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Flowering and fruiting calendar of the Angiospermic weeds in and around Guwahati city of Assam, India

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Abstract

The importance of understanding the phenology of a species is wide including ecology, evolution, genetics and weed control. This paper describes two major phenophases, *viz.* flowering and fruiting periods of weeds in an urban ecosystem of Guwahati city – the capital of the Indian state of Assam.

A total of 173 species of angiospermic weeds were identified among which 139 were dicotyledonous and 34 were monocotyledonous. The study was concentrated on two important phenophages i.e. period of flowering and fruiting in four seasons *i.e.* spring, summer, autumn and winter. Maximum and minimum number of species with flowering was recorded in spring (April) and summer (August) respectively, while maximum and minimum number of species with fruiting was recorded in spring (May) and autumn (October) respectively.

***Key words*:** Guwahati, flowering, fruiting, phenology, seeds, weeds

INTRODUCTION

The word 'phenology' was derived from the Greek root, *phainomai* ('to appear'). Phenology is the study of the timing of recurring seasonal biological events and has existed as a field of scientific inquiry for centuries (Sparks & Menzel 2002; Aono & Kazui 2008).

Phenology describes the changes to the natural world over time. The change over time determines the stage of development of an organism or population when it intersects with particular components of its environment. Ecological and evolutionary studies with a focus on phenology have a long history (Robertson 1924; Leopold & Jones 1947).

Although phenology deals with population-level patterns, individual level patterns are to be understood to make assumptions on climate change (Visser *et al*. 2010). Some events, like mass flowering, do not depend on the life history of a species, but on the community level participation of the individuals.

Phenological shifts in the natural world in response to warming up of climate were studied by many authors in different parts of the world (Beebee 1995; Myneni *et al*. 1997; Fitter & Fitter 2002; Parmesan & Yohe, 2003; Miller-Rushing *et al*. 2006).

The drivers of phenology – genes, temperature, photoperiod, precipitation and soil condition, would give us a basis on which to compare the different timings of the same phenological process, or to predict the future (Fitter & Fitter 2002).

Long term climate change can have dire consequences for interacting species, which can be explained by shift of their different phenophases – having either positive or negative consequences, depending on the interaction being mutually beneficial, competitive or predative (Harrington *et al*. 1999; Both *et al*. 2009; Hegland *et al*. 2009). Shifts in interactions are inevitable as species use different cues to regulate phenology.

Much attention has been drawn to the study of phenology of species which are beneficial to human society like agricultural crops or to showy plants (Rhododendrons) from time immemorial. Weeds, which occur almost everywhere, were ignored as an indicator to climate change and as such phenological records of weeds are few and far between. These species make an interesting study subject because of their universal occurrence and easy availability (Both *et al*. 2009).

It can be assumed that some very important weed species might have lost forever due to uncontrolled ever increasing anthropogenic pressure. Probably, some wild relatives of present day cultivated plants have lost from this earth forever. Identification of presently existing weeds and preservation of germplasm of necessary weeds will definitely be useful for future generations (Bhattacharjya & Borah 2006; Bhattacharjya *et al.* 2008).

There has been an increasing effort on the study of weeds in connection with their phenology in different times (Deen *et al*. 1998; Kon *et al*. 2007; Chakravorty & Ghosh 2012; Sohrabi *et al*. 2014; Enquist *et al*. 2014; Hegazy *et al.* 2015). However, no such study has been conducted hitherto in the urban areas of Guwahati, Assam. The present work, therefore, aims at to study few important phenophases of the weeds present in and around Guwahati.

MATERIALS AND METHODS

The study area: Guwahati belonging to the Kamrup (Metro) district is the capital city of the Indian state of Assam having the area of 1,528 sq km and is considered as the gateway to North-Eastern states. It is the major metropolis of North Eastern India (Figure 1). The city is located between $25^{o}43^{/}$ – $26^{o}51^{/}$ N Latitudes and $90^{o}36^{/}$ – $92^{o}12^{/}$ E Longitudes. The Greater Guwahati is situated on the northern slope of the pre-Cambrian hard rock formation of the plateau of Meghalaya and is divided into three geographic domains namely inselbergs, swamps and lacustrine wetlands. The area is traversed by three perennial streams namely Bharalu, Basistha and Bahini. The Brahmaputra is the major river flowing through the city. Soil is of three different types, *viz*. red soil, alluvial soil and marshy soil. Thick natural vegetation is a composite outcome of climatic condition, soil type and other physiographic conditions in Guwahati although the vegetation has been fragmented due to rapid urbanization processes. The climate of the place is mainly subtropical with semi-dry summer and cold winter. The maximum temperature ranges between 37 – 39^{o} C during summer and minimum 6 – 7^{o} C during winter. Average annual rainfall ranges between 1500 – 2600 mm. Annual average humidity is 76 %. The city is bounded on the West and North by the Kamrup (Rural) district and on the East by the Morigaon district. On the South, lies the state of Meghalaya (www.kamrupmetro.in, Phukon *et al.* 2012).

Weeds in and around the Guwahati city were surveyed in 8 locations during the years 2014 to 2016 to record the calendar of their 2 major phenophages. The weeds were identified basically by using available literature and matched at the Herbarium of the Department of Botany, Gauhati University, Guwahati. Nomenclatures were confirmed in the website www.theplantlist.org. Voucher specimens were deposited in the Department of Botany, M.C. College, Barepta.

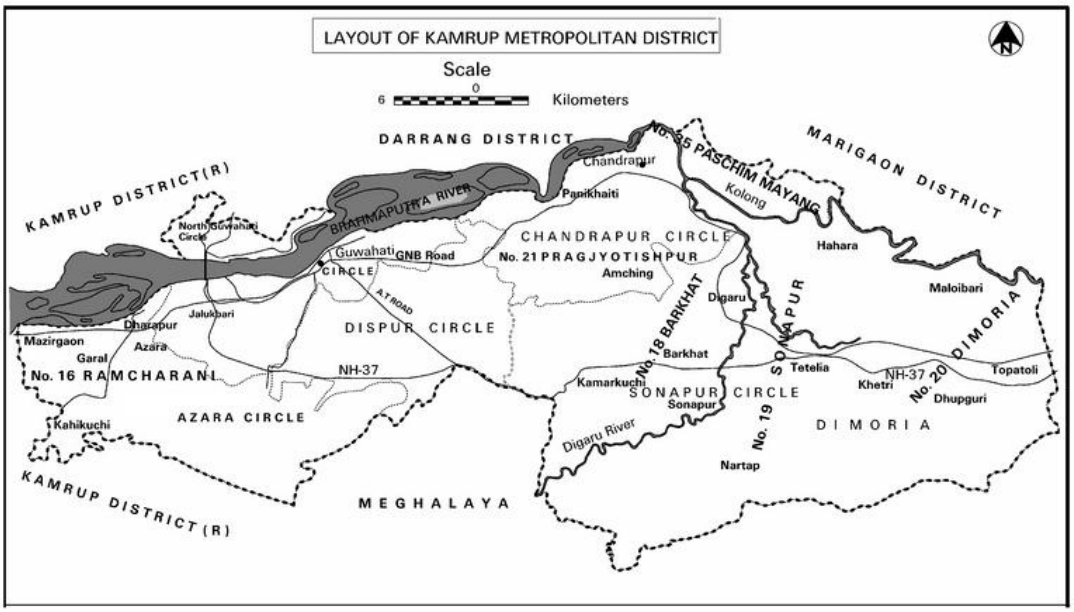


Figure 1. Map of the Kamrup Metropolitan District of Assam, - the study are.

Weed species are arranged in alphabetical order under 2 major angiospermic groups, *viz*. Dicotyledons and Monocotyledons followed by family names, range of flowering and fruiting periods (Table 1).

For the present purpose of study, whole the year was divided into the following seasons:

1. Spring (March to early June)
2. Summer/Monsoon (Mid June to mid-September)
3. Autumn (Late September to November)
4. Winter (December to February)

RESULTS AND DISCUSSION

The results of the survey of phenophages are presented in Table 1. A total of 173 species of weeds were identified, of which 139 were dicotyledonous and 34 were monocotyledonous. Two important phases which are the period of flowering and the fruiting were considered for the present study.

Flowering: Under this phenophase 2 sub-phenophases including flower initiation and full bloomed inflorescence were considered. Most of the **plants initiate flowering** during spring and winter, while some occur during summer and autumn also. The number of species in flowering stage during spring was 70 and 15, during summer 09 and 06, during autumn 25 and 08 and during winter 35 and 05 for dicot and monocot species respectively (Table 2). The month of April (spring) showed the maximum number of species initiating flower (27). Minimum number of species bearing flower bud (4) was during August (summer) (Figure 2).

Fruiting: Under this phenophase, sub-phenophase like fruit initiation, fruit development, and fruit and seed maturity were taken into consideration. The number of species showing development of fruit during spring was 72 and 09, during summer 28 and 08, during autumn

Table 1: Flowering and fruiting calendar of the weeds growing in the Guwahati Metropolis

Species	Family	Flowering		Fruiting	
		From	To	From	To
DICOTYLEDONS					
Abelmoschus moschatus Medikus	Malvaceae	Apr-W4	May-W3	Jul-W2	Aug-W1
Abroma augusta (Linnaeus) Linnaeus f.	Malvaceae	Oct-W2	Nov-W3	Jan-W1	Mar-W3
Abutilon indicum (Linnaeus) Sweet	Malvaceae	Nov-W1	Nov-W4	Jan-W1	Apr-W2
Acalypha indica Linnaeus	Euphorbiaceae	Sep-W1	Sep-W4	Nov-W1	Jan-W1
Achyranthes aspera Linnaeus	Amaranthaceae	Aug-W4	Sep-W3	Dec-W1	Dec-W4
Acmella paniculata (Wallich ex DC.) R.K.Jansen	Asteraceae	Jan-W4	Mar-W1	Feb-W4	Apr-W4
Ageratum conyzoides (Linnaeus) Linnaeus	Asteraceae	Sep-W1	Nov-W4	Nov-W4	Jan-W3
Alternanthera paronychioides A. Saint-Hilaire	Amaranthaceae	May-W4	Jun-W2	Jul-W3	Aug-W4
Amaranthus spinosus Linnaeus	Amaranthaceae	Jan-W1	May-W1	Apr -W3	Jun-W4
Amaranthus viridis Linnaeus	Amaranthaceae	Dec-W2	Jan-W2	Apr -W4	May-W3
Anagallis arvensis Linnaeus	Primulaceae	Feb-W1	Feb-W4	Apr-W1	Jun-W2
Anisomeles indica (Linnaeus) Kuntze.	Lamiaceae	Jan-W2	Apr-W1	Apr-W3	Jul-W1
Antigonon leptopus Hooker & Arnott	Polygonaceae	Mar-W3	May-W4	Apr-W4	Aug-W1
Argyreia acuta Loureiro	Convolvulaceae	Jan-W4	Feb-W3	Mar-W1	Mar-W4
Argyreia nervosa (Burman f.) Bojer	Convolvulaceae	Aug-W4	Oct-W1	Oct-W4	Dec-W2
Argemone aenea Ownbey	Papaveraceae	Jan-W1	Feb-W4	Apr-W4	Jul-W1
Asclepias curassavica Linnaeus	Apocynaceae	Dec-W2	Feb-W3	Feb-W4	May-W1
Barleria cristata Linnaeus	Acanthaceae	Dec-W3	Mar-W3	Mar-W3	Jun-W1
Blumea laciniata (Wallich ex Roxburgh) DC.	Asteraceae	Feb-W4	Apr-W1	Apr-W3	Jun-W1
Boehmeria cylindrica (Linnaeus) Swartz	Urticaceae	Jun-W4	Sep-W1	Oct-W2	Nov-W4
Boerhavia diffusa Linnaeus	Nyctaginaceae	Sep-W2	Nov-W3	Nov-W2	Dec-W4
Spermacoce neohispida Govaerts	Rubiaceae	Nov-W3	Jan-W1	Jan-W2	Mar-W3
Brassica campestris Linnaeus	Brassicaceae	Feb-W1	Mar-W2	Mar-W3	Apr-W2
Caesalpinia bonduc (Linnaeus) Roxburgh	Leguminosae: Caesalpinioideae	Jul-W3	Sep-W4	Nov-W3	Jan-W2
Callicarpa macrophylla Vahl	Lamiaceae	Apr-W4	May-W4	Jul-W1	Sep-W3
Calotropis gigantea (Linnaeus) Dryander	Apocynaceae	Nov-W1	Dec-W4	Jan-W4	Mar-W4
Cannabis sativa Linnaeus	Cannabaceae	Mar-W3	Apr-W4	Jun-W1	Jun-W3
Cardamine macrophylla Willdenow	Brassicaceae	Feb-W3	Apr-W2	Apr-W4	May-W2
Centella asiatica (Linnaeus) Urban	Apiaceae	Mar-W1	Apr-W1	Apr-W1	May-W4
Chrozophora rottleri (Geiseler) A.Jussieu ex Sprengel	Euphorbiaceae	Mar-W2	Apr-W3	May-W2	May-W4
Cissampelos pareira Linnaeus	Menispermaceae	Oct-W2	Nov-W3	Nov-W4	Jan-W2
Cleome gynandra Linnaeus	Cleomaceae	Feb-W4	May-W1	May-W1	Jul-W2
Cleome rutidosperma var. *burmannii* (Wight & Arnott) Siddiqui & S.N. Dixit	Cleomaceae	Mar-W4	May-W1	May-W1	Jul-W2
Clerodendrum densiflorum Griffith	Lamiaceae	Mar-W2	Apr-W4	Jun-W1	Sep-W1
Clerodendrum infortunatum Linnaeus	Lamiaceae	Jan-W2	Mar-W1	Mar-W3	May-W4

Species	Family	Flowering		Fruiting	
		From	To	From	To
Clerodendrum japonicum (Thunberg) Sweet	Lamiaceae	Apr-W4	Jul-W1	Jul-W4	Aug-W2
Cirsium arvense (Linnaeus) Scopoli	Asteraceae	Feb-W3	Mar-W4	May-W2	Jul-W2
Crotalaria juncea Linnaeus	Leguminosae: Faboideae	Oct-W3	Dec-W1	Dec-W2	Jan-W4
Croton bonplandianus Baillion	Euphorbiaceae	Jan-W1	Apr-W2	Feb-W4	Jul-W4
Cucumis melo Linnaeus ssp. *agrestis*	Cucurbitaceae	Sep-W2	Oct-W4	Jan-W1	Jan-W4
Cuphea hyssopifolia Kunth	Lythraceae	Apr-W1	May-W2	May-W2	Jun-W4
Cuscuta europaea Linnaeus	Convolvulaceae	May-W3	Jun-W4	Jun-W4	Jul-W2
Cynoglossum officinale Linnaeus	Boraginaceae	Mar-W2	May-W1	May-W1	Jun-W4
Cyanthillium cinereum (Linnaeus) H.Robson	Asteraceae	Nov-W2	Jan-W3	Dec-W4	Feb-W2
Cleome gynandra Linnaeus	Cleomaceae	Feb-W4	May-W1	May-W1	Jul-W2
Datura stramonium Linnaeus	Solanaceae	Feb-W3	May-W3	May-W1	Aug-W3
Dendrocnide excelsa (Weddell) Chew	Urticaceae	Nov-W1	Dec-W1	Feb-W2	Mar-W3
Desmodium gangeticum (Linnaeus) DC.	Leguminosae: Faboideae	Oct-W1	Nov-W3	Dec-W1	Feb-W1
Drymaria cordata (Linnaeus) Willdenow ex Schultes	Caryophyllaceae	Oct-W4	Nov-W4	Jan-W1	Feb-W2
Dysphania ambrosioides (Linnaeus) Mosyakin & Clemants	Amaranthaceae	May-W4	Jun-W3	Jul-W3	Aug-W3
Eclipta prostrata (Linnaeus) Linnaeus	Asteraceae	Apr-W1	Jul-W1	May-W2	Aug-W2
Emilia sonchifolia (Linnaeus) DC. ex DC.	Asteraceae	Jan-W1	Feb-W1	Mar-W1	Apr-W3
Ethulia conyzoides Linnaeus f.	Asteraceae	Apr-W3	Jun-W1	May-W3	Jul-W2
Euphorbia hirta Linnaeus	Euphorbiaceae	Sep-W3	Oct-W4	Oct-W4	Dec-W3
Euphorbia prostrata Aiton	Euphorbiaceae	Jun-W3	Jul-W4	Aug-W4	Oct-W2
Evolvulus numularis (Linnaeus) Linnaeus	Convolvulaceae	Feb-W1	Mar-W2	Feb-W4	Apr-W2
Galinsoga parviflora Cavanilles	Asteraceae	Jan-W4	Mar-W2	Mar-W3	May-W4
Grangea maderaspatana (Linnaeus) Poiret	Asteraceae	Mar-W3	Apr-W1	May-W3	Jun-W1
Glycosmis pentaphylla (Retzius) DC.	Rutaceae	Oct-W3	Nov-W4	Jan-W1	Feb-W3
Gnaphalium indicum Linnaeus	Asteraceae	Feb-W4	Apr-W1	May-W2	Jun-W3
Gomphrena celosioides Martius	Amaranthaceae	Apr-W2	May-W4	May-W4	Jul-W4
Gynura nepalensis DC.	Asteraceae	Feb-W1	Feb-W4	Mar-W3	Jun-W4
Helichrysum luteoalbum (Linnaeus) Reichenbach	Asteraceae	Apr-W1	May-W3	May-W1	Jun-W3
Heliotropium indicum Linnaeus	Boraginaceae	Apr-W1	Apr-W4	May-W2	Jun-W3
Hydrocotyle rotundifolia Roxburgh	Apiaceae	Feb-W3	Mar-W4	Mar-W4	May-W2
Hydrolea zeylanica (Linnaeus) Vahl	Hydroleaceae	Feb-W1	Mar-W4	Apr-W1	May-W1
Ipomoea aquatica Forsskål	Convolvulaceae	Oct-W2	Dec-W1	Dec-W4	Jan-W4
Ipomoea carnea Jacquin	Convolvulaceae	Mar-W3	Apr-W2	May-W4	Jul-W1
Justicia adhatoda Linnaeus	Acanthaceae	Mar-W1	Apr-W2	Jun-W2	Jul-W2

Species	Family	Flowering		Fruiting	
		From	To	From	To
Justicia gendarussa Burman f.	Acanthaceae	Jan-W2	Feb-W1	Feb-W3	Mar-W4
Jatropha gossypiifolia Linnaeus	Euphorbiaceae	Apr-W1	Jun-W1	May-W3	Aug-W3
Lantana camara Linnaeus	Verbenaceae	Jan-W1	May-W4	May-W1	Jul-W4
Leea asiatica (Linnaeus) Ridsdale	Vitaceae	Apr-W4	Jun-W2	Jun-W2	Sep-W3
Leonurus sibiricus Linnaeus	Lamiaceae	Dec-W1	Jan-W2	Jan-W2	Feb-W3
Leucas aspera (Willdenow) Link	Lamiaceae	Dec-W4	Feb-W4	Feb-W1	Apr-W1
Lindernia crustacea (Linnaeus) F. Mueller	Linderniaceae	May-W4	Jul-W1	Aug-W1	Sep-W2
Lippia alba (P.Miller) N.E. Brown ex Britton & P. Wilson	Verbenaceae	Oct-W1	Nov-W3	Nov-W4	Feb-W1
Mecardonia procumbens (P.Miller) Small	Plantaginaceae	Jan-W4	Feb-W3	Feb-W4	Apr-W1
Merremia vitifolia (Burman f.) Hallier f.	Convolvulaceae	Mar-W1	Apr-W1	May-W2	Jun-W4
Mikania micrantha Kunth	Asteraceae	Nov-W1	Dec-W2	Dec-W1	Feb-W3
Mimosa pudica Linnaeus	Leguminosae: Mimosoideae	Nov-W1	Dec-W3	Jan-W1	Feb-W3
Mollugo verticillata Linnaeus	Molluginaceae	May-W4	Jul-W3	Jun-W4	Aug-W4
Momordica dioica Roxburgh ex Willdenow.	Cucurbitaceae	Apr-W1	May-W4	Jun-W2	Aug-W3
Nelsonia canescens (Lamarck) Sprengel	Acanthaceae	Feb-W1	Feb-W4	May-W1	Jul-W2
Nicotiana plumbaginifolia Viviani	Solanaceae	Apr-W2	May-W2	May-W2	Jun-W3
Rorippa indica (Linnaeus) Hiern	Brassicaceae	Jan-W4	Mar-W2	Mar-W4	May-W3
Ocimum basilicum Linnaeus	Lamiaceae	Oct-W3	Nov-W4	Nov-W4	Feb-W1
Ocimum gratissimum Linnaeus	Lamiaceae	Mar-W1	Apr-W2	Apr-W3	Jun-W1
Operculina turpethum (Linnaeus) Silva Manso	Convolvulaceae	May-W4	Jul-W1	Aug-W4	Sep-W4
Oxalis corniculata Linnaeus	Oxalidaceae	Dec-W4	Mar-W2	Feb-W4	Apr-W4
Oxalis debilis Kunth	Oxalidaceae	Jan-W4	Feb-W3	Mar-W3	Jun-W2
Peperomia pellucida (Linnaeus) Kunth	Piperaceae	Apr-W3	Jun-W1	Jun-W2	Jul-W4
Persicaria barbata (Linnaeus) H.Hara.	Polygonaceae	Sep-W3	Nov-W1	Dec-W4	Jan-W2
Persicaria glabra (Willdenow) M.Gómez	Polygonaceae	Feb-W3	Apr-W4	May-W4	Jun-W3
Persicaria hydropiper (Linnaeus) Delarbre	Polygonaceae	Apr-W1	Apr-W4	Jun-W1	Jul-W3
Persicaria orientalis (Linnaeus) Spach	Polygonaceae	Mar-W3	Apr-W4	Apr-W4	Jun-W4
Phyla nodiflora (Linnaeus) Greene	Verbenaceae	Mar-W2	Apr-W3	May-W1	Jun-W2
Phyllanthus amarus Schumacher & Thonning	Phyllanthaceae	Apr-W4	Jul-W2	May-W4	Sep-W3
Physalis minima Linnaeus	Solanaceae	May-W3	Jun-W1	Jul-W3	Aug-W4
Plumbago zeylanica Linnaeus	Plumbaginaceae	Feb-W4	Apr-W1	Apr-W1	May-W4
Pogostemon benghalensis (Burman f.) Kuntze	Lamiaceae	Jan-W4	Mar-W2	Feb-W4	Apr-W3
Polygonum plebeium R. Brown	Polygonaceae	Mar-W3	Apr-W3	Apr-W3	May-W2

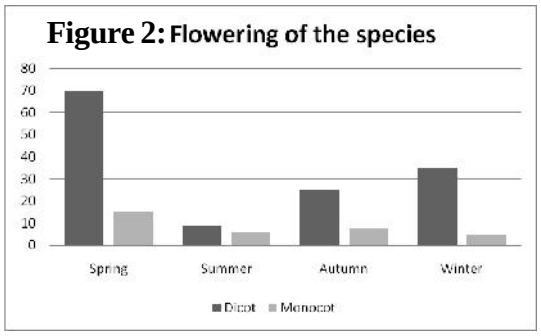
Species	Family	Flowering		Fruiting	
		From	To	From	To
Portulaca oleracea Linnaeus	Portulacaceae	Mar-W2	May-W3	May-W1	Jun-W4
Pouzolzia hirta Blume ex Hasskarl	Urticaceae	Apr-W3	Jun-W3	May-W4	Sep-W3
Pueraria tuberosa (Willdenow) DC.	Leguminosae: Faboideae	Oct-W1	Nov-W3	Dec-W3	Feb-W2
Ranunculus scelerotus Linnaeus	Ranunculaceae	Apr-W1	May-W2	May-W1	Jun-W4
Rauvolfia serpentina (Linnaeus) Bentham ex Kurz	Apocynaceae	Mar-W2	Apr-W4	Apr-W3	Jun-W1
Rauvolfia tetraphylla Linnaeus	Apocynaceae	Apr-W2	May-W1	May-W3	Jul-W4
Rumex maritimus Linnaeus	Polygonaceae	Jan-W3	Apr-W4	Mar-W1	Jun-W4
Scoparia dulcis Linnaeus	Plantaginaceae	Dec-W2	Feb-W4	Jan-W2	Mar-W4
Senna alata (Linnaeus) Roxburgh	Leguminosae: Caesalpinioideae	Jan-W1	Feb-W3	Mar-W3	May-W1
Senna occidentalis (Linnaeus) Link	Leguminosae: Caesalpinioideae	Jul-W3	Aug-W3	Sep-W3	Oct-W4
Senna sophera (Linnaeus) Roxburgh	Leguminosae: Caesalpinioideae	Sep-W1	Oct-W2	Nov-W3	Feb-W2
Senna tora (Linnaeus) Roxburgh	Leguminosae: Caesalpinioideae	Jul-W1	Jul-W4	Aug-W4	Sep-W2
Sida cordifolia Linnaeus	Malvaceae	Dec-W3	Feb-W1	Feb-W3	Apr-W4
Sida rhombifolia Linnaeus	Malvaceae	Aug-W4	Oct-W1	Oct-W3	Dec-W1
Solanum aligerum Schlechtendal	Solanaceae	Sep-W1	Sep-W3	Nov-W2	Dec-W3
Solanum indicum Linnaeus	Solanaceae	Mar-W2	Apr-W4	Apr-W3	Jun-W4
Solanum aculeatissimum Jacquin	Solanaceae	Mar-W4	May-W1	Jun-W1	Jul-W2
Solanum mouritianum Scopoli	Solanaceae	Jan-W1	Mar-W4	Mar-W1	May-W2
Solanum americanum P.Miller	Solanaceae	Jan-W3	Mar-W1	Feb-W4	Apr-W1
Solanum sisymbriifolium Lamarck	Solanaceae	Apr-W2	May-W4	May-W4	Jul-W4
Solanum torvum Swartz	Solanaceae	Mar-W1	Apr-W1	Apr-W3	Jun-W3
Sonchus arvensis Linnaeus	Asteraceae	Mar-W1	Apr-W3	May-W2	Jul-W2
Spilanthes acmella (Linnaeus) Linnaeus	Asteraceae	May-W4	Jun-W2	Jul-W4	Aug-W4
Stachys oblongifolia Wallich ex Benth..	Lamiaceae	Apr-W2	May-W4	May-W3	Jun-W4
Stachytarpheta jamaicensis (Linnaeus) Vahl	Verbenaceae	Dec-W1	Jan-W3	Jan-W3	Feb-W4
Stellaria media (Linnaeus) Villars	Caryophyllaceae	Jan-W1	Jan-W4	Feb-W3	Mar-W4
Synedrella nodiflora (Linnaeus) J.Gaertner	Asteraceae	Dec-W1	Jan-W2	Jan-W3	Feb-W4
Tephrosia purpuria (Linnaeus) Persoon	Leguminosae: Faboideae	Aug-W3	Oct-W4	Nov-W2	Jan-W2
Thunbergia alata Bojer ex Sims	Acanthaceae	Oct-W4	Nov-W4	Dec-W3	Jan-W4
Torenia diffusa Roxburgh	Scrophulariaceae	Dec-W4	Feb-W3	Feb-W2	Mar-W3
Trichosanthes dioica Roxburgh	Cucurbitaceae	Mar-W1	Apr-W4	Jun-W1	Aug-W2
Trichosanthes wallichiana (Sering) Wight	Cucurbitaceae	Jul-W4	Sep-W1	Sep-W3	Nov-W2
Tridax procumbens (Linnaeus) Linnaeus	Asteraceae	Apr-W2	May-W3	Jul-W1	Sep-W4
Triumfetta rhomboidea Jacquin	Malvaceae	Sep-W4	Oct-W3	Nov-W4	Jan-W3
Vallaris solanacea (Roth) Kuntze	Apocynaceae	Feb-W2	Mar-W4	Apr-W2	May-W4

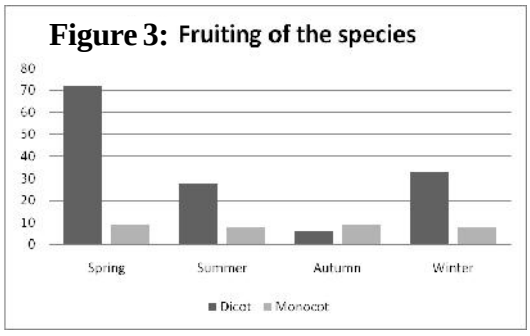
Species	Family	Flowering		Fruiting	
		From	To	From	To
Vicia sativa Linnaeus	Leguminosae: Faboideae	Jan-W4	Feb-W3	Apr-W4	May-W2
Xanthium strumarium Linnaeus	Asteraceae	Jan-W3	Feb-W2	Mar-W2	May-W4
MONOCOTYLEDONS					
Alopecurus pratensis Linnaeus	Poaceae	Aug-W4	Dec-W3	Oct-W4	Dec-W2
Cenchrus ciliaris Linnaeus	Poaceae	Jul-W3	Aug-W4	Sep-W4	Nov-W1
Cenchrus echinatus Linnaeus	Poaceae	Sep-W2	Oct-W3	Nov-W3	Dec-W2
Coix aquatic Roxburgh	Poaceae	Mar-W2	Mar-W4	Apr-W4	Jun-W1
Colocasia esculenta (Linnaeus) Schott	Araceae	Jun-W1	Jun-W4	Sep-W1	Oct-W2
Colocasia indica (Loureiro) Kunth	Araceae	Jun-W1	Jul-W2	Sep-W2	Oct-W3
Colocasia oresbia A. Hay	Araceae	May-W1	May-W4	Jul-W2	Sep-W1
Commelina benghalensis Linnaeus	Commelinaceae	May-W1	May-W4	Jun-W2	Aug-W1
Commelina longifolia Lamarck	Commelinaceae	Jan-W1	Jan-W4	Feb-W4	Apr-W1
Cynodon dactylon (Linnaeus) Persoon	Poaceae	Feb-W3	Apr-W4	Mar-W1	Jul-W1
Cyperus esculentus Linnaeus	Cyperaceae	Jul-W2	Aug-W2	Oct-W4	Nov-W4
Cyperus iria Linnaeus	Cyperaceae	Aug-W3	Oct-W1	Sep-W4	Nov-W1
Pycreus polystachyos (Rottbøll) P.Beauvois	Cyperaceae	Aug-W3	Sep-W4	Oct-W3	Dec-W2
Cyperus rotundus Linnaeus	Cyperaceae	Mar-W4	May-W3	May-W3	Aug-W1
Dactyloctenium aegyptium (Linnaeus) Willdenow	Poaceae	Jan-W1	Apr-W2	Feb-W4	May-W3
Digitaria adscendens (Kunth) Henrard	Poaceae	May-W1	Jun-W4	Jun-W1	Aug-W3
Digitaria abludens (Roemer & Schultes) Veldkamp	Poaceae	Sep-W4	Oct-W4	Dec-W1	Jan-W2
Digitaria cognate (Schultes) Pilger	Poaceae	Jan-W1	Jan-W4	Mar-W1	Apr-W2
Echinochloa barbata Vanderyst	Poaceae	May-W2	Jun-W4	Jun-W2	Sep-W2
Echinochloa polystachya (Kunth) Hitchcock	Poaceae	Sep-W1	Sep-W4	Nov-W4	Dec-W3
Eleusine indica (Linnaeus) Gaertner	Poaceae	Apr-W4	May-W2	May-W4	Aug-W1
Eragrostis amabilis (Linnaeus) Wight & Arnott	Poaceae	Mar-W4	May-W2	Apr-W3	Aug-W3
Eragrostis cilianensis (Allioni) Janchen	Poaceae	Sep-W4	Nov-W1	Dec-W1	Jan-W2
Eragrostis lehmanniana Nees	Poaceae	Apr-W4	Jun-W2	May-W4	Sep-W3
Eragrostis superb Peyritsch	Poaceae	Nov-W3	Dec-W4	Jan-W3	Mar-W2
Eustachys bahiensis (Steudel) Herter	Poaceae	Jul-W3	Aug-W4	Sep-W3	Nov-W3
Fimbristylis dichotoma (Linnaeus) Vahl	Cyperaceae	May-W3	Jun-W4	Jun-W3	Aug-W1
Hemarthria altissima (Poiret) Stapf & C.E. Hubbard	Poaceae	Jun-W2	Jul-W4	Aug-W2	Sep-W4
Kyllinga brevifolia Rottbøll	Cyperaceae	Dec-W2	Jan-W3	Jan-W3	Feb-W3
Leptochloa panicea (Retzius) Ohwi	Poaceae	Jul-W3	Aug-W4	Sep-W3	Oct-W4
Oplismenus affinis Schultes	Poaceae	Oct-W1	Nov-W2	Dec-W3	Jan-W4
Oplismenus burmanni (Retzius) P. Beauvois	Poaceae	Oct-W3	Dec-W2	Dec-W2	Jan-W4
Paspalum scrobiculatum Linnaeus	Poaceae	Oct-W2	Nov-W3	Dec-W3	Jan-W4
Typhonium trilobatum (Linnaeus) Schott	Araceae	Mar-W3	May-W2	May-W4	Jul-W3

06 and 09 and during winter 33 and 08 for dicot and monocot species respectively (Figure 3). The month of May (spring) showed the maximum number of species showing fruit formation (31), while minimum (4) was in October (autumn).

Table 2. Number of species showing flowering and fruiting in different seasons.

Season	Flowering		Fruiting	
	Dicot	Monocot	Dicot	Monocot
Spring	70	15	72	09
Summer	09	06	28	08
Autumn	25	8	06	09
Winter	35	5	33	08
Total	139	34	139	34





Present phenological observation of the weeds is basically conducted in uncropped areas of the urban ecosystem and it was observed that the month of April and August showed maximum and minimum numbers of species with flowering stage respectively, while the month of May and October showed the maximum and minimum number of species respectively in relation to the fruiting stage. Bora and Gogoi (2002), Basumatari *et al*. (2003) found the months of March and September as maximum and minimum respectively in relation to flowering time of the weeds. Chakravorty & Ghosh (2012) recorded that majority of the crop-field weeds were with their flowering stage during July whereas fruiting stage during September and October. The observed phenophases in the study area in the respective months may be due to the climatic condition prevailed in the area.

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