

Flora of Solapur District of Maharashtra (India): A Detailed Synoptical Account

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Abstract—The present paper provides the first systematic and comprehensive account of the flora of Solapur district of Maharashtra. The flora of Solapur district demonstrates wide range of species diversity and growth forms. The vegetation of the district mainly represents tropical dry deciduous forests, thorny open scrub jungles and vast grasslands. During the present work, a total of 1438 taxa belong to 694 genera and 143 families of flowering plants have been recorded for Solapur district. A remarkable new species *Crinum solapurense* Gaikwad *et al.* has described. Poaceae is the dominant family with 157 taxa, followed by Fabaceae (130 taxa), Asteraceae (85 taxa), Euphorbiaceae (61 taxa) and Cyperaceae (47 taxa). *Acacia* is the largest genus with 25 taxa, followed by *Euphorbia* (23), *Cyperus* (22), *Crotalaria* (19) and *Ipomoea* (19). The herbaceous flora of the district is notable as it amounts to 65% of the whole of flora. The ratio of indigenous woody to herbaceous components is 1:1.87. The proportion of indigenous taxa (978) to the cultivated ones (460) is 1.35: 0.5 in the district. Thus, Solapur district is rich in its plant wealth.

Index Terms—Flora, Taxonomy, Solapur, Maharashtra.

I. INTRODUCTION

Solapur district is named after its town headquarter 'Solapur' the name is believed to be derived from two words '*sola*' meaning sixteen and '*pur*' meaning village. The district is predominantly an agrarian tract endowed with a variety of natural resources in the plains of Bhima, Sina and Man Rivers. The climate of the district, in general can be said to be dry and moderately extreme. It supports the vegetation that can be conveniently divided into tropical dry deciduous forests (Champion & Seth, 1968), the open scrub jungles and vast grasslands. The dry deciduous forests and thorny scrub jungles play a vital role in

dry land ecosystem by performing many ecological functions such as ground-water recharge, flood control, retention of nutrients and sediments, and provide habitat for enormous number of birds, insects, mammals, reptiles, spiders and microbes. The grasslands of the district are unique and popularly known as Indian Savannas, famous for bird diversity. A hundreds of bird species including a critically endangered Indian bustard (*Ardeotis nigriceps*) inhabit in these grasslands. Thus, Solapur district is rich in biological diversity but remained rather neglected or unprogressive with regard to its plant wealth.

In Maharashtra, the recorded history suggests that the plant taxonomic researchers were attracted by the forests of Western Ghats. Surprisingly, none had shown any interest in the plants of drought prone region of Maharashtra in general and of Solapur district in particular. There is absolutely no record of plants of Solapur district anywhere. The botanical exploration in the district remained rather neglected or unprogressive. A few plants have recorded in different floristic works in past such as Dalzell & Gibson (1861) recorded just five species in their 'The Bombay Flora' from Solapur district, Cooke (1901-1908) recorded mere ten species in his 'Flora of the Presidency of Bombay' and Talbot (1909-1911) included only one species in his 'Forest Flora of Bombay Presidency and Sind'. Further, these collections do not precisely indicate the localities, also in many cases important field notes are wanting. Much of these collections are hardly available in Indian herbaria such as BSI, BLAT, CAL etc. Though State floras like Almeida's Flora of Maharashtra (1996, 1998, 2001a, 2001b, 2003a, 2003b, 2009a, 2009b), Lakshminarasimhan's Flora of Maharashtra State: monocotyledons (1996) and Singh

& Karthikeyan's Flora of Maharashtra State: dicotyledons (2000, 2001) had been published, they are not directly connected with flora of Solapur district as they dealt with Maharashtra State of which Solapur district happens to be part. Further, there are a few scattered publications on the plants of Solapur district (e.g. Hemadri, 1970; Pathak, 2006; Dalave *et al.*, 2010; Suryavanshi & Bachulkar, 2011; Tembhurne & Nanir, 2012; Das Das & Singh, 2012; Gaikwad *et al.*, 2012, 2014a), which are far from satisfaction. Hence, the present work was inevitable to get comprehensive and dependable floristic survey of Solapur district.

II. STUDY AREA

The district of Solapur lies between 17° 10' N - 18°32' N and 74°42' E - 76°15' E. The district is fairly well defined to its west as well as to its east by the inward-looking scarps of Phaltan Range and the Osmanabad Plateau respectively. Though of an irregular shape, the district is roughly square, 200 km east - west and 150 km north - south. The district has a total area of 14,844.6 sq km and it is divided into eleven-revenue tahsils (Fig. 1). The district is about 550 m above mean sea level. The entire district has the rock type composed of basaltic lava-flows, which erupted in the Cretaceous-Eocene age and a popularly known as Deccan traps. The presence of thin mantle of black cotton soil almost everywhere on basalts, river alluvium, sands, gravels, slits and clays represent the recent deposits. Calcareous concretions and nodules commonly found in the soil are concentrated near stream courses. The chief rivers of the district are the Bhima, its left-bank feeder the Sina and its right-bank feeders the Nira and the Man. Besides, a good number of lesser streams form the tributaries of the Bhima and serve as its local feeders. The climate of Solapur district is overall agreeable and characterized by general dryness in the major part of the year. The rainfall in the district varies from 448.8 mm (17.67") to 689.2 mm (27.14"). The rainfall during the south-west monsoon in the months of June to September amounts to about 74% of the annual rainfall. September is the rainiest month. The whole district experiences extremes of climate with temperature going down to 5° C in winter and rising up to 45° C in summer. The air is highly humid from June to September (monsoon season) and mostly

dries during the rest of the year. The driest part of the year is from March to May when the humidity is between about 20 and 25% on the average in the afternoons. The climate of the region supports the vegetation that can be conveniently divided into tropical dry deciduous forests, thorny forests and vast tracts of grasslands (Champion & Seth, 1968; Dikshit, 2001). A population of the district is 43, 17,756 (as per 2011 Census), which constitute 3.84% of the State figures.

III. MATERIALS AND METHODS

During the period of five years i.e. from 2009 to 2013, field visits of 2–3 days duration were undertaken to collect plants from selected localities. During the present study, a total of 1438 field numbers comprising about 4467 specimens were collected and deposited in Herbarium of Walchand College, Solapur. While carrying out the floristic survey, every effort was made to collect the plants in all three seasons viz. pre-monsoon (April – May), monsoon (June – September) and post-monsoon (October – March). Special attention was paid to under or unexplored remote areas of the district. In addition to the collection of wild plants, the efforts were made to collect weeds, which cover a wide range of ecological habitats. Cultivated plants have also been collected as the work was undertaken to study the flora of the district. All the collected specimens processed for drying by using regular drying method with blotting papers and newspapers (Santapau, 1955; Jain & Rao, 1960; Rao & Sharma, 1990). Most of the specimens and field identifications confirmed satisfactorily with the help of available literature (Chakravarty, 1982; Sanjappa, 1991; Sharma & Balakrishnan, 1993; Sharma & Sanjappa, 1993; Sharma *et al.*, 1993; Hajra *et al.*, 1995a, 1995b; Cook, 1996; Almeida, 1996, 1998, 2001a, 2001b, 2003a, 2003b, 2009a, 2009b; Naik, 1998; Jagtap & Singh, 1999; Singh *et al.*, 2000; Singh & Karthikeyan, 2000, 2001; Mishra & Singh, 2001; Singh, 2001a, 2001b; Dutta & Deb, 2004; Balakrishnan & Chakrabarty, 2007; Ansari, 2008; Ansari & Balakrishnan, 2009; Binoj Kumar & Balakrishnan, 2010; Yadav, 2010; Potdar *et al.*, 2012). Doubtful identifications of the specimens were confirmed by comparing them with authentically identified specimens deposited in the Herbarium of

Botanical Survey of India, Pune and Blatter Herbarium, St. Xavier's college, Mumbai. Some important plants are featured in photographs (Figs. 4, 5, 6).

IV. RESULTS

In the present work, we have provided the first hand information of floristic diversity of Solapur district of Maharashtra, India. A total of 1438 species including infraspecific taxa belonging to 694 genera and 143 families of flowering plants have been recorded for Solapur district of which about 860 species are reported for the first time. An assessment of the total constituents of the flowering plants of the district shows that the dicotyledonous taxa outnumber those of the monocotyledons. The herbaceous flora of the district is notable as it amounts to 65% of the whole of flora. Poaceae and Fabaceae are dominant in herbaceous vegetation in terms of number of species and frequency percentages indicate favorable climatic and edaphic factors for agriculture in the district. *Aristida*, *Cenchrus*, *Chloris*, *Cymbopogon*, *Cynodon*, *Dichanthium*, *Dactyloctenium*, *Dinebra*, *Eragrostis*, *Euclasta*, *Heteropogon*, *Lophopogon*, *Melanocenchris*, *Mnesithea*, *Paspalum*, *Sehima*, *Setaria*, *Themeda* etc. are dominant grass genera in the study area. *Acacia catechu*, *A. chundra*, *A. leucophloea*, *A. nilotica*, *Bauhinia racemosa*, *Butea monosperma*, *Capparis divaricata*, *C. grandis*, *Euphorbia tirucalli*, *Lannea coromandelica*, *Morinda citrifolia*, *M. coreia* and *Ziziphus caracutta* are common trees in Solapur district whereas *Hardwickia binata*, *Lagerstroemia parviflora*, *Miliusa tomentosa*, *Terminalia cuneata*, *T. bellirica*, *Pterocarpus marsupium* and *Wrightia arborea* are rare in occurrence. In spite of dry or semi-arid general climate of the district, the notable amount of climbers (10%) occurs in Solapur district. Some of them are *Aspidopterys cordata*, *Clitoria ternatea*, *Cocculus hirsutus*, *Commicarpus boissieri*, *Ctenolepis garcinii*, *Diplocyclos palmatus*, *Jasminum auriculatum*, *Mucuna pruriens*, *Operculina turpethum*, *Passiflora edulis*, *Tinospora cordifolia* and *Ventilago denticulata*. Solapur district harbors great deals of wealth of vegetables, cereals, pulses and fruit crops due to its varied climatic and edaphic conditions. Mangalveda tahsil of the district is popularly known as store-house of Jawar (*Sorghum*) of the

Maharashtra State. About 15 local varieties of *Sorghum* are traditionally cultivated in the district under different local names viz. Boru, Dagadi, Gulbhendi, Kakla, Kuch-kuchi, Lal-jawari, Maldandi, Pawli, Shalu, Tambadi-Jawari, Vandi etc. These varieties are important genome of *Sorghum* crop.

Most of the talukas except some part of Barshi taluka depict thorny scrub forest; the barren hills of this area should be afforested with deciduous elements, which are wild, indigenous and adaptable to dry climate. Solapur district has the forest area about 0.94% (Pathak, 2006) of the total area i.e. about 21.06% less than the minimum requirement (22%), indicating how fast the deterioration of forest has taken place. If the destruction of the vegetation is not checked at this crucial juncture, then it is certainly heading towards natural calamities like drought and flood. The heavy grazing and anthropogenic activities along with uneven pattern of rainfall and frequent droughts for successive years are major causes for deterioration of forest in the district.

In conclusion, therefore, it may be said that the district has a far better potential of plant wealth than was supposed earlier and needs a further careful investigation.

V. DISCUSSION

During the present work, a total of 1438 species (including infraspecific taxa) belonging to 694 genera and 143 families of flowering plants have been recorded for Solapur district of which 1046 species and 45 infraspecific taxa are dicotyledonous belonging to 529 genera and 115 families, while 336 species and 11 infraspecific taxa are monocotyledonous belonging to 165 genera and 28 families (Table 1, 2). About 860 species (including infraspecific taxa) have recorded for the first time to Solapur district. A total 1382 species and 56 infraspecific taxa distributed over 14,844.6 sq km area reveal a relatively high species density (0.096) when compared with the figure given for adjoining Ahmednagar district (0.061) by Pradhan & Singh (1999). Therefore, it may be said that Solapur district rich in its plant wealth.

The total number of species (including subspecies, varieties and forma) reported for Maharashtra as on to-day is 3191 (Table 3). For Solapur district, the number of taxa works out to be 1438. Therefore,

percentage of flora of Solapur district out of whole flora of Maharashtra will be 45.06.

To evaluate the dominant ten families a comparison has been made between major floras of the Maharashtra State such as Cooke's The Flora of the Presidency of Bombay (1901-1908), Lakshminarasimhan's Flora of Maharashtra: monocotyledons (1996), Naik's Flora of Marathwada (1998), Singh & Karthikeyan's Flora of Maharashtra: dicotyledons (2000, 2001) and Flora of Solapur district (present work). If the three families, namely Fabaceae, Caesalpiniaceae and Mimosaceae are taken as subfamilies of a single combined family Leguminosae, as done by Hooker in his Flora of British India, then that family stands first in the list with 65 genera and 210 species and Solanaceae (12:32) finds tenth place in the list of dominant families (Table 5). This order of dominance, when compared with above-mentioned three floras, it roughly corresponds to the Flora of Marathwada (Table 4). In both floras, same nine families find a place, of-course, with varying positions. Rubiaceae, which occupies the ninth position, fails to find a place amongst the ten dominant families in Flora Solapur district; on the other hand the family Solanaceae which occupy tenth position in Solapur district could not find a place anywhere among the top ten families in Flora of Marathwada. Further, Poaceae and Fabaceae are occupied top positions in the both floras. These facts indicate more or less similar climatic and edaphic situations in Marathwada region and Solapur district.

The family Leguminosae shares maximum number of prominent genera whereas other families except Cyperaceae have only one prominent genus each (Table 6). In contrast to these prominent genera, there are about 416 genera represented by only one species. The ratio of indigenous woody (341 taxa) to herbaceous (637 taxa) components is 1:1.87 and that of monocots (244 indigenous taxa) to dicots (734 indigenous taxa) is 1:3 (Table 7). The floristic spectrum of the district shows very low percentage of phanerophytes and a very high percentage of therophytes. It clearly indicates the drier climatic conditions together with other biological influence (Fig. 2).

Mere 23 endemic plant species occur in Solapur district which include *Hardwickia binata* Roxb. a monotypic tree genus, *Acacia campbellii* Arn., an endemic tree, *Dipcadi saxorum* Blatt. a critically endangered species and *Dregea lanceolata* (Cooke) Santapau & Wagh, (Ahmedullah & Nayar, 1986, Nayar & Sastry, 1887; Nayar, 1996; Mishra & Singh, 2001; Irwin & Narasimhan, 2011; Gaikwad *et al.*, 2014b).

In the present floristic work, the commonly cultivated species are also included in addition to indigenous ones. The proportion of indigenous taxa (978) to the cultivated ones (460) is 1.35: 0.5 (Fig. 3). This high proportion of cultivated species cannot be neglected as it forms the major component of urban flora in particular.

Table 1. List of families with number of genera and species including infraspecific taxa.

S. No.	Family	Genera	Species including infraspecific taxa
DICOTYLEDONS			
1.	Ranunculaceae	1	1
2.	Magnoliaceae	1	1
3.	Annonaceae	4	6
4.	Menispermaceae	3	4
5.	Nymphaeaceae	1	1
6.	Nelumbonaceae	1	1
7.	Papaveraceae	2	3
8.	Fumariaceae	1	1
9.	Brassicaceae	9	14
10.	Capparaceae	4	16
11.	Violaceae	2	2

12.	Bixaceae	1	1
13.	Cochlospermaceae	1	1
14.	Flacourtiaceae	2	3
15.	Polygalaceae	1	4
16.	Caryophyllaceae	4	5
17.	Portulacaceae	1	5
18.	Tamaricaceae	1	1
19.	Elatinaceae	1	1
20.	Malvaceae	12	37
21.	Bombacaceae	3	3
22.	Sterculiaceae	8	9
23.	Tiliaceae	3	18
24.	Elaeocarpaceae	1	1
25.	Linaceae	1	2
26.	Malpighiaceae	4	5
27.	Zygophyllaceae	2	3
28.	Geraniaceae	2	2
29.	Averrhoaceae	1	2
30.	Oxalidaceae	2	4
31.	Tropaeolaceae	1	1
32.	Balsaminaceae	1	1
33.	Rutaceae	5	12
34.	Simaroubaceae	1	1
35.	Balanitaceae	1	1
36.	Ochnaceae	1	1
37.	Burseraceae	2	2
38.	Meliaceae	5	7
39.	Flindersiaceae	1	1
40.	Celastraceae	3	3
41.	Rhamnaceae	2	7
42.	Vitaceae	4	7
43.	Sapindaceae	4	5
44.	Anacardiaceae	6	6
45.	Moringaceae	1	1
46.	Fabaceae	44	130
47.	Caesalpiniaceae	9	35
48.	Mimosaceae	12	45
49.	Rosaceae	1	5
50.	Crassulaceae	2	5
51.	Combretaceae	3	9
52.	Myrtaceae	4	8
53.	Lecythidaceae	1	1
54.	Lythraceae	5	12
55.	Punicaceae	1	1
56.	Onagraceae	1	2
57.	Turneraceae	1	1
58.	Passifloraceae	1	3

59.	Caricaceae	1	1
60.	Cucurbitaceae	15	30
61.	Begoniaceae	1	1
62.	Cactaceae	4	4
63.	Aizoaceae	3	4
64.	Molluginaceae	3	7
65.	Apiaceae	8	9
66.	Araliaceae	2	6
67.	Alangiaceae	1	1
68.	Rubiaceae	17	30
69.	Asteraceae	57	85
70.	Plumbaginaceae	1	3
71.	Primulaceae	1	2
72.	Sapotaceae	3	5
73.	Ebenaceae	1	5
74.	Oleaceae	2	8
75.	Salvadoraceae	1	1
76.	Apocynaceae	15	22
77.	Asclepiadaceae	16	19
78.	Periplocaceae	4	4
79.	Loganiaceae	1	1
80.	Buddlejaceae	1	2
81.	Gentianaceae	5	10
82.	Polemoniaceae	1	1
83.	Boraginaceae	4	17
84.	Convolvulaceae	10	38
85.	Cuscutaceae	1	2
86.	Solanaceae	12	33
87.	Scrophulariaceae	14	19
88.	Orobanchaceae	1	1
89.	Lentibulariaceae	1	2
90.	Gesneriaceae	1	1
91.	Bignoniaceae	16	19
92.	Pedaliaceae	1	2
93.	Martyniaceae	1	1
94.	Acanthaceae	21	39
95.	Thunbergiaceae	1	4
96.	Verbenaceae	12	19
97.	Lamiaceae	11	31
98.	Nyctaginaceae	4	8
99.	Amaranthaceae	8	25
100.	Chenopodiaceae	4	5
101.	Basellaceae	1	1
102.	Polygonaceae	5	7
103.	Aristolochiaceae	1	1
104.	Piperaceae	1	1
105.	Proteaceae	1	1

106.	Viscaceae	1	1
107.	Santalaceae	1	1
108.	Euphorbiaceae	19	61
109.	Ulmaceae	1	1
110.	Urticaceae	1	1
111.	Cannabaceae	1	1
112.	Moraceae	3	15
113.	Casuarinaceae	1	1
114.	Salicaceae	1	1
115.	Ceratophyllaceae	1	1
MONOCOTYLEDONES			
116.	Hydrocharitaceae	3	3
117.	Orchidaceae	2	2
118.	Zingiberaceae	4	4
119.	Marantaceae	2	2
120.	Cannaceae	1	3
121.	Musaceae	1	1
122.	Heliconiaceae	1	1
123.	Strelitziaceae	1	1
124.	Iridaceae	1	1
125.	Hypoxidaceae	1	1
126.	Amaryllidaceae	6	11
127.	Alliaceae	1	2
128.	Agavaceae	7	18
129.	Dioscoreaceae	1	1
130.	Liliaceae	10	18
131.	Smilacaceae	1	1
132.	Pontederiaceae	2	3
133.	Commelinaceae	6	17
134.	Arecaceae	17	22
135.	Pandanaceae	1	1
136.	Typhaceae	1	1
137.	Araceae	12	19
138.	Lemnaceae	2	2
139.	Potamogetonaceae	2	3
140.	Najadaceae	1	3
141.	Eriocaulaceae	1	1
142.	Cyperaceae	10	47
143.	Poaceae	67	157

Table 2. Showing statistical account of the flora of Solapur district.

Class	Families	Genera	Species	Intraspecific taxa
Dicotyledons	115	529	1046	45
Monocotyledons	28	165	336	11
Total	143	694	1382	56

Table 3. Showing comparative account of taxa reported in different taxonomic works on Maharashtra State and Solapur district.

Name of the flora	Families	Genera	Species	Infraspecific taxa
Flora of The Presidency of Bombay (1958 Repr.)	139 (147)	849 (999)	1938 (2513)	94 (162)
Flora of Maharashtra (1996 - 2002)	187	1081	3025	166
The previous literature (1901 - 2012)	-----	-----	578	-----
Flora of Solapur District (Present work)	143	694	1382	56

Note: The figure in the parenthesis indicates account of the Bombay State including Maharashtra, Karnataka and Gujarat, Baluchistan and some part of Rajasthan.

Table 4. Comparative account of ten dominant families reported in different taxonomic works and Solapur district.

Flora of the Presidency of Bombay (BSI) (1901 - 1908)	Flora of Maharashtra State (BSI) (1996 - 2001)	Flora of Marathwada (1998)	Flora of Solapur District (Present work)
Fabaceae	Poaceae	Poaceae	Poaceae
Poaceae	Fabaceae	Fabaceae	Fabaceae
Acanthaceae	Cyperaceae	Asteraceae	Asteraceae
Asteraceae	Acanthaceae	Cyperaceae	Euphorbiaceae
Euphorbiaceae	Asteraceae	Euphorbiaceae	Cyperaceae
Rubiaceae	Orchidaceae	Acanthaceae	Mimosaceae
Orchidaceae	Euphorbiaceae	Malvaceae	Acanthaceae
Lamiaceae	Rubiaceae	Convolvulaceae	Convolvulaceae
Scrophulariaceae	Scrophulariaceae	Rubiaceae	Malvaceae
Asclepiadaceae	Malvaceae	Mimosaceae	Solanaceae

Table 5. Showing ten dominant families in the order of dominance.

Sl. No.	Families	Number of taxa	Sl. No.	Families	Number of taxa
1.	Poaceae	157	6.	Mimosaceae	45
2.	Fabaceae	130	7.	Acanthaceae	39
3.	Asteraceae	85	8.	Convolvulaceae	38
4.	Euphorbiaceae	61	9.	Malvaceae	37
5.	Cyperaceae	47	10.	Solanaceae	33

Table 6. List of top twenty genera represented by higher number of species in the flora of Solapur district.

Sl. No.	Genus	Number of taxa	Sl. No.	Genus	Number of taxa
1.	<i>Acacia</i>	25	11.	<i>Hibiscus</i>	10
2.	<i>Euphorbia</i>	23	12.	<i>Vigna</i>	10
3.	<i>Cyperus</i>	22	13.	<i>Leucas</i>	09
4.	<i>Crotalaria</i>	19	14.	<i>Corchorus</i>	08
5.	<i>Ipomoea</i>	19	15.	<i>Blumea</i>	08
6.	<i>Cassia</i>	18	16.	<i>Phyllanthus</i>	08

7.	<i>Alysicarpus</i>	14	17.	<i>Commelina</i>	08
8.	<i>Indigofera</i>	13	18.	<i>Desmodium</i>	07
9.	<i>Ficus</i>	13	19.	<i>Jasminum</i>	07
10.	<i>Fimbristylis</i>	12	20.	<i>Heliotropium</i>	07

Table 7. Showing analysis of life forms of indigenous taxa.

Life form	Number of species	Percentage (%)
Herbs	637	65.13
Shrubs	115	11.75
Twiners & Climbers	101	10.32
Trees	125	12.78



Fig. 1. Location map of Solapur district of Maharashtra, India.

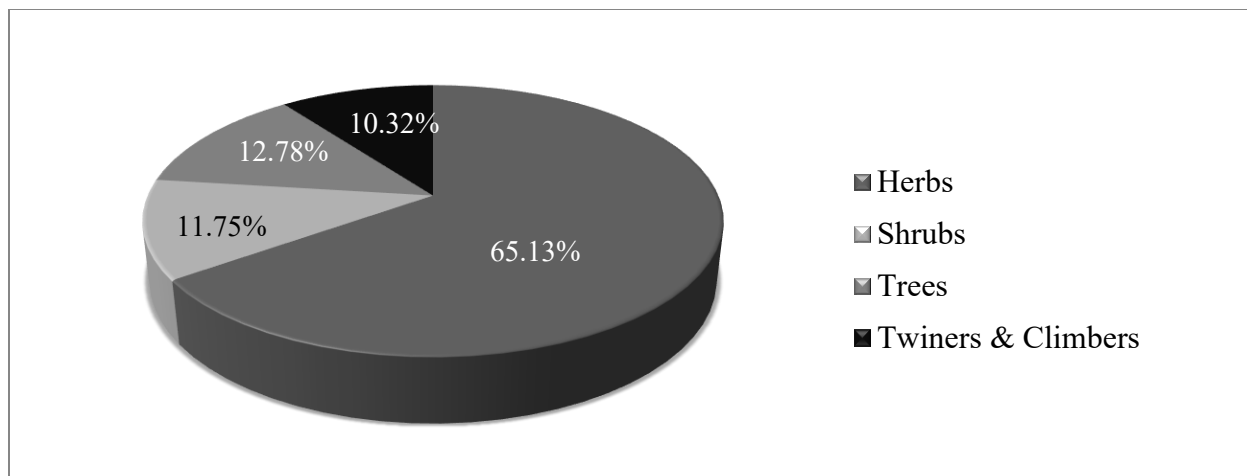


Fig. 2. Analysis of life forms of indigenous taxa in flora of Solapur district.

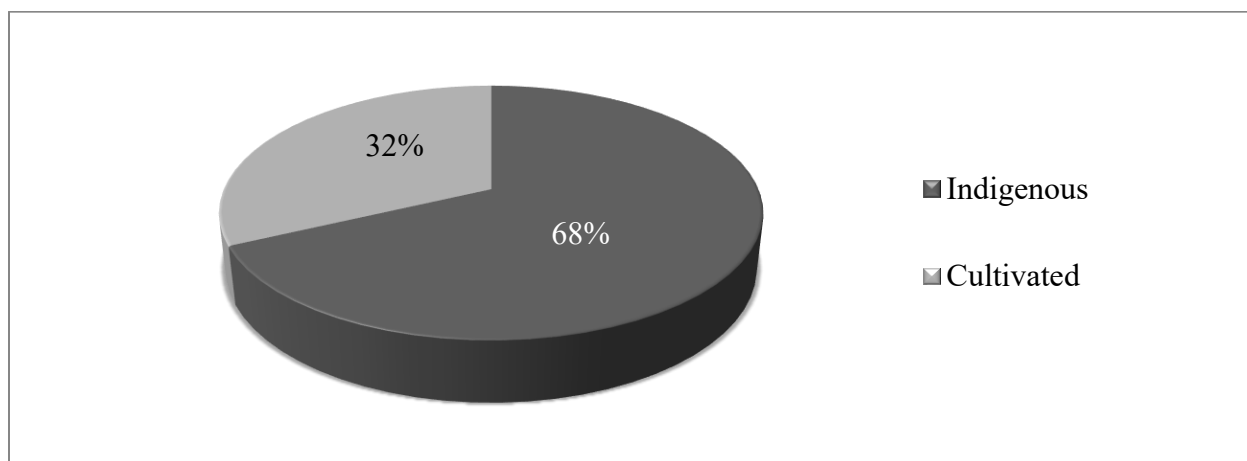


Fig. 3. Proportion of indigenous to cultivated taxa.





Fig. 4. a. *Grewia tenax* (Forssk.) Fiori; b. *Cucumis prophetarum* L.; c. *Pascaliala glauca* Ortega; d. *Monsonia senegalensis* Guill. & Perr.





Fig. 5. a. *Solanum elaeagnifolium* Cav.; b. *Dregea lanceolata* (Cooke) Santapau & Wagh; c. *Ficus palmata* Forssk subsp. *virgata* (Roxb.) Browicz.





Fig. 6. a. *Astraea lobata* (L.) Klotz.; b. *Dipcadi saxorum* Blatt.; c. *Crinum solapurense* Gaikwad et al. (showing fruits).

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