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THE STUDY OF HORTICULTURAL ATTRIBUTES OF SELECTED MEDICINAL PLANTS OF KHANPUR VALLEY IN THE SUB HIMALAYAN MOUNTAINS OF PAKISTAN

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ABSTRACT

Data was recorded on plant height, leaves plant^{-1}, stem diameter, leaf dry weight, plants meter^{-2}, yield plant^{-1}, yield meter^{-2} and yield hectare^{-1} for three selected medicinal plants of Khanpur valley (*Adhatodavasica, Calotropisprocera and Recinuscommunis)* at their natural habitats at four selected sites and two seasons during 2013. Significant effects were observed at different seasons and sites upon various horticultural attributes of all three medicinal plants. *Adhatodavasica* showed significantly higher values for plants meter^{-2} (0.18) at Mang during summer, yield meter^{-2} (10.28g) at Mang during summer and yield hectare (102.76kg) at Mang during summer. *Recinuscommunis* revealed higher values for yield hectare (248.82kg) at Mang during summer followed by Dam site during summer (220.55kg). *Calotropisprocera* revealed higher values for yield hectare (530.02kg) at Mang during summer followed by Dabola site during summer (367.67kg). It was concluded that medicinal plants under study gave maximum yield during summer (last week of July) showed maximum yield at Mang site. Therefore, medicinal plants may be collected during last week of July for best yield.

Key words: Horticultural attributes, medicinal plants, Khanpur valley.

INTRODUCTION

Since ancient times, people have collected flora and fauna for their existence and wellbeing. Principal examples are herbs, mushrooms, fruits, edible nuts, spices, fodder, gums, fibers used in the making of shelters, food, feed, cosmetics, cloths, utensils, medicines and social uses. Currently, worldwide, especially in developing countries, hundreds of millions of people, depend for a major part of their daily needs and economic benefits, on plant and animal products (Walter, 2001).

Quantitative information on the morphological and yield performance of medicinal herbs in nursery (Bargali, 1997; Karikanthimath *et al.* 1997) as well as in natural habitats (Chauhan *et al.* 1997) are plenty in literature. However, when we look at the flora of Himalayan Mountains the recorded information on the medicinal plants is too little to be considered. Rather the quantitative information on growth performance of medicinal flora of Pakistan has gained very little attention. Quantitative analysis in terms of horticultural attributes can contribute towards understanding of the actual yield of the medicinally important part of plant and its sustainable collection without damaging the invaluable flora, indigenous to the valleys of Pakistan. The current study was undertaken to gauge the growth performance of three most important medicinal plants of Khanpur valley with the following objectives:

1. To determine the annual yield for sustainable harvest of the selected medicinal plant species.
2. To find out the comparative suitability of seasons and sites for the growth and yield ofthree selected medicinal plants.

MATERIALS AND METHODS

The experiment was conducted during 2013. Three medicinal shrubs were selected for horticultural studies at their natural habitat. Through quadrate transact method, three transacts (replications) were taken and in every transact data on horticultural attributes was recorded on the plants at their natural habitat at all the four sites:

Dam Site: Itis situated in the center of the valley with a beautiful lake (Khanpur Dam) which is located at longitude 725552.38E and latitude 334845.87N with an altitude of 1940 feet.

Dabola Site: This site of Khanpur valley is located at longitude 730433.36E and latitude 334950.73N with an altitude of 3940 feet.

Jabri Site: Itis situated at the north-east of the Khanpur valley. Jabri is located at longitude 731008.98E and latitude 335411.69N with an altitude of 3120 feet.

Mang Site: Itis situated at north-west of the Khanpur valley. Mang is located at longitude 725449.24E and latitude 335421.12N with an altitude of 1885 feet.

The horticultural parameters were measured and data were collected during summer (April-September) and winter (October-March) at different specified periods as below:

1. *Adhatodavasica* Last week of July and last week of December.
2. *Calotropisprocera* Last week of July and last week of December.
3. *Recenuscommunis* Last week of July and last week of December.

Study Parameters: The horticultural attributes were studied with the help of the following parameters.

1. **Plant height** (cm)

Plant height of the six selected medicinal species was measured with a standard ruler in cm. The average height of ten randomly selected plants was recorded, from each site in both seasons.

2. **Leaf dry weight** (g)

Leaves were excised with the help of cutter, dried with electric drier and weighed on electronic balance in grams. Leaf weight of the selected medicinal plants was calculated by taking the average of ten randomly selected leaves in the available plants, for all sites in both seasons.

3. **Number of leaves plant^{-1}**

Number of leaves per plant was calculated by taking the average of number of leaves of ten randomly selected plants, in four sites in both seasons.

4. **Stem diameter** (cm)

Stem diameter was measured with the help of standard ruler. Average stem diameter of ten randomly selected plants was recorded for all sites and both seasons.

5. **Number of plants meter^{-2}**

Total number of individuals of a species in a quadrate, were counted in all the quadrates and its average was taken as number of plants per quadrate. Plants per quadrate were then converted to plants meter^2.

6. **Yield plant^{-1}** (Total leaves dry weight) (g).

Ten randomly selected plants of each medicinal species were taken and the single leaf dry weight of each plant was multiplied with the total number of leaves per plant and was taken as yield per plant.

7. **Yield meter^2** (g).

This was calculated with the help of the following formula:

Yield per meter^{-2} = number of plants per meter^2 × yield per plant

8. **Yield hectare^{-1}** (kg)

This was calculated with the help of the following formula:

Yield per hectare = yield per meter^2 (g) × 10000/1000.

Statistical Analysis: The data on horticultural parameters were analyzed by using the statistical software "Statistics-8.1", using linear model and general ANOVA with specific AOV model statement. The mean data, for factors and their interactions, were compared by using LSD at 0.05.

RESULTS

Results on all parameters for *Adhatodavasica*, *Recinuscommunis* and *Calotropisprocera*are shown in table-1, table-2 and table-3 respectively.

Table-1 Effect of Different Seasons and Sites on Horticultural Parameters of *Adhatodavasica*.

Seasons	Plant Height (cm)	Leaves Plant^{-1}	Stem Diameter (cm)	Leaf Dry Weight (g)	Plants Meter^{-2}	Yield Plant^{-1} (g)	Yield Meter-$^{-2}$ (g)	Yield Ha^{-1} (kg)
Summer	130.82a	238.75a	3.81	0.2183	0.13	51.90a	6.86a	68.58a
Winter	92.96b	170.15b	3.84	0.2058	0.12	34.80b	4.19b	41.92b
Significance level	*	*	ns	ns	Ns	*	*	*
Sites								
Dam	116.75	205.00	3.87	0.2233	0.14b	45.50	6.52b	65.22b
Dabola	106.45	197.00	3.75	0.2150	0.11c	42.13	4.64c	46.38c
Jabri	103.10	188.43	3.83	0.2067	0.07d	39.62	2.84d	28.41d
Mang	121.25	227.63	3.85	0.2033	0.17a	46.12	8.10a	80.98a
LSD at α 0.05	ns	ns	ns	ns	0.0202	ns	1.3815	13.822
Interactions								
Seasons*Sites	ns	ns	ns	ns	*	ns	*	*

Means followed by similar letter(s) in column do not differ significantly.
ns = Non-Significant. * = Significant at 5 % level of probability.

Table-2 Effect of Different Seasons and Sites on Horticultural Parameters of *Recinuscommunis*.

Seasons	Plant Height (cm)	Leaves Plant^{-1}	Stem Diameter (cm)	Leaf Dry Weight (g)	Plants Meter^{-2}	Yield Plant^{-1} (g)	Yield Meter-$^{-2}$ (g)	Yield Ha^{-1} (kg)
Summer	271.67a	308.00a	3.89	2.12b	0.03	616.93a	18.35a	183.55a
Winter	240.93b	202.17b	3.88	2.39a	0.03	477.70b	13.20b	132.04b
Significance level	*	*	ns	*	ns	*	*	*
Sites								
Dam	284.67a	272.83	4.03	2.11	0.04a	572.70a	20.07a	200.72a
Dabola	274.33a	259.50	3.97	2.12	0.02c	533.32b	9.42c	94.26c
Jabri	193.67b	241.17	3.58	2.20	0.03b	513.88b	13.29b	132.95b
Mang	272.53a	246.83	3.97	2.37	0.04a	571.37a	20.32a	203.25a
LSD at α 0.05	35.56	ns	ns	ns	0.0066	34.120	3.1586	31.587
Interactions								
Seasons*Sites	ns	ns	ns	ns	ns	ns	ns	ns

Means followed by similar letter(s) in column do not differ significantly.
ns = Non-Significant. * = Significant at 5 % level of probability.

Table-3 Effect of Different Seasons and Sites on Horticultural Parameters of *Calotropisprocera*.

Seasons	Plant Height (cm)	Leaves Plant^{-1}	Stem Diameter (cm)	Leaf Dry Weight (g)	Plants Meter^{-2}	Yield Plant^{-1} (g)	Yield Meter-$^{-2}$ (g)	Yield Ha^{-1} (kg)
Summer	98.27a	102.17a	1.93b	0.1776b	0.90a	42.73a	38.77a	387.65a
Winter	57.73b	69.92b	2.39a	0.2115a	0.63b	34.42b	21.77b	217.71b
Significance level	*	*	*	*	*	*	*	*
Sites								
Dam	87.00a	99.00a	2.32	0.1732b	0.67b	39.85b	26.74bb2	267.43b
Dabola	71.02b	81.33b	2.10	0.1891b	0.77ab	36.13c	7.99b	279.93b
Jabri	65.40b	68.00c	2.05	0.2209a	0.72b	34.62c	25.52b	255.16b
Mang	88.59a	95.83a	2.18	0.1950ab	0.91a	43.72a	40.82a	408.19a
LSD at α 0.05	16.101	11.914	ns	0.0295	0.1203	3.9888	4.2916	42.923
Interactions								
Seasons*Sites	ns	ns	ns	ns	ns	ns	ns	ns

Means followed by similar letter(s) in column do not differ significantly.
ns = Non-Significant. * = Significant at 5 % level of probability.

1. Plant Height (cm): The results revealed that the effect of seasons on plant height of *Adhatodavasica*, was significant while the effect of sites and that of their interactions was non-significant.Maximum plant height was observed at summer (130.82cm) while minimum at winter (92.96cm).

Plant height of *Recinuscommunis* was significantly higher at summer (271.67cm) andlower at winter (240.93cm) while maximum plant height was observed at Dam site (284.67cm) while least of it was found at Jabri site (193.67cm).*Calotropisprocera* was observed with maximum plant height at summer (98.27cm) while minimum at winter (57.73cm). Similarly maximum plant height was observed at Mang site (88.59cm) while minimum at Jabri site (65.40cm).

2. Number of leaves plant^{-1}: The findings revealed that the impact of seasons on number of leaves plant^{-1}of *Adhatodavasica* was significantly higher at summer (238.75) while minimum at winter (170.15). Similarly, *Recinuscommunis* was observed with maximum number of leaves plant^{-1} at summer (308.00) while minimum at winter (202.17). In case of *Calotropisprocera*, effect of seasons and sites on number of leaves plant^{-1} was significant while the effect of their interactions was non-significant.Higher number of leaves plant^{-1} was observed at summer (102.17) while lower at winter (69.92). Similarly maximum number of leaves plant^{-1} was observed at Dam site (99.00) while minimum of it was found at Jabri site (68.00).

3. Stem Diameter (cm): The results discovered that the effect of seasons, sites and their interactions on stem diameter of *Adhatodavasica* and *Recinuscommunis* was non-significant, while *Calotropisprocera* showed significantly higher stem diameter at winter (2.39cm) than at summer (1.93cm).

4. Leaf Dry Weight (gm): The results on leaf dry weight of *Adhatodavasica* for various seasons and sites, revealed that the effect of seasons, sites and their interactions on leaf dry weight was non-significant, while *Recinuscommunis* revealed higher values for leaf dry weight at winter (2.93g) while lower at summer (2.12g). The mean data on leaf dry weight of *Calotropisprocera* for various seasons and sites reflects that maximum leaf dry weight was observed at winter (0.211g) while minimum at summer (0.177g). Similarly maximum leaf dry weight was observed at Jabri site (0.221g) while minimum of it was found at Dam site (0.173g).

5. Plants Meter^{-2}: The findings on plants meter^{-2}of *Adhatodavasica* revealed that maximum number of plants meter^{-2} was observed at Mang site during summer (0.1833) while minimum plants meter^{-2} was observed at Jabri site during summer (0.0700).

Recinuscommunis was found with highest result at Dam and Mang sites (0.04) followed by Jabri site (0.03) while minimum of it was found at Dabola site (0.02). Highest number of plants meter^{-2} for *Calotropisprocera* was observed at summer (0.90) while lowest at winter (0.63). Similarly maximum number of plants meter^{-2} was observed at Mang site (0.91) while minimum was observed at Dam site (0.67).

6. Yield Plant^{-1} (g):3: The results revealed that the effect of seasons on yield plant^{-1}of *Adhatodavasica* was significant while the effect sites and that of their interactions was non-significant.Maximum yield plant^{-1} was observed at summer (51.90g) while minimum at winter (34.80g).

The results on yield plant^{-1}of *Recinuscommunis* for various seasons and sites, revealed that maximum yield plant^{-1} was observed at summer (616.93g) while minimum at winter (477.70g). Similarly maximum yield plant^{-1} was observed at Dam site (572.70g)while minimum at Jabri site (513.88g). In case of *Calotropisprocera* maximum yield plant^{-1} was observed at summer (42.73g) while minimum at winter (34.42g). Similarly maximum number of yield plant^{-1} was observed at Mang site (43.72g) while minimum of it was recorded at Jabri site (34.62g).

7. Yield Meter^{-2} (g): The mean data on yield meterт$^{-2}$of *Adhatodavasica* discovered that the effect of seasons, sites and their interactions on yield meter^{-2} was significant.Highest yield meter^{-2} was found at Mang site during summer (10.277g) followed by Dam site during summer (8.570g) while minimum plants meter^{-2} was observed at Jabri site during winter (2.327g).

Recinuscommunis was observed with significantly higher yield meter^{-2} at summer (18.35g) while lowest at winter (13.20g). Similarly it was observed maximum at Mang site (20.32g) while minimum at Dabola site (9.42g). The data recorded on *Calotropisprocera* revealed that significantly higher yield meter^{-2} was observed at summer (38.77g) while minimum at winter (21.77g). Similarly maximum yield meter^{-2} was observed at Mang site (40.82g) while minimum of it was recorded at Jabri site (25.52g).

8. Yield Hectare^{-1} (kg): The results revealed that the impact of seasons, sites and their interactions on yield hectare^{-1}of *Adhatodavasica* was significant. Maximum yield hectare^{-1} was observed at Mang site during summer (102.76kg) followed by Dam site during summer (85.71kg) while minimum yield hectare^{-1} was observed at Jabri site during winter (23.30kg).

The mean data on yield hectare^{-1}of *Recinuscommunis* was observed higher at summer (183.55kg) while least at winter (132.04kg). Similarly maximum yield plant^{-1} was observed at Mang site (203.25kg) followed by Dam site (200.72kg) while minimum of it was found at Dabola site (94.26kg). While *Calotropisprocera* showed maximum yield hectare^{-1} at summer (387.65kg), while minimum at winter (217.71kg). Similarly maximum number of yield plant^{-1} was observed at Mang site (408.19kg) while minimum of it was found at Jabri site (255.16kg).

DISCUSSION

It is evident from the results that the plants performed best during summer. The obvious reason for these results can be the availability of required light, temperature, water and nutrients during summer. In *Adhatodavasica*, *Recinuscommunis* and *Calotropisprocera*, which are evergreen shrubs, the summer rains and high water availability to plants might be conducive for enhanced yield and yield related parameters as mentioned by Krishnan *et al.* (2000). Similar results were obtained by Sher *et al.* (2010), who concluded that summer temperature boost growth and yield of plant species. Similarly, Liu *et al.*(2014), stated that plants accumulated maximum bio-chemical compounds in summer to grow at higher rate and accumulate biomass at an increased rate.

The sites comparison revealed that maximum plant height, plants meter^{-2}, yield plant, yield meter^{-2} and yield hectare^{-1} were recorded at Mang and Dam sites while its minimum values were observed at Jabri and Dabola sites. One possible reason for this variation could be affiliated with the topography of the site which affect the productivity directly (Lamrani *et al.* 2014). Krishnan

et al. (2000) contended that it was the altitude which affected the growth and performance of plants. Mang site with low altitude and dry hot climate and rough terrain was suitable for the natural growth and abundance of *Adhatodavasica*, *Recinuscommunis* and *Calotropisprocera*. The lowest performance at Jabri site might be due its high altitude and low temperature during winter. In connivance with these findings, Liu *et al.*(2014) discovered that plant density and abundance depend on the climate and topography of sites. Mang and Dam sites with dry hot climate and hilly rough terrain might be suitable for the growth of these plants while its growth was retarded by the cool climate and high altitude of Jabri and Dabola. It is due to the fact that growth and growth related parameters are directly related to the soil and climatic conditions of the site (Kane *et al*. 2014). The Precipitation intensity and water availability at sites might have triggered photosynthesis and affected growth performance (Samuelson *et al.* 2014).

With the increased realization that some wild species are being over-exploited, a number of scientists are recommending that wild species must be brought into cultivation systems (WHO 1993; Lambert *et al*. 1997).

Conclusions and Recommendations: Growth geometry of medicinal plants at natural habitats, which is an important and novel aspect, was studied for the first time ever in the history of research on plant sciences in the Himalayan region of Pakistan.

It was concluded that medicinal plants under study gave maximum leaves yield during summer (last week of July). All three of the medicinal plant species *A.vasica, C.procera and R.communis* showed maximum yield at Mang site followed by Dam site. So, the leaves of these medicinal plants may be collected during last week of July for best yield.

The following conclusions weredrawn

1. *A. vasica*, *C. procera* and *R. communis* may be better harvested during the last week of July than December.
2. It was observed that summer season was the best period for collecting the leaves to get maximum yield.
3. The three woody medicinal plant species *A. vasica, C. procera* and *R. communis* were found with higher yield per hectare at Mang and Dam sites.

Following are some of the recommendations derived, after thorough consideration, from the study and based on the research findings;

- It is strongly recommended that while collecting the medicinal raw material from the indigenous flora, guidelines regarding appropriate season and site must be followed. Like the last week of July, for *A. vasica*, *C. procera* and *R. communis*is the most appropriate time for harvesting.
- Where conservation of medicinal plant species in nature is not possible these may be brought into cultivation at nursery and be conserved.
- Sustainable harvesting is the best policy to make the requirements fulfilled without any damage to the flora of these valleys. The farmers or anyone who is interested in the collection of medicinal plants must have the knowledge of the spatio-temporal existence of these plants.

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