

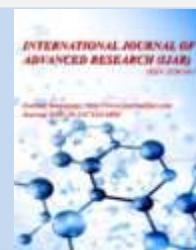


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RESEARCH ARTICLE

A STUDY ON CORRELATION AND ASSOCIATION OF CHARACTERS OF *EXACUM TETRAGONUM* ROXB. IN NORTH KERALA, INDIA

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Abstract

Western Ghats provide asylum to several endemic plants. *Exacum tetragonum* Roxb. is one of the important endemic herbs inhabiting the hilly tracts and midlands of Kerala, the state of India located towards the south-western side of the Western Ghats. The plant is used for treating fever, stomach disorders, gout, diabetics, and eye diseases. It is also found associated with antioxidant, anti-inflammatory, anti-helminthic and anti-hyperglycemic activities. Correlation and association of characters of this important medicinal plant was analyzed based on the observations on thirteen salient morphological characters recorded from twenty three populations of the species distributed across Malappuram, Thrissur, Kozhikode and Palakkad Districts of Kerala State of India. All the characters studied such as plant height, number of leaves, number of flowers, number of inflorescences, leaf length, leaf breadth, peduncle length, pedicel length, internodal length, leaf area, mean stem girth, number of branches and fresh weight of plants showed statistically significant variations between the populations. Number of flowers showed significant positive correlation with the maximum number of characters (ten characters) whereas number of leaves showed significant positive correlation with the minimum number of characters (two characters). By factor analysis, two factors could be extracted and fresh weight of plant was found to be the lead character. Significant variability with regard to morphological characters indicates the strong genetic base of the plant species in the field. However, drastic changes in its habitat for various reasons can certainly cause severe threats to its continued existence and hence appropriate actions to conserve the natural habitats of this species are vital.

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Introduction:-

Exacum tetragonum is a herbaceous medicinal plant with bicoloured petals and it comes under the family Gentianaceae. Its natural habitat is tropical moist grassy forests. The species is widespread in Indomalaysia and reaches the extreme north of Australia (Yuan *et al.*, 2005). About three to four decades ago, the plant was seen abundantly in different parts of Kerala. The plant is not amenable to propagation in gardens. The plant is known as *kannanthali* in Malayalam and Persian blue violet in English (Sreelatha *et al.*, 2007). It is regarded as a promising

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anti-oxidant, thrombolytic and anti-inflammatory agent (Ashwini *et al.*, 2015). It contains various phytochemicals such as phenols, saponins, flavonoids and alkaloids. Naga people have been using *Exacum tetragonum* against malaria fever since long (Rao, 1983). The plant is used as an antidiabetic herb in Kerala (Sreelatha *et al.*, 2007). In Khao Kho District of Thailand the species is considered as a valuable medicinal herb (Chuakul, 2000). Roots of *Exacum tetragonum* contain a colouring matter and hence it is used in alcoholic drinks in Germany and Switzerland (Torfida, 1944). Whole plant is used as tonic and stomachic by Ambalabe rural community (Vinayaka *et al.*, 2016). Decoction of leaves and bark of *Exacum tetragonum* is used by Angami Nagas for curing malarial fever (Rao, 1983). It is widely used for curing human ailments like diabetes, malaria, skin disorders, fungal diseases and inflammation (Marles and Farnsworth, 1995).

The species is seen limited to small pocket areas even in vast stretches of grassland. This unique feature accompanied by the drastic social changes has subjected the plant to the threat of extinction (Sreelatha *et al.*, 2007). The forest ecosystems of Western Ghats are under severe threat due to a variety of reasons. Understanding the genetics and interrelationship of the quantitative characters of such plants is an important step towards developing strategies for conservation. Hence the present study has been carried out to analyze the correlation and association of characters of *Exacum tetragonum* based on thirteen morphological characters (Table 1).

Materials and Methods:-

Twenty three natural populations of the plant were located at different parts of Malappuram, Thrissur, Kozhikode and Palakkad Districts of Kerala State of India during August-November 2018. The populations were frequently visited to assess their growth and when the plants matured and flowered, twelve plants were collected at random from each population so as to represent intrapopulational variability appropriately. The collected plants were observed for thirteen quantitative morphological characters. Correlation of these characters was analyzed as suggested by Rangaswami (1995). Study of association of characters was carried out to group the characters based on their relationship and also to find out the lead characters in each group. Study of character association of *Exacum tetragonum* was carried out using principal component analysis with the help of the statistical software STATISTICA.

Results and Discussion:-

Most of the growth and yield characters of plants are polygenic in nature. Polygenic systems are complex systems in which alleles located at different loci contribute towards the expression of other related characters also. Hence different levels of interrelationships can be observed between polygenic quantitative characters. The extent of this relationship can be analyzed using correlation analysis. In the present study, plant height showed significant positive correlation with number of flowers, leaf length, peduncle length, pedicel length, internodal length, mean stem girth and fresh weight of plants; number of leaves showed significant positive correlation with leaf length and number of branches; number of flowers showed significant positive correlation with plant height, number of inflorescences, leaf length, peduncle length, pedicel length, internodal length, leaf area, mean stem girth, number of branches and fresh weight of plants; number of inflorescences showed significant positive correlation with number of flowers, leaf length, peduncle length, pedicel length, internodal length, leaf area, mean stem girth and fresh weight of plants; leaf length showed significant positive correlation with plant height, number of flowers, number of inflorescences, leaf breadth, internodal length, leaf area, mean stem girth and fresh weight of plants; leaf breadth showed significant positive correlation with number of leaves, leaf length, leaf area and number of branches; peduncle length showed significant positive correlation with plant height, number of flowers, number of inflorescences, pedicel length, internodal length, mean stem girth and fresh weight of plants; pedicel length showed significant positive correlation with plant height, number of flowers, number of inflorescences, peduncle length, internodal length, mean stem girth and fresh weight of plants; internodal length showed significant positive correlation with plant height, number of flowers, leaf length, peduncle length, pedicel length, leaf area and fresh weight of plants; mean stem girth showed significant positive correlation with plant height, number of flowers, number of inflorescences, leaf length, peduncle length, pedicel length, leaf area and fresh weight of plants; leaf area showed significant positive correlation with number of flowers, number of inflorescences, leaf length, leaf breadth, internodal length, mean stem girth and fresh weight of plants; number of branches showed significant positive correlation with number of leaves, number of flowers and leaf breadth; fresh weight of plants showed significant positive correlation with plant height, number of flowers, number of inflorescences, leaf length, peduncle length, pedicel length, internodal length, leaf area and mean stem girth (Tables 2 and 3). Number of flowers showed significant positive correlation with the maximum number of characters (ten characters) whereas number of leaves

showed significant positive correlation with the minimum number of characters (two characters). Characters having interrelationship with the maximum number of characters show high level of gene sharing. Analysis of such interrelationships has been already carried out in other economically important plant species by earlier workers like Sankaran *et al.* (1994) and Priya *et al.* (2012).

Factor analysis of thirteen morphological characters of *Exacum tetragonum* has been studied based on UPGMA method using STATISTICA software. Two factors were extracted from the data based on the relative contribution of the variable towards the variability of the species. Based on factor loading, plant height, number of flowers, numbers of inflorescences, leaf length, peduncle length, pedicel length, internodal length, leaf area, mean stem girth and fresh weight were grouped under factor 1 and number of leaves, leaf breadth and number of branches under factor 2 (Tables 4, 5 and 6).

It can be assumed that there is a sharing of common alleles between plant height, number of flowers, numbers of inflorescences, leaf length, peduncle length, pedicel length, internodal length, leaf area, mean stem girth and fresh weight come under factor 1 and there is a sharing of common alleles between number of leaves, leaf breadth and number of branches under factor 2. In factor 1, fresh weight can be considered the lead character since it shows the maximum factor loading.

Grouping of variables can be used as a tool in selection programmes in future when commercialization of medicinal plant production may necessitate development of improved strains. Factor analysis has been used to group variables in different plants like rubber (Abraham *et al.*, 2002), cardamom (Radhakrishnan *et al.*, 2004) and chillies (Hrideek *et al.*, 2006). Though considerably high field level variability is present in the plant species under study, steps should be taken to conserve its natural habitats from anthropogenic destruction and to augment its genetic base.

Table 1:- Growth and yield characters of *Exacum tetragonum* studied.

Sl. No.	Character	Mean \pm SE	CD (5%)	CV (%)
1	Plant height (cm)	52.89 \pm 3.23	9.25	30.99
2	Number of leaves	21.63 \pm 1.61	5.31	24.64
3	Number of flowers	24.66 \pm 3.07	9.09	41.36
4	Number of inflorescences	4.96 \pm 0.55	1.69	39.52
5	Leaf length (cm)	5.83 \pm 0.27	0.78	19.90
6	Leaf breadth (cm)	1.45 \pm 0.08	0.20	11.72
7	Peduncle length (cm)	3.02 \pm 0.27	0.69	32.45
8	Pedicel length (cm)	1.15 \pm 0.13	0.33	27.83
9	Internodal length (cm)	4.50 \pm 0.21	0.65	25.56
10	Mean stem girth (cm)	1.51 \pm 0.08	0.27	16.67
11	Leaf area (cm ²)	748.90 \pm 62.99	188.04	23.89
12	Number of branches	1.61 \pm 0.04	0.27	39.75
13	Fresh weight (g)	18.62 \pm 1.83	5.41	44.58

Table 2:- *Exacum tetragonum* - Correlation of characters.

	Plant height	Number of leaves	Number of flowers	Number of inflorescences	Leaf length	Leaf breadth	Peduncle length	Pedicel length	Internodal length	Mean stem girth	Leaf area	Number of branches	Fresh weight
Plant height	1												
Number of leaves	0.281477	1											
Number of flowers	0.535445*	-0.10696	1										
Number	0.3	-	0.8374	1									

of inflorescences	330 11	0.186 88	02*										
Leaf length	0.3 555 8*	- 0.028 61	0.6291 34*	0.6607 51*	1								
Leaf breadth	0.2 257 17	0.407 299*	0.0545 91	0.1815 34	0.4 879 63*	1							
Peduncle length	0.7 146 09*	0.078 778	0.6830 15*	0.4630 54*	0.2 675 29	- 0.01 948	1						
Pedicle length	0.5 982 64*	0.206 163	0.5757 55*	0.4779 43*	0.1 793 42	0.15 654 2	0.839 155*	1					
Internodal length	0.8 557 57*	0.277 335	0.3553 8*	0.2651 53	0.3 843 82*	0.32 297 8	0.613 53*	0.60 8787 *	1				
Mean stem girth	0.5 438 45*	0.208 993	0.7857 84*	0.6206 17*	0.4 805 24*	0.21 902 8	0.596 579*	0.68 6809 *	0.347 386	1			
Leaf area	0.3 183 17	0.069 076	0.6248 53*	0.6741 56*	0.9 488 53*	0.65 065 4*	0.278 076	0.26 0057	0.355 828*	0.528 862*	1		
Number of branches	- 0.2 568 5	0.722 18*	- 0.3625 8*	- 0.2481 3	- 0.1 257 5	0.42 319 5*	- 0.324 41	- 0.12 482	- 0.186 06	- 0.013 44	0.0 188 22	1	
Fresh weight	0.6 843 1*	0.176 275	0.8135 38*	0.6543 13*	0.6 289 43*	0.23 835	0.640 205*	0.56 1966 *	0.566 55*	0.811 468*	0.6 171 79*	- 0.1264 9	1

Table 3:- *Exacum tetragonum* – Correlation of characters – Characters correlated.

Characters	Characters showing significant positive correlation
Plant height	Number of flowers, leaf length, peduncle length, pedicle length, intermodal length, mean stem girth and fresh weight
Number of leaves	Leaf length and number of branches
Number of flowers	Plant height, number of inflorescences, leaf length, peduncle length, pedicle length, intermodal length, leaf area, mean stem girth, number of branches and fresh weight
Number of inflorescences	Number of flowers, leaf length, peduncle length, pedicle length, intermodal length, leaf area, mean stem girth and fresh weight
Leaf length	Plant height, number of flowers, number of inflorescences, leaf breadth, intermodal length, leaf area, mean stem girth and fresh weight
Leaf breadth	Number of leaves, leaf length, leaf area and number of branches
Peduncle length	Plant height, number of flowers, number of inflorescences, pedicle length, intermodal length, mean stem girth and fresh weight
Pedicle length	Plant height, number of flowers, number of inflorescences, peduncle length, intermodal length, mean stem girth and fresh weight
Internodal length	Plant height, number of flowers, leaf length, peduncle length, pedicle length, leaf area and fresh weight
Mean stem girth	Plant height, number of flowers, number of inflorescences, leaf length, peduncle length, pedicle length, leaf area and fresh weight
Leaf area	Number of flowers, number of inflorescences, leaf length, leaf breadth, intermodal length, mean stem girth and fresh weight

Number of branches	Number of leaves, number of flowers and leaf breadth
Fresh weight	Plant height, number of flowers, number of inflorescences, leaf length, peduncle length, pedicel length, intermodal length, leaf area and mean stem girth.

Table 4:- Factor analysis of thirteen characters of *Exacum tetragonum*- Eigen values.

Factor	Eigen value	% of total variance	Cumulative Eigen value	Cumulative % of total variance
1	6.275553	48.27348	6.27555	48.27348
2	2.277164	17.51665	8.55272	65.79013

Table 5:-Factor analysis of thirteen characters of *Exacum tetragonum*- Factor Loadings.

Characters	Factor I	Factor II
Plant height	0.763739	-0.002627
Number of leaves	0.138896	-0.799330
Number of flowers	0.875020	0.285939
Number of inflorescences	0.765469	0.193441
Leaf length	0.717046	-0.160003
Leaf breadth	0.354235	-0.750765
Peduncle length	0.772273	0.268638
Pedicel length	0.738038	0.071851
Internodal length	0.685310	-0.108963
Mean stem girth	0.825392	-0.044414
Leaf area	0.732455	-0.301032
Number of branches	-0.213148	-0.864652
Fresh weight	0.898763	-0.019508

Table 6:- Factor analysis – Characters associated with factors.

Factor	Variables
1	Plant height, number of flowers, number of inflorescences, leaf length, peduncle length, pedicel length, intermodal length, leaf area, mean stem girth, fresh weight
2	Number of leaves, leaf breadth, number of branches

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