International Journal of Advanced Research in Biological Sciences
ISSN: 2348-8069
www.ijarbs.com
DOI: 10.22192/ijarbs Coden: IJARQG(USA) Volume 5, Issue 3 - 2018

Research Article

DOI: http://dx.doi.org/10.22192/ijarbs.2018.05.03.015

Study of phenology process of Roselle (*Hibiscus sabdariffa* L.) in South-east Iran

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Abstract

Roselle (*Hibiscus sabdariffa* L.) is a medicinal plant cultivated in south-east Iran. Despite the intriguing characteristics of this plant and its economic importance, to date, there was no coding method to describe developmental stages of Roselle. An univocal description of the growth stages of this plant will offer an useful tool for several agronomic research activities, weed management practices and for further genetic improvement programmers. Nine principal stages are described for germination, leaf development, formation of side shoots, main shoot elongation, inflorescence emergence, flowering, development of fruit (calyces and seeds), ripening of fruit, and senescence. Results also showed that growth and development stages of the Roselle consists of three stages: vegetative growth stages, reproductive growth stages and physiological maturity.

Keywords: phenology, flowering, growth, developmental phases.

Introduction

Phenology is defined as a branch of science dealing with the relationship between climate and periodic biological phenomena; it is the study of the response of living organisms to seasonal and climatic changes in the environment in which they live; seasonality exposes plant to regular, periodic changes in the quality and abundance of resources (Fretwell, 1972) and the study of plant and animal life cycle phenomenon, composed of environmental changes (Meier et al, 2008). Phenological studies are important for understanding the influence of climate dynamics on vegetative growth, flowering and fruiting on plants and can be used in many scientific subjects, such as Agronomy, Botany and Plant Biology, but also Climatology as a result of the current global interest in climate change monitoring. The purpose of the detailed specific culture descriptions of the principal growth stages in plants is to provide an instrument for standardization of data recording. Almost all tropical environments vary seasonally in temperature, humidity, rainfall, wind speed and day length, although the amplitude of the variation may be small. All of these factors are known to play a role, alone or in combination, in triggering phenological changes in tropical plants (Longman & Jenik, 1974).Most agricultural issues such as suitable date for implanting, irrigation, reaping, fight against pest vermin and the optimum production can be obtained through determining the stages of phenology in each area, the required temperature units in each stage and the overall period of plant growth (Mirhaji et al, 2010). Phenological data are important for many aspects of agricultural production as they provide basic information oncrop requirements at certain times

which are essential to achieve sufficient yield and sustainable management(Chmielewski, 2003).

Roselle, an annual plant belongs to the genus *Hibiscus*. It is an important annual crop which grows successfully in the tropics and sub-tropics (Cobley, 1975). Roselle (*Hibiscus sabdariffa* L.) belongs to the family Malvaceae has more than 300 species in the world (Laila et al., 2002; Maryam Mirza et al., 2004). Roselle is a tetraploid (2n = 4x = 72) (Wilson & Menzel., 1964), annual and flowering plant (Javadzadeh, 2015). It is cultivated for calyx. Roselle may have been domesticated in western Sudan before4000 BC(Wilson & Menzel., 1964). The use of the plant as “greens” was known in Java as early as1658 (Lainbourne, 1913). The origin is believed to be from West Africa (Mohamed et al. 2012). Taken to the New World, Roselle wascultivated in Mexico, parts of Central America, the West Indies, and insouthern Florida, Texas and California in the late Nineteenth-century. Roselle was called Jamaicansorrel in 1707 in Jamaica, where the regular use of the calyces as foodseems to have been first practiced (Wilson & Menzel., 1964).Roselle gaining importance in the manufacture of many small industries, e.g. cosmetics, sweets, sauces, jams, and jellies and a substitute for tea and also used as a coloring material for food.The fleshy calyces of Roselle have been used in various countries as food or a food ingredient such as jellies, syrups, beverages, puddings, cakes, and wines (Christian et al., 2006). It is also used in medicine, especially with problems related to the digestive tract (El Naimet al, 2012). It is nowgrown for medicinal purposes in much of the tropical world.Many parts of Roselle including roots, stem, leaves, seeds, flowers and fruits are used in various foods. Roselle is used in many countries of the world for Local and traditional medicines. It is claimed as a traditional medicine for kidney stones and urinary bladder stones (Hirunpanich et al., 2006), also has been shown to have diuretic effects, used effectively in folk medicines for the treatment of inflammatory diseases (Dafallah & Al-Mustafa, 1996) and cancer (Chewonarin et al., 1999).More recently, the antihypertensive action of Roselle has been confirmed with experimental hypertension (Odigie et al., 2003). In addition, studies on humans also demonstrated the anti-inflammatory effect of Roselle consumption (Beltrán-Debón et al., 2010; Herrera et al., 2004).Roselle isa relatively new crop in Iran (Javadzadeh,2013) and medicinal plant known in Iran as sour tea or Maki tea which grows successfully in South-east Iran. It was introduced into Iran in early 1990s. Presently, theplanted area is quite small approximately 180 ha. It islocally known as “Tea Sour"and “Tea Maki"(Javadzadeh,2017).Tea sour or tea Maki (*Hibiscus sabdariffa* L.) is one of the most important andpopular medicinal plants. Roselle has been usedtraditionally as a medicinal.(Javadzadeh & Saljooghianpour. 2017).

Until the early 1990s, there was not a homogeneous code to describe the growth stages in most plants and crops. Zadoks et al. (1974) published the first decimal code aiming at standardizing the phenological development stages description for similar cereal crops by using the same codes. Further development derived in the BBCH (Biologische Bundesanstalt, Bundessortenamt und Chemische Industrie) scale proposed by Bleiholder et al (1989) and in the extended BBCH-scale proposed by Hack et al (1992). Since then, the extended BBCH-scale has become a world-wide coding system commonly used to integrate phenology in agricultural, horticultural, environmental and meteorology and climatic studies (Meier et al., 2008). It has been broadly accepted for its use in many crops like cereals (Lancashire et al., 1991), sugar beet (Meier et al., 1993),and *Citrus*spp (Agustí et al., 1997). The extended BBCH-scale is a system for a uniform coding of phonologically similar growth stages of all mono- and dicotyledonous plant species carried out by a work team referenced by Enz & Dachler (1997). The entire developmental cycle of the plants is subdivided into ten clearly recognizable and distinguishable longer-lasting developmental phases. These ten principal growth stages alone are not sufficient to define exactly application or evaluation dates, since they always describe time spans in the course of the development of a plant. Secondary stages are used if points of time or steps in the plant development must be indicated precisely. In contrast to the principal growth stages they are defined as short developmental steps characteristic of the respective plant species, which are passed successively during the respective principal growth stage. They are also coded by using a second digit with figures from 0 to 9.So far, the BBCH scale for many products such as cereals, rapeseed, legumes by Lancashire et al. (1991), beetroot by Meier et al., (1994), Potato by Hack et al (1992), peach and apple fruit trees by Meier et al(1994), grapes by Lorenz et al(1994), Citrus by Agustí et al (1997), Japanese marigolds by Martinez-Calvo et al (1999), Olive by Sanz-Cortés et al (2002), Guava by Salazar et al (2006), Kiwi by Salinero et al (2009) and mango by Rajan et al(2011); Hernández Delgado et al (2011) has been investigated. Martinelli

& Galasso (2014) reported that different phenological growth stages *Camelina sativa*, utilizing both the two and three-digit BBCH coding system described.

The dearth of phenological studies in tropical plants had been pointed out by various authors (Frankie et al, 1974).The aim of this paper was to define the phenological stages of Roselle (*Hibiscussabdariffa*L.), describing the different growth stages using the BBCH code (Lancashire et al, 1991 andMeier et al., 1994). This information will improve the cultivation of this crop in Iranshahr Region(which produces 90% of the total Iran production) by expressing the timing of most agricultural operations on a standardized scale.In this article, a proposed scale of the phenological growth stages of Roselle based on the BBCH coding system was developed. Growth stages were described utilizing the decimal code of the BBCH system, and figures were included for the most representative stages.To date, there was no coding method to describe developmental stages on Roselle. Because of the increasing world-wide interest on this crop, a novel growth development code based on the BBCH extended scale is proposed in this paper.

Materials and Methods

This research was conducted with the purpose of precise identification of the growth stages and phenological stages based on BBCH-scale (from culture to harvest time) and plant height in each stage at Roselle in this study, phenological stages and the growth stages of Roselle (*Hibiscus sabdariffa* L.) were studied in the region of Iranshahr (South East part of Iran) At latitude 27 ° 12'N, longitude 60 ° 41'E and at an altitude of 591m above sea level during the years of 2015-2016(June to December). The weather of the area based on the Embrothermic Evaluation Method was estimated to be warm and dry (javadzadeh, 2015). The average annual relative humidity is 31.3% and average monthly relative humidity ranges from 22% in May to 46% in January. Iranshahr, with a loam texture soil, pH 7.8, and with low organic matter. During the experimental period, the climate was Tropical, with dry summer (Table.1). The annual evaporation for the experimental period averaged 113 mm. Annual rainfall averaged 136 mm. The rainy period was as usual in this area, occurring during spring and autumn. During the experimental Climate data, the hottest month (July) with the average maximum temperature of 48 °C and the average minimum temperature of 13 °C in the coolest month (November)andthe average temperature is 27 °C (Table 1).

Table 1. Characteristics of climate factors of Synoptic stations Iranshahrin the year 2015-2016.

Months / Climate factors	March	April	May	June	July	August	September	October	November	December	January	February
Average maximum temperature (°C)	32.3	37.7	42.8	45	42.1	42.1	39	30.8	24.8	18.4	20.6	27.7
Average minimum temperature (°C)	18.3	23.8	29.5	31.5	29.1	27.4	23.9	16.6	12.8	8.53	8.3	14.9
Absolute maximum temperature (°C)	38.5	42.9	46.5	48.2	47.9	44.5	42.1	34.5	28.3	23.3	25.9	32.4
Absolute minimum temperature (°C)	12.2	18.2	25	27.2	24	21.9	20.1	11.8	6	-0.9	1.3	8
Rainfall (mm)	26.5	0	1.5	0	21.1	3.9	0	1	18.7	17.7	19.3	26.5

The land was plowed completely and was soft by cultivator and disc. Soil was brought to a fine tilt by crushing the clods and harrowing two times. Later, the land was smoothened with wooden plank. The experiment design was in a Randomized Complete Design (RCD) with three replications. The total area of the experiment was 115m^2. Each replication consisted of 10 rows. Seed planting method was manual. Depth of planting was 2-4 cm. Culture distances were 50×25.Planting densities were 10 to 15 plants in each square meter and irrigation period was chosen for 8 to 10 days. The crop was seeded directly after the soil is well prepared.

Fertilizers, irrigation and Pest management was done on proper time. Plants were fertilized with 100kg N (Urea), 60 kg P_2O_5 and 100 kg K_2O, per ha per year. No weeds were allowed to develop within the Farm, for the duration of the experiment. Half dose of fertilizers (Urea) was applied at the time of sowing and half dosage of fertilizers was applied after 60days. Randomly three plants from each row were selected for data. The date of planting and germination were recorded. The following phenological stages in Roselle was tracked weekly throughout the germination periods until maturity namely: time, duration and frequency of leafing, flowering, and fruiting.Using specific codes in agriculture is a traditional method for describing the phenological growth stages of the plants (Zadoks et al., 1974). In this research, Phenology stages were examined based on Roselle BBCH stages. In this scale, the growth stages are divided into two principal and secondary stages. The principal growth stages are described using numbers from 0 to 9. Secondary stages has a table of 100 sections from 0-99 designed for different phases of the plants' growth. Secondary growth stages are used to express the exact stage of plant growth. Unlike the main growth stages, they are defined as short developmental stages that include their main growth stage. The two-digit code is a scale which offers the possibility of precisely defining all phenological growth stages for the majority of plant species. The combination of the codes of the primary and secondary growth stages will produce a two-digit code that can express the exact phenological stages of most plants in two digits (Hack et al., 1992). All phenological stages of Roselle from germination to Senescence are based on BBCH and are recorded in the observational cards. Statistical analyses were made through Spss software (version 19).

Results and Discussion

Phenology is the study of the relationship between periodic biological events in plants andanimals and the environment, especially temperature changes caused by weather and climate (Schwartz, 2003). Principal growth stages the 'Extended BBCH scale' (Hack et al., 1992) considers 9 growth stages for Roselle numbered from 0 to 9 (Table 2). Based on BBCH scale, nine phenological stages were recorded for Roselle that included: Germination (stage 0), Leaf development (stage 1), Formation of side shoots (stage 2), shoot development (stage 3), Inflorescence emergence (stage 5), Flowering (stage 6), Development of bolls (stage 7), ripening of calyces and Seeds (stage 8) Senescence (stage 9) and 65 secondary stages(Table 2).

Table 2. Principal growth stages *Hibiscus sabdariffa* L.

Stage	Description
0	Germination
1	Leaf development
2	Formation of side shoots (branches)
3	shoot development (Main stem elongation)
4	the vegetative parts of Roselle are not harvested
5	Inflorescence emergence
6	Flowering
7	Development of fruit orbolls (calyces and seeds)
8	Ripening bolls
9	Senescence

Principal growth stage 0:

Germination begins as the seed absorbs water and oxygen through its chalaza after planting. Germination normally takes place 5 to 6 days after planting (Figure.1). At this point, germination and seedling emergence are complete and the plant begins its active vegetative growth. Principal growth stage 0 in Roselle takes place in the soil. Stage 0 (principal growth) describes seed germination until the cotyledons emerge from the soil surface (Table 2). At the soil surface, the hypocotyl straightens and pulls the folded cotyledons out of the soil, a process known as Epigeal germination (In this type of seed germination the cotyledons come out of the soil). When the hypocotyl emerges it straightens, and in the process pulls the cotyledons out of the soil (Figure 2).

Figure 1. Stages of Germination. Under favorable germinationconditions, the radicle emerges within two to three days. The radicle becomes the taproot that grows downward into the soil.

Figure 2. Epigeal germination. Hooked hypocotyl and cotyledons breaking through the soil surface.

Figure 3. The cotyledons are storage organs that are formed in the seed. The cotyledons provide nutrients for the seedling. The apical meristem emerges through the cotyledons and will be the source of new growth as the plant matures.

The germination process begins with seed imbibition (Sub-stage 01–03) and continues with radicle and hypocotyl emergence (Sub-stage 04–06). Germination was Epigeal followed by the emergence of the hypocotyl (Sub-stage 07) and the hypocotyl with the cotyledons growing towards the surface (Sub-stage 08). The germination stage finishes with the emergence of the cotyledons through the soil surface (Sub-stage 09) (Table 3 & Figure.3). After the cotyledons are pulled through the soil surface, they unfold and expose the epicotyl and the apical meristem, or growing point, which will be the source of subsequent growth.

Principal growth stage 1: leaf development (Main Shoot)

Leaf development normally takes place 10 to 35 days after planting. Principal growth stage 1 describes the aerial development of the young plant and describes the development of the foliar apparatus of the plant and the emergence of the photosynthetic leaves on the main shoot (Table 2). Leaf development of Roselle from seeds begins after the cotyledons have completely unfolded (It begins with Sub-stage 10). Leaves emerged in pairs, so a leaf pair was considered visible when the two leaf blades were separated from each other. This stage began when cotyledons were separated between them (Sub-stage 11 -13) while the appearance of the photosynthetic leaves in the main shoot determined the secondary growth stage. The first pair of photosynthetic leaves visible was coded as Sub-stage 15. Followed by the Sub-stage 19 and successively (Table 3).

Principal growth stage 2: formation of side shoots

Formation of side shoots normally takes place 40 to 55 days after planting (Figure 6). In Roselle, the development of the vegetative side shoots is described in principal growth stage 2 (Table 2). The formation of side shoots usually occurs on the main stem (principal growth Sub-stage 21).The second, third, fourth or higher basal side shoots are described accordingly with Sub-stage 22, 23 to 29. The growth of the main stem of Roselle is Monopodial. The development of side shoots is extremely variable and dependent on plant density in the field, Genotype, environmental conditions and plant vigour .therefore, the number of branches can vary between 15to30. In this way, the quality describing development of the basal side shoots can be expressed using the basic principles of the BBCH scale (Table 3).

Principal growth stage 3: Main stem elongation

Main stem elongation normally takes place 55 to 70 days after planting (Figure 6). The description of the growth stage 3 includes the measurement of main stem. In the development of the Roselle plant the vertical growth of the main stem proceeds parallel to the formation of new leaves (Table 3).This stage with the beginning of crop cover and the closure of the crown cover end.

Principal growth stage 4: development of harvestable

Vegetative plant parts Principal growth stage 4 has been omitted because the vegetative parts of Roselle are not harvested.

Table3. Growth stages of Roselle (*Hibiscus sabdariffa*) following the extended BBCH Scale

stage	Principal growth stage	Sub-stage	Secondary growth stage
0	Germination		
		00	Dry seed
		01	Beginning of seed imbibition
		03	Seed imbibition complete
		05	Radicle emerged from seed
		06	Elongation of radicle
		07	Hypocotyl with cotyledons breaking through seed coat
		08	Hypocotyl with cotyledons growing towards soil surface
		09	Emergence: hypocotyl with cotyledons breaking through soil surface
1	Leaf development (Main shoot)		
		10	Cotyledons completely unfolded
		11	First true leaf unfolded
		12	2nd true leaf unfolded
		13	3rd true leaf unfolded
		15	Stages continuous
		19	12 true leaves unfolded
2	Formation of side shoots		
		21	First vegetative side shoot visible
		22	2vegetative side shoots visible
		23	3vegetative side shoots visible
		29	8 side shoots visible
3	Main stem elongation (Crop cover)		
		31	Beginning of crop cover: 10% of plants meet between
		32	20% of plants meet between rows
		33	30% of plants meet between rows
		34	40% of plants meet between rows
		35	50% of plants meet between rows
		36	60% of plants meet between rows
		37	70% of plants meet between rows
		38	80% of plants meet between rows
		39	Canopy closure: 90% of the plants meet between rows
5	Inflorescence emergence (Main shoot)		
		51	First floral buds detectable
		52	First floral buds visible
		55	Floral buds distinctly enlarged
		59	Petals visible: floral buds still closed
6	Flowering		
		60	First flowers opened (sporadically within the Farm)
		61	Beginning of flowering

	65	Full flowering
	67	Flowering finishing: majority of flowers faded
	69	End of flowering
7	Development of fruits and seeds	
	71	About 10% of bolls have attained their final size
	72	About 20% of bolls have attained their final size
	73	About 30% of bolls have attained their final size
	75	About 50% of bolls have attained their final size
	76	About 60% of bolls have attained their final size
	78	About 80% of bolls have attained their final size
	79	About 90% of bolls have attained their final size
8	Ripening of calyces and seeds	
	80	First boll Ripening (sporadically within the farm)
	81	Beginning of boll Ripening: about 10% of bolls
	82	Beginning of boll Ripening: about 20% of bolls
	83	Beginning of boll Ripening: about 30% of bolls
	85	Beginning of boll Ripening: about 50% of bolls
	87	Beginning of boll Ripening: about 70% of bolls
	89	Beginning of boll Ripening: about 90% of bolls
9	Senescence	
	91	About 10% of leaves discolored or fallen
	92	About 20% of leaves discolored or fallen
	93	About 30% of leaves discolored or fallen
	95	About 50% of leaves discolored or fallen
	97	plant dormant
	99	Harvested product (septal and seeds)

Principal growth stage 5: inflorescence emergence

Inflorescence emergence normally takes place 75 to 95 days after planting (Figure 6). In Roselle (*Hibiscus sabdariffa*), the inflorescence is small; flowering extends over 1 months. The appearance of reproductive organs on the main stem is qualitatively describes the morphology and codified in principal growth stage 5 (Table 2). Inflorescence emergence usually takes place at the Along with of leaf development (principal growth stage 1). Flowers are not formed on the main stem of the Roselle plant, but rather on the side branches that arise from extra-axillary buds on the main stem. sub-Stage 51 represents the First floral buds detectable of principal growth stage 5 and sub-Stage 59 represents the end of principal growth stage 5, at this stage, the first flower petals are visible, but the bud is still closed (Table 3).

Principal growth stage 6: flowering (main shoot)

Flowering normally takes place 100 to 120 days after planting (Figure 6). Principal growth stage 6 describes the development of the flowers within the main inflorescence (Table 3). Roselle is a short-day plant and photoperiodic (Javadzadeh, 2016). This stage when the first open flowers occur sporadically in the farm. The beginning of flowering (Sub-stage 61), the full flowering (Sub-stage 65), the flowering finishing (Sub-stage 67) , which the majority of flowers faded and End of flowering (Sub-stage 69) (Table 3).

Principal growth stage 7: development of fruit (bolls)

Development of fruit normally takes place 124 to 148 days after planting (Figure 6). Principal growth stage 7 describes the development of the fruits from fertilization when almost all the bolls have reached the final size typical (Table 3 & Figure. 4). As observed for flowering, bolls development takes place. The development of the fruits (bolls) with vegetative growth Increase considerably. Fruit size and form that are a significant quality feature of Roselle are described by Sub-stage 71 (About 10% of bolls have attained their final size) to 79 (About 90% of bolls have attained their final size). On reaching the final size, the bolls are approximately 10–25 mm large, 8–15 mm long and contain 20–35 seeds (Javadzadeh, 2016).

Figure. 4. Development of the Roselle (*Hibiscus sabdariffa L.*) boll and seeds

Principal growth stage 8: ripening

Ripening bolls of fruit normally takes place 150 to 165 days after planting (Figure 6). Principal growth stage 8 describes the First boll Ripening occurs sporadically within the farm (sub- stage 80) to Beginning Ripening about 90% of bolls(sub- stage 89) (Table 2 , 3).When the bolls have reached their maximum size and the seeds their maximum weight, capsule desiccation begins. During the ripening process, the water content in the bolls, decrease and changing the bolls colour and transitioned from green to black.

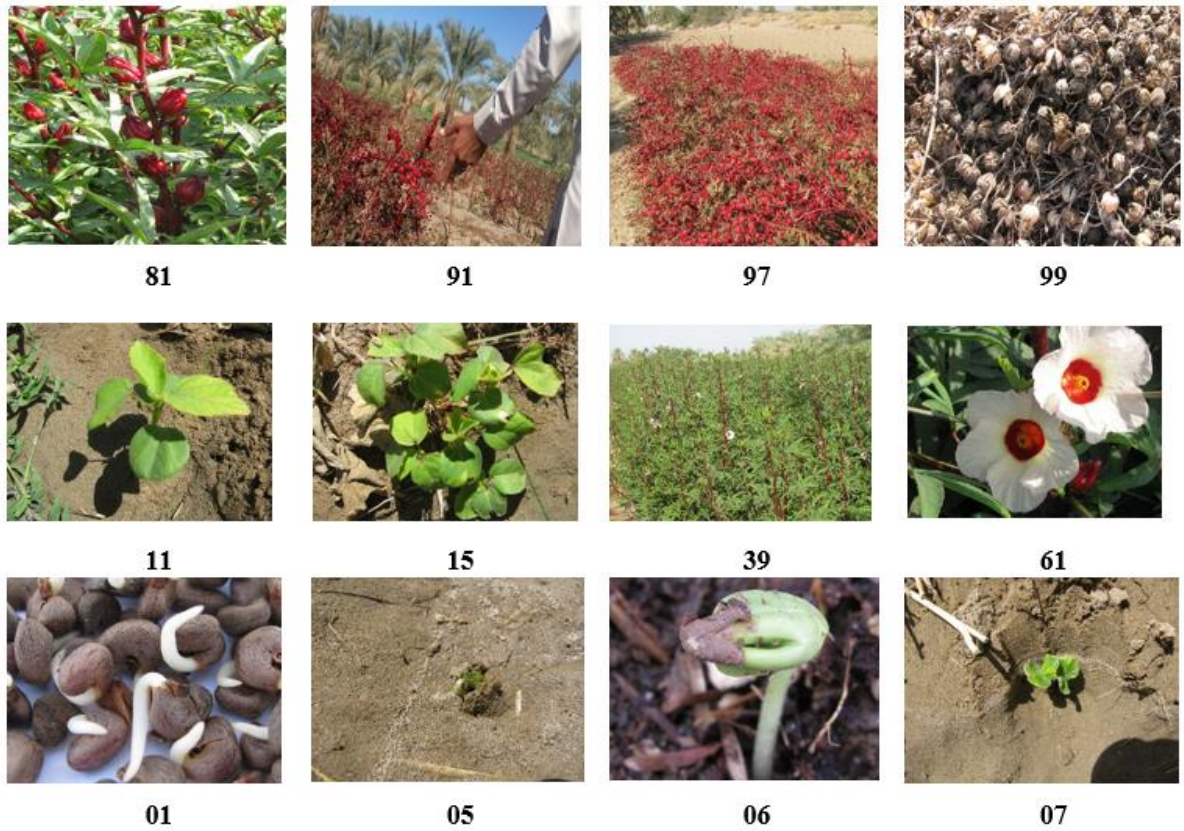

Figure 5. Selected principal and secondary phenological growth stages of annual cycle of Roselle (*Hibiscus sabdariffa* L.) corresponding to Germination, leaf development, appearance of flower cataphylls, flowering, development of fruit according to the extended BBCH-scale:
01: germination,05:Radicle emerged from seed,06:Elongation of radicle, 07:Hypocotyl with cotyledons breaking through seed coat,11:First true leaf unfolded,15:Stages continuous, 39:Canopy closure, 61:Beginning of flowering, 81:Beginning of boll Ripening,91:leaves discolored,97:plant dormant, 99:Harvested product.

Once the bolls attain the final size, ripening starts and bolls begin to yellow (Table 3 & Figure. 5).Calyx production per plant has ranged from (1.5 - 3 kg) in Iran (Javadzadeh. 2015).The fruits of Roselle ripen progressively from the lowest to the highest. Harvesting of seeds takes place when the lower and middle tiers of the last of the fruits are allowed to mature, at which time the plants are cut down, stacked for a few days.

Principal growth stage 9: Senescence

Senescence of fruit normally takes place 170 to 185days after planting and calyces will be ready to harvest in December (Figure 6).Principal growth stage 9 (Senescence) describes the plant senescence after fruit ripening (Table 2). Once the bolls have opened, the leaves of Roselle slowly turn yellow. Sub-stage 91(About 10% of leaves discolored or fallen) to 96 (About 60% of leaves discolored or fallen) can be used to describe the condition of the vegetative plant parts at this time. Senescence started in the basal leaves (Sub-stage 91) (Figure. 1) and continued upwards, but the stem remained green (Sub-stage 93). Then, the remaining leaves became dead, and the stem turned from yellow to brown (Sub-stage 95) but the stem still appears hydrated and light green. Finally, thereafter, the plant dormant and completely desiccates (Sub-stage 97), and the product (septal and seeds) was then harvested (Sub-stage 99) (Table 3 & Figure 5).

Growth and development stages of the Roselle (*Hibiscus sabdariffa* L.)

The following is a uniform system for the development of Roselle (*Hibiscus sabdariffa* L.) developmental stages.

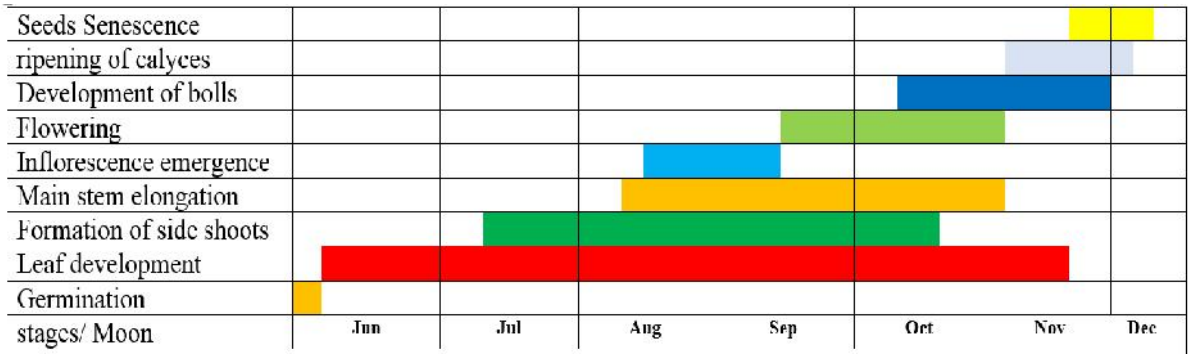

Figure 6. The duration and occurrence of phenological phenomena Roselle (*Hibiscus sabdariffa* L.) in the weather conditions of Iranshahr

1- Vegetative Growth Stages

Vp - Planting to Emergence
Vc - Seedling emergence, cotyledon visible
Vf - the first simple leaf has been unfolded at the first node
Vs - The second simple leaf has been unfolded at the second node
VB - Formation of side shoots

2- Reproductive Growth Stages

Flowering in Roselle (*Hibiscus sabdariffa* L.) is an indeterminate, occurring from the axillary buds on the side branches.
R1 - Flower in primary branch visible
R2 - bolls in primary branch visible
R3 - calyces growth & Emergence
R4 - full calyces growth
R5 - full growth calyces & seed

3- Physiological Maturity

P1 - the leaves start yellowing and 50% of the bolls have brown
P2 - 90% of the bolls on the plant are brown / open boll
P3 - seeds and calyces ripening

Conclusion

The result of this review revealed that Roselle is one of the medicinal plant cultivated in south-east Iran. Nine principal stages are described for germination, leaf development, formation of side shoots, main shoot elongation, inflorescence emergence, flowering, development of fruit(bolls), ripening of fruit, and senescence. Also the results showed that Growth and development stages of the Roselle (*Hibiscus sabdariffa* L.) Consists of three stages: Vegetative Growth Stages, Reproductive Growth Stages and Physiological Maturity.

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DOI:10.22192/ijarbs.2018.05.03.015	

How to cite this article:
Seyyed Mahdi Javadzadeh. (2018). Study of phenology process of Roselle (*Hibiscus sabdariffa* L.) in South-east Iran. Int. J. Adv. Res. Biol. Sci. 5(3): 145-156.
DOI: http://dx.doi.org/10.22192/ijarbs.2018.05.03.015