973, Shuja Uddin 1974, Agarwala 1979)
Solanum persicum Willd. Ex Roem & Schult. (Ghosh and Raychaudhuri 1962c, Behura 1963, Basu and Raychaudhuri 1980)
Solanum torvum Sw. (Raychaudhuri 1973)
Solanum tuberosum L. (Despande 1938, Banerjee and Basu 1955, Basu and Banerjee 1958, David 1958b, Behura 1963b, Chakrabarti 1972, Verma et al. 1975, Raychaudhuri et al. 1979, Bhalla and Pawar 1980, Agarwala and Raychaudhuri 1980, Agarwala et al. 1982)
Solanum xanti A. Gray (= *Solanum xanthum* auct. nonn.) (Chakrabarti 1972)
Withania somnifera (L.) Dunal (Agarwala and Raychaudhuri 1980, Kumar et al. 2009)
- 58. Theaceae :**
Schima wallichii (DC.) Korth. (Raychaudhuri 1973)
- 59. Tiliaceae :**
Triumfetta pilosa Roth (Agarwala 1979)
- 60. Tropaeolaceae :**
Tropaeolum majus L. (Raychaudhuri 1973)
Tropaeolum officinalis (?) (Behura 1963b)
- 61. Urticaceae :**
Urtica sp. (Raychaudhuri et al. 1980)
- 62. Verbenaceae :**
Duranta erecta L. (Ghosh and Raychaudhuri 1962b, Raychaudhuri 1973)
Lantana camara L. (Ghosh and Agarwala 1980, Ghosh and Agarwala 1985)
Verbena officinalis L. (Agrawal and Singh 2005, Agrawal et al. 2006)
- 63. Violaceae :**
Viola sp. (Batra and Kumar 1961, Behura 1963)
Viola tricolor L. (Behura 1963b)
- 64. Zingiberaceae :**
Hedychium sp. (Raychaudhuri 1973)
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