

PLANT PHENOLOGY AND ITS RELATION TO THE COOL SEMI-ARID CONDITIONS OF SANA'A

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مظاهر نمو النباتات البرية وعلاقتها بالمناخ المعتدل شبه الجاف لمنطقة صنعاء

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في منطقة صنعاء المتميزة بمناخ معتدل شبه جاف طيلة العام تبدأ النباتات البرية بالإنبات بعد سقوط الدفعة الغزيرة الأولى من الأمطار، خلال شهري مارس وأبريل من كل عام، وللدفعة الغزيرة الثانية من الأمطار والتي تسقط بين شهري يوليو وأغسطس دوراً متواضعاً في عملية الإنبات والنمو. أهم نباتات المنطقة تلك التي تسلك سلوك حولي - ثنائي الحول - معمر، حسب كمية الرطوبة المتوفرة في التربة. فكلما طال فترة توفر الماء في التربة كلما طال عمر الإنبات. تبدي النباتات المعمرة أنماطاً مختلفة من النمو، فالكثير منها يفقد الجزء الظاهري خلال فترة الجفاف، والقليل ينمو بشكل شجيرات أو أشجار دائمة الخضرة. يسود النمو الخضري وتكوين الأزهار والثمار بين مارس ونوفمبر، وينخفض النمو إلى أدنى معدلاته خلال فصل الشتاء بين ديسمبر وفبراير. تزهر وتثمر النباتات لفترات طويلة من السنة بسبب اعتدال درجات الحرارة.

Key Words : Plant phenology, Growth form, Arid Environments, Sana'a, Republic of Yemen.

ABSTRACT

In the cool semi-arid highland areas of Sana'a a plant phenological study of forty two species revealed that there was one major outburst of plant emergence corresponding with the first period of the heavy rainfall which take place during March-April. The second period of heavy rainfall which takes place during July-August shows moderate effect on emergence and growth.

Plant Species included annuals, biennials and perennials. Perennials showed the following growth forms: hemicryptophytes, chamaephytes, phanerophytes, and cryptophytes. Most plants were herbaceous and a few were woody.

Different Individuals of the same species could behave as annuals, biennials or perennials. In areas where soil moisture lasted for a short period plants behaved as annuals, and in areas where moisture lasted for longer periods the plants behaved as biennials or perennials. The prolonged period of leafing, flowering and fruiting experienced by most species also was caused by the moderate temperature which prevailed during the year.

Leafing, flowering, and fruiting periods varied among species. However, they prevailed from March to November. Growth of most species was minimal during winter. Most of the species were growing in upright forms, and a few grew in prostrate and rosette forms.

INTRODUCTION

A series of publications on the vegetation of the neighbouring highlands of southwestern region of Saudi Arabia were found to be of value in the course of this study. A number of articles written by the author and various collaborators on plant ecology were very helpful in the process of conducting this project. Such articles included the followings: Abdulfatih (1, 2, 3, 4, 5, 6), Abdulfatih and Emara (7), Abdulfatih, Emara and Hashish (8), Abdulfatih and Nasher (9), Al-Shihri and Abdulfatih (10) and Alwadi and Abdulfatih (11). Publications of other authors were also helpful in executing this project. Madaville (12), and Boulods (13) provided a list of common plant species found over the neighbouring high mountains of Asir; Chaudhary and El-Sheikh (14) recorded a list of plant species found on the Raidah escarpment which is located west of Abha; Brook and Mandil (15) discuss the role of slope aspect on the distribution of Juniper trees and the common associated species; Frey and Kurschner (16) and Kurschner (17) evaluated the distribution of bryophytes on the Asir mountains. General information on the flora and vegetation of southwestern Saudi Arabia).

A number of publications concerning the vegetation and flora of the Republic of Yemen were also of great assistance in the process of orientation of the subject material of this article. Among such publications are those written by Schwartz (24), Lavranos (25), Hepper (26), Newton (27), Chaudhary and Revri (28), Al-Hubaishi and Muller-Hohenstein (29), Al-Khuleidi et al. (30), Scholte, et al. (31), Gabali (32) and Abdulfatih (33). Sewage microorganisms was surveyed by Nasher et al. (34).

Information concerning the climatic conditions of the Sana'a area were extracted from the Statistical Year Book for the years 1975-1987 (35).

In the present study, an attempt has been made to describe the plant phenology and growth forms of the common plants, in the Sana'a area, throughout the year. Climatic information was used to facilitate understanding of plant development and phenology.

MATERIALS AND METHODS

The influence of the weather changes on the plant phenology and growth forms have been observed over a

period of one year in the Sana'a area, in the Republic of Yemen. Forty two randomly chosen wild species have been observed constantly to evaluate their phenology and growth forms. Ten individuals of each species were marked and their phenological changes were observed every month. During the monthly visits made to the field information concerning the following parameters were recorded: annual, biennial, perennial, herbaceous, woody, leafing, flowering, fruiting, emergence time, hemicryptophyte, chamaephyte, phanerophyte, cryptophyte, and plant crown forms.

CLIMATE

Climatic data for the period of 1975-1987 were extracted from the annual publications of the Statistical Year Book [34]. Sana'a is located between 44° 14' and 44° 09' eastern longitude, 15° 18' and 15° 15' northern latitude. The climate of Sana'a, the capital of the Republic of Yemen (Fig. 1), which is located at 2360 m above sea level, is affected by the prevailing south westerly wind and the monsoon rains which fall at two major periods the first in spring (March-April), and the second in summer (July-August), accordingly initiating two plant growing seasons. Rainfall is commonly characterised by erratic heavy showers which last for short time, and take place mostly around sunset.

Average annual rainfall is about 200 mm. Rain water usually does not stay on the ground surface for very long. Rain water either penetrates deep through the soil to enrich the ground water, or moves on the ground surface through wadis (temporary water ways). Mean monthly temperature is 22°C during the warmest month (July) and 14°C during the coolest months (January and December). Under such moderate semi-arid conditions it seems that rainfall is the limiting factor in controlling plant growth in the Sana'a area. Vegetation is most common in places of relatively high water content. Such places are either wadi basins, depressions, water ways, or flood plains.

RESULTS AND DISCUSSION

Sana'a (2360 m) is considered as a cool semi-arid area, and its plant cover is sparse and of low stature because of low rainfall (about 200mm per year). Sana'a soil is mostly sandy

or sandy loam mixed with various sizes of volcanic rocks. The soil is disturbed by the effect of human activities and urbanisation in most places around Sana'a. The research revealed that there was one major outburst of plant growth during the year, in spring, between March and April. Such an outburst of plant growth is triggered mainly by the effect of rainfall (Fig. 1).

Seedlings of most species were frequent between March and April. Plants showed various growth strategies. Plant life span analysis showed that annuals and biennials were the most common plants, followed by perennials (Table 1). Annuals were represented by *Echium longifolium*, *Malva parviflora*, *Oxalis corniculata*, *Rumex vesicarius*, *Tribulus terrestris* and *Zygophyllum simplex*.

Different Individuals of the same species behaved as annuals, biennial or perennials (Table 1). In areas where soil moisture lasted for a short period plants behaved as annuals, while in areas where moisture lasted for a longer period the plants behaved as biennials or perennials. These species included *Aerva javonica*, *Cenchrus ciliaris*, *Convolvulus arevensis*, *Echinops sp.*, *Fagonia indica*, *Francoeria crispa*, *Peganum harmala*, *Salsola botaie*, *Solanum sepicula*, *Tagetes minuta*, and *Xanthium spinosa*. The undaughtedly perennial plants were represented by

Abutilon bidentatum, *Acacia sp.*, *Calotropis procera*, *Cenchrus ciliaris*, *Commicarpus grandiflorus*, *Datura innoxia*, *Dipcadi virule*, *Gonphocarpus sinaicus*, *Ochradenus baccatus*, *Pennisetum setaceum*, *Ricinus communis*, *Themeda triandra*, *Withania somnifera*.

Among the randomly chosen forty two species in this study many grew upright, a few grew prostrate, and one in a rosette form. Plant species were mostly annuals, biennials, hemicryptophytes (which loses its aerial part at the end of the growing season) and chamaephytes (shrubs). Phanerophytes (trees) were few, and there was only one cryptophyte (bulbous plant). Most plants were herbaceous and a few were woody (Table 1).

The majority of the species showed prolonged periods of leafing, flowering and fruiting as a result of the moderate temperature which prevailed in the area (Table 2). Flowering of most plants was common from spring to summer (May-November). Certain plants were seen flowering throughout the year but with lesser degree in winter. These plants include *Aerva javonica*, *Commicarpus grandiflorus*, *Fagonia indica*, *Francoeria crispa*, *Osteospermum vaillantii*, *Ricinus communis*, and *Tagetes minuta*. Leafing, flowering, and fruiting were minimal during the cold period, from December to February.

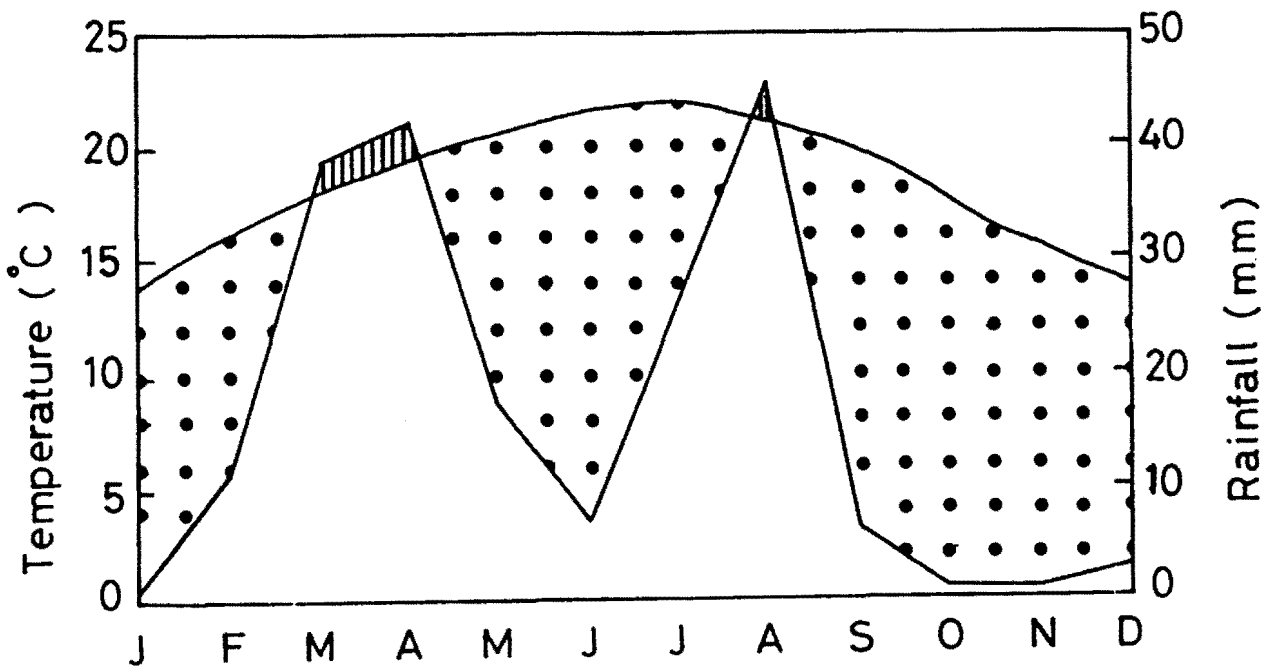


Figure 1. Climatic diagra for Sana'a (at 2360m). Graphs were based on information extracted from meteorological data of Sana'a for the period 1975 - 1987 .

Table 1. Plant growth and crown forms. A: annual, B: biennial, P: perennial, E: hemicryptophyte, CH: chamaephyte, PH: phanerophyte, CR: cryptophyte, H: herbaceous, W: woody, U: upright, S: prostrate, R: rosette

Species	A	B	P	HE	CH	PH	CR	H	W	U	S	R
<i>Abutilon bidentatum</i>			+		+			+		+		
<i>Acacia sp.</i>			+			+			+	+		
<i>Aerva javanica</i>	+	+	+	+				+		+		
<i>Altenanthera pungens</i>			+	+				+			+	
<i>Argemone mexicana</i>	+	+		+	+			+		+		
<i>Calotropis procera</i>			+			+			+	+		
<i>Caylusea hexagyna</i>	+	+				+				+		
<i>Cenchrus ciliaris</i>			+	+				+		+		
<i>Centaurea pseudosinaica</i>	+	+			+			+		+		
<i>Chenopodium chaderianum</i>	+				+			+		+		
<i>Citrullus colocynthis</i>	+	+			+			+			+	
<i>Commicarpus grandiflorum</i>			+		+			+		+		
<i>Convolvulus arvensis</i>	+	+	+	+				+			+	
<i>Datura innoxia</i>			+		+			+		+		
<i>Dipcadi virule</i>			+				+	+				+
<i>Echinops sp.</i>	+	+	+	+				+		+		
<i>Echium longifolium</i>	+							+		+		
<i>Fagonia indica</i>	+	+	+	+				+		+		
<i>Francoeria crispa</i>	+	+	+		+			+		+		
<i>Gomphocarpus sinaicus</i>			+		+			+		+		
<i>Heliotropium ramosissimum</i>	+	+			+			+			+	
<i>Indigofera arabica</i>	+	+	+	+				+		+		
<i>Leucas inflata</i>	+			+				+		+		
<i>Malva parviflora</i>	+							+			+	
<i>Ochradenus baccatus</i>			+		+			+		+		
<i>Onopordon heterocarthus</i>	+	+						+		+		
<i>Osteospermum vaillantii</i>	+	+	+		+			+		+		
<i>Oxalis corniculata</i>	+							+		+		
<i>Peganum harmala</i>	+	+	+		+			+		+		
<i>Pennisetum setaceum</i>			+	+				+		+		
<i>Ricinum communis</i>			+			+			+	+		
<i>Rumex vesicarius</i>	+							+		+		
<i>Salsola bottae</i>	+	+						+		+		
<i>Solanum incanum</i>	+	+	+		+				+	+		
<i>Solanum nigrum</i>	+	+	+	+				+		+		
<i>Solanum sepicula</i>	+	+	+		+				+	+		
<i>Tagetes minuta</i>	+	+	+	+				+		+		
<i>Themada triandra</i>			+	+				+			+	
<i>Tribulus terrestris</i>	+							+			+	
<i>Withania somnifera</i>			+		+				+	+		
<i>Xanthium spinosum</i>	+	+						+		+		
<i>Zygophyllum simplex</i>	+							+			+	

Table 2. Plant phenology showing leafing, flowering, and fruiting stages of the common species found in Sana'a. Leafing (lower bars), flowering (middle bars), fruiting (upper bars).

SPECIES	MONTHS											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Abutilon bidentatum</i>												
<i>Acacia sp.</i>												
<i>Aerva javanica</i>												
<i>Altenanthera pungens</i>												
<i>Argemone mexicana</i>												
<i>Calotropis procera</i>												
<i>Caylusea hexagyna</i>												
<i>Cenchrus ciliaris</i>												
<i>Centaurea pseudosinaica</i>												
<i>Chenopodium chaderianum</i>												
<i>Citrullus colocynthis</i>												
<i>Commicarpus grandiflorum</i>												
<i>Convolvulus arvensis</i>												
<i>Datura innoxia</i>												
<i>Dipcadi virule</i>												
<i>Echinops sp.</i>												
<i>Echium longifolium</i>												
<i>Fagonia indica</i>												
<i>Francoeria crispa</i>												
<i>Gomphocarpus sinaicus</i>												
<i>Heliotropium ramosissimum</i>												

Table 2. Continued.

SPECIES	MONTHS											
	J	F	M	A	M	J	J	A	S	O	N	D
<i>Indigofera arabica</i>												
<i>Leucas inflata</i>												
<i>Malva parviflora</i>												
<i>Ochradenus baccatus</i>												
<i>Onopordon heterocarthus</i>												
<i>Osteospermum vaillantii</i>												
<i>Oxalis corniculata</i>												
<i>Peganum harmala</i>												
<i>Pennisetum setaceum</i>												
<i>Ricinum communis</i>												
<i>Rumex vesicarius</i>												
<i>Salsola bottae</i>												
<i>Solanum incanum</i>												
<i>Solanum nigrum</i>												
<i>Solanum sepicula</i>												
<i>Tagetes minuta</i>												
<i>Themada triandra</i>												
<i>Tribulus terrestris</i>												
<i>Withania somnifera</i>												
<i>Xanthium spinosum</i>												
<i>Zygophyllum simplex</i>												

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