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Research Note

Phenotypic Plasticity in Turkish *Commelina communis* L. (*Commelinaceae*) Populations

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Abstract: Phenotypic plasticity was investigated in *Commelina communis* L. (*Commelinaceae*), which is a perennial herb native to temperate Asia (China) and widely naturalised in the central and eastern Black Sea regions were investiguted *C. communis* has a relatively high ecological tolerance with respect to climatic and soil factors. It was found that the shoot length, leaf width, number of branches, dead leaves and flowers, root:shoot ratio, total -flower- and root biomasses, flower and root nitrogen and RE_1 and RE_2 varied significantly in among the three populations. In addition, there were statistically important correlations between reproductive effort (RE) values in the three natural populations of *C. communis.* Consequently, it was concluded that *C. communis* has a high phenotypic plasticity.

Key Words: *Commeline communis* L., Pheotypic Plasticity, Reproductive Effort, Soil Factors.

Türkiye'deki *Commelina communis* L. (*Commelinaceae*) Populasyonlarında Fenotipik Pilastisite

Özet: Bu çalışmada ılıman Asya (Çin) için doğal bir çok yıllık otsu bitki olan ve Orta ve Doğu Karadeniz Bölgesinde doğallaşmış olan *Commelina communis* L. (*Commelinaceae*)'nin fenotipik pilastisitesi araştırılmıştır. *C. communis*, iklimsel faktörler ve toprak faktörleri yönünden nisbeten yüksek bir ekolojik toleransa sahiptir. Sürgün uzunluğu, yaprak genişliği, dal, ölü yaprak ve çiçek sayısı, kök:sürgün oranı, toplam biyomas, çiçek ve kök biyoması, çiçek ve kök azotu ve RE_1 ve RE_2 yönünden üç populasyon arasında önemli farklılıklar bulunmşutur. Buna ek olarak üreme çabası (RE) yönünden *C. communis*'in üç doğal populasyonu arasında istatistiksel yönden önemli korelasyonlar vardır. Bu nedenlere bağlı olarak *C. communis*'in geniş bir fenotipik plastisiteye sahip olduğu söylenebilir.

Anahtar Sözcükler: *Commelina communis* L., Fenotipik Plastisite, Üreme Çabası, Toprak Faktörleri

Introduction

Phenotypic plasticity can be defined as the adaptive capability of a plant population under genetic control in response to a changing environment. Plants show considerable character variation and phenotypic plasticity when introduced to different environments. Phenotypic plasticity ensures that a plant adjusts to new environments (1).

Some species can be considerably adaptable to new environments. This can be primarily due to the similarity of ecological conditions, the most important of which are climatic factors. However, the disturbance capacity of individuals and genetically fixed differences in certain traits must also be taken into consideration (2).

Commelina communis L. (*Commelinaceae*) is a perennial herb which is native to temperate Asia (China) and it is widely naturalised in Turkey, especially around the Black Sea region (3). In this study the population structure, phenotypic plasticity and character variation of *C. communis,* which occurs in the central and eastern Black Sea regions, were investigated, and three natural populations of *C. communis*, in which this species is common, were compared in terms of certain morphological and ecological characteristics.

Materials and Methods

C. communis specimens were collected from three natural populations during the generative growth

Table 1. Mean values of morphological parameters

Locality	Parameter	Mean Values (Standart error)
1	Shoot length	21.47 (2.70)
2	Shoot length	36.63 (2.49)
3	Shoot length	55.22 (1.80)
1	Number of nodes	6.00 (0.55)
2	Number of nodes	5.11 (0.55)
3	Number of nodes	6.00 (0.62)
1	Number of branches	2.11 (0.38)
2	Number of branches	2.66 (0.22)
3	Number of branches	3.66 (0.33)
1	Number of living leaves	9.11 (2.25)
2	Number of living leaves	9.22 (1.25)
3	Number of living leaves	12.11 (1.25)
1	Number of dead leaves	1.44 (0.29)
2	Number of dead leaves	1.44 (0.35)
3	Number of dead leaves	3.55 (1.01)
1	Number of flowers	7.00 (1.40)
2	Number of flowers	4.11 (0.46)
3	Number of flowers	7.33 (0.47)
1	Leaf length	7.47 (0.59)
2	Leaf length	6.26 (0.33)
3	Leaf length	6.98 (0.70)
1	Leaf width	1.97 (0.11)
2	Leaf width	1.77 (0.09)
3	Leaf width	2.90 (0.19)
1	Root:shoot ratio	0.39 (0.05)
2	Root:shoot ratio	0.21 (0.01)
3	Root:shoot ratio	0.15 (0.02)

phase (August 1993-August 1995) in order to determine reproductive effort, which is defined as the ratio of reproductive biomass and nitrogen to total plant biomass and nitrogen (4).

Reproductive effort was determined according to following criteria:

RE_1 = flower biomass/above-ground plant biomass,

RE_2 = flower biomass/total plant biomass

RE_3 = flower nitrogen/above-ground plant nitrogen.

RE_4 = flower nitrogen/total plant nitrogen.

The collection sites were as follows, *C. communis* occurring in dense stands in these regions:

1. A6 Samsun: Tekkeköy, degraded *Fraxinus angustifolia* Vahl. subsp. *angustifolia* forest, 20m., Kutbay 1126-1225.

2. A7 Trabzon: Of, degraded *Alnus glutinosa* (L.) Gaertner forest, 100m., Kutbay 1232-1273.

3. A8 Rize: Pazar, Boğazlı Village, degraded *A. glutinosa* florest, 130m., Kutbay 1406-1437.

Table 2. Mean values of plant biomass (g) and plant nitrogen (%).

Locality	Parameter	Mean Values (Standart error)
1	Total biomass	1.14 (0.29)
2	Total biomass	2.42 (0.36)
3	Total biomass	3.45 (0.59)
1	Flower biomass	0.31 (0.02)
2	Flower biomass	0.18 (0.02)
3	Flower biomass	0.37 (0.03)
1	Root biomass	0.43 (0.12)
2	Root biomass	0.38 (0.03)
3	Root biomass	1.43 (0.17)
1	Shoot biomass	0.19 (0.02)
2	Shoot biomass	0.25 (0.02)
3	Shoot biomass	0.27 (0.03)
1	Leaf nitrogen	0.46 (0.04)
2	Leaf nitrogen	0.56 (0.28)
3	Leaf nitrogen	1.06 (0.54)
1	Flower nitrogen	0.69 (0.03)
2	Flower nitrogen	0.44 (0.04)
3	Flower nitrogen	0.82 (0.05)
1	Shoot nitrogen	0.26 (0.11)
2	Shoot nitrogen	0.32 (0.07)
3	Shoot nitrogen	0.52 (0.19)
1	Root nitrogen	0.16 (0.11)
2	Root nitrogen	0.17 (0.04)
3	Root nitrogen	0.43 (0.15)
1	RE_1	0.37 (0.09)
2	RE_1	0.26 (0.02)
3	RE_1	0.33 (0.02)
1	RE_2	0.32 (0.05)
2	RE_2	0.06 (0.02)
3	RE_2	0.16 (0.03)
1	RE_3	0.48 (0.02)
2	RE_3	0.34 (0.05)
3	RE_3	0.38 (0.07)
1	RE_4	0.44 (0.02)
2	RE_4	0.35 (0.06)
3	RE_4	0.37 (0.08)

All the plant specimens were collected from 0.25m. x 0.25 m. Quadrast located at random in each of the three populations. At least 30 plant specimens were taken from each site. The shoot length, number of nodes, branches, living leaves, dead leaves, flowers, leaf length and width and root: shoot ratio were

Table 3. Comparison of three populations using one-way ANOVA with respect to morphological and ecological parameters.

Parameter	Mean Square	F. Ratio	Probability	Significance
Shoot length	2570.888	50.926	2.313×10^{-9}	**
Number of nodes	2.370	.295	.7472	NS
Number of branches	5.593	5.864	8.441×10^{-3}	**
Number of living leaves	26.037	.346	.7112	NS
Number of dead leaves	13.370	3.619	.0423	*
Number of flowers	49.926	4.974	.0516	*
Leaf length	3.341	1.384	.2699	NS
Leaf width	3.247	17.351	2.181×10^{-5}	**
Root:shoot ratio	.134	11.550	3.064×10^{-3}	**
Total biomass	6.713	7.181	8.897×10^{-3}	**
Flower biomass	.027	16.007	3.932×10^{-3}	**
Root biomass	1.049	70.815	6.713×10^{-5}	**
Shoot biomass	5.6778x10-3	4.258	.0706	NS
Leaf nitrogen	.307	1.597	.2780	NS
Flower nitrogen	.108	61.800	9.923×10^{-5}	**
Shoot nitrogen	.056	2.060	.2084	NS
Root nitrogen	.069	8.956	.0158	*
RE1	.029	10.503	5.287×10^{-4}	**
RE2	.029	16.451	1.106×10^{-5}	**
RE3	.016	2.453	.1665	NS
RE4	7.0778x10-3	1.120	.3862	NS

*P<.05 **P<.01 NS: Not significant

Table 4. Mean values of soil-chemical parameters.

Locality	Parameter	Mean Values (Standart error)
1	Soil pH	7.05±0.152
2	Soil pH	5.70±0.138
3	Soil pH	4.94±0.139
1	Total salinity	.050±0.008
2	Total salinity	0.64±0.003
3	Total salinity	0.46±0.003
1	$CaCO_3$	9.308±1.395
2	$CaCO_3$	.436±0.058
3	$CaCO_3$	.482±0.005
1	Total nitrogen	.614±0.076
2	Total nitrogen	.514±0.015
3	Total nitrogen	.564±0.071
1	Organic matter	4.566±0.145
2	Organic matter	4.300±0.308
3	Organic matter	15.904±2.763

recorded for each plant. After being washed in deionized water the plants were separated into stems, branches, leaves, roots and reproductive structures. All the collected material was dried at 60°C for 72 hours and weighed according to the class of the plant material.

Soil samples were also taken from the three populations and physical and chemical analysis (pH, total salinity, $CaCO_3$, total nitrogen, organic matter) was carried out according to standard methods. The nitrogen (%) concentrations of different plant parts were also determined in terms of RE values using standard methods (5, 6). Soil chemical values were explained according to the method of Kaçar (7).

Differences in morphological and chemical traits were assessed with a one-way ANOVA test (8).

Climate diagrams for the plant sampling sites are shown in Figure 1.

Results

The mean values and standard erros of the morphological and chemical parameters and reproductive efforts are shown in Tables 1 and 2.

Parameter	Mean Square	F. Ratio	Probability	Significance
Soil pH	5.710	55.394	$8.713x10^{-7}$	**
Total salinity	$4.467x10^{-4}$	2913	.0931	NS
CaCO3	130.5111	40.141	$4.835x10^{-6}$	**
Total nitrogen	0.13	.669	.5305	NS
Organic matter	219.395	16.975	$3.172x10^{-4}$	**

**P<.01 NS: Not significant

Table 5. Comparison of three populations, using one-way ANOVA test with respect to soil.

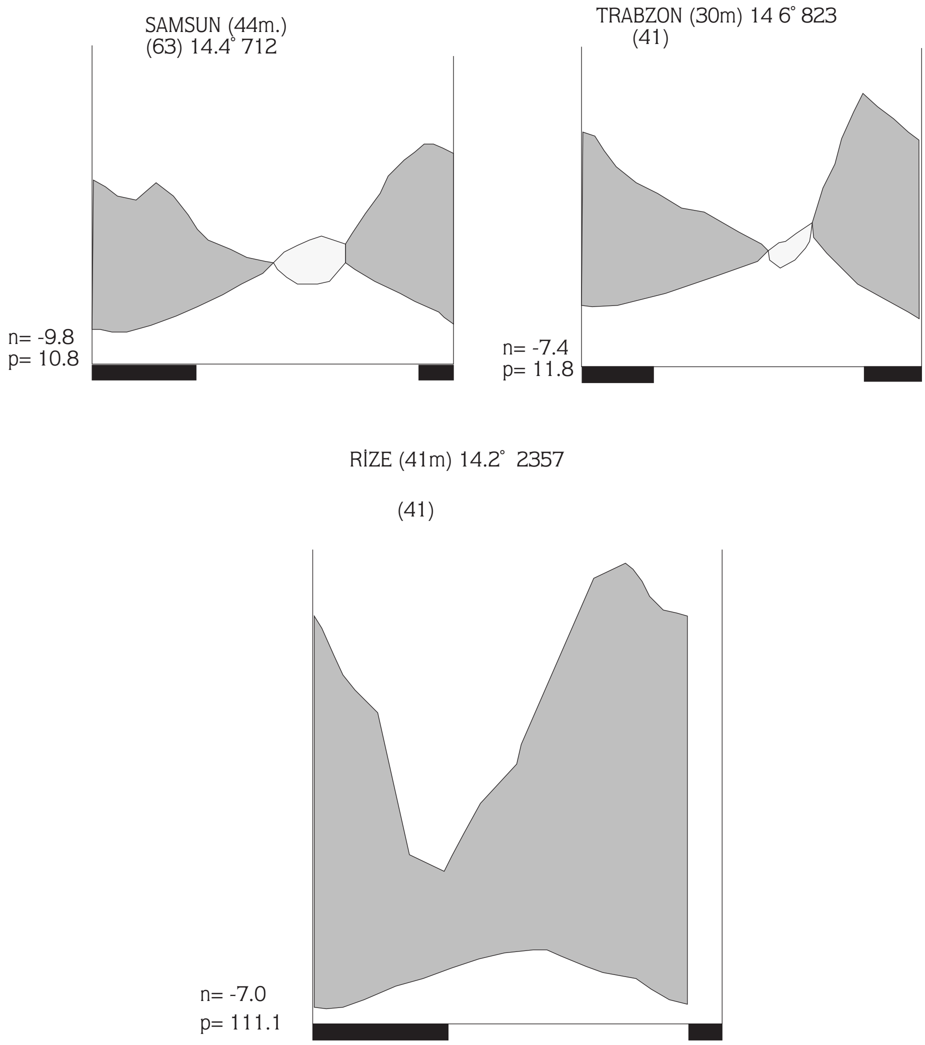

Figure 1. Climate diagrams from the main meteorological stations

Table 3 shows the differences between three natural populations of *C. communis* according to morphological and chemical parameters and reproductive effort. As shown in Table 3, the three natural populations of *C. communis* differed in terms of shoot length, number of branches, leaf width, root:shoot ratio, total biomass, leaf, flower and root biomasses, flower and root nitrogen, RE_1 and RE_2 (P<.01), the number of dead leaves and root nitrogen (P<0.5). There were no statistically significant differences between the three populations with respect to the number of node, number of living leaves, leaf length, shoot biomass, shoot nitrogen, leaf nitrogen, RE_3 or RE_4.

Table 6. Correlation coefficients in values of reproductive effort ($r=.532^{*}=p<0.05$; $r=.661^{**}$ $p<0.01$)

SAMSUN

	RE_1	RE_2	RE_3	RE_4
RE_1	——			
RE_2	-.403	——		
RE_3	-.904**	.755*	——	
RE_4	-.403	.997**	.755*	——

TRABZON

	RE_1	RE_2	RE_3	RE_4
RE_1	——			
RE_2	.911**	——		
RE_3	.934**	.705*	——	
RE_4	.998**	.888**	.952*	——

RİZE

	RE_1	RE_2	RE_3	RE_4
RE_1	——			
RE_2	-.709**	——		
RE_3	-.752**	.998**	——	
RE_4	.198	-.831**	-.795**	——

Table 4 shows the mean values of the chemical soil factors. The soils in which *C. communis* populations grow vary from lightly alkaline to slightly acidic. The total salinity is too low in all of the populations. In the Samsun population, the $CaCO_3$ value is quite high but the Trabzon and Rize populations occur on low-calcareous soils. The total nitrogen and organic-matter values are quite high in all of the populations (7). The three populations differ with respect to soil pH, $CaCO_3$ and organic matter (Table 5). According to the result of physical analysis *C. communis* prefers clay loam soils.

Table 6 shows the correlation coefficients between the values for reproductive effort. High correlation coefficients were observed in RE_1, RE_2, RE_3 and RE_4.

Figure 1 shows the climate diagrams for the plant sampling sites. An arid period can be seen in the climate diagrams for Samsun and Trabzon. However, it is not possible to detect an arid period in the climate diagram for Rize.

Discussion

The data presented here indicates that reproductive parts have a great effect on phenotypic plasticity. Statistically significant differences were observed in the three populations with respect to the number of flowers, flower biomass, flower nitrogen, RE_1 and RE_2 (Table 3). It was found that three are no significant differences in the three populations with respect to the number of nodes, number of living leaves and leaf length. However, the number of flowers and flower biomass differed significantly in the three populations (Table 3). This might allow a more efficient dispersal of seeds and lead to a greater likelihood that some seeds will reach appropriate safe sites, as hypothesized by Janzen (9). Additionally, this may indicate that reproductive structures play an important role in the phenotypic plasticity of *C. communis* compared to vegetative structures. It has been concluded that measuring reproductive effort is "inherently wrong in plants", buy it might be acceptable if a high correlation in reproductive effort values of *C. communis* (10). As shown in Table 6, the majority of correlation coefficients between values of reproductive effort are statistically important. Comsequently, suggest that correlation coefficients for reproductive effort must be taken into account when phenotypic plasticity is examined. It can be concluded that the phenotypic plasticity of *C. communis* is quite high due to the high correlation coefficients for reproductive effort (11).

The mean values of RE_1, RE_2, RE_3 and RE_4 were higher in the Samsun and Rize populations than the Trabzon population. It has been suggested that higher RE values are related to the increased number of flowers (12). Our results fully support this hypothesis (Table 1). However, the three populations are not different with respect to RE_3 and RE_4 (Table 3). It has been suggested that some convergences and divergences in the reproductive strategies of different populations may occur (13). Our results can be explained in this way. In addition to this, there are no significant differences in the three natural populations with respect to leaf and shoot nitrogen (Table 3). The differences in RE_3 and RE_4 and RE_1 and RE_4 may also be due to this.

C. communis can occur on both slightly acidic and alkaline soils and calcerous and non-calcareous soils (Table 4). There are statistically important differences in the three populations with respect to soil pH, $CaCO_3$ and concentrations of organic matter. As shown in Table 4, the pH values fell in the second and third populations. PH and $CaCO_3$ values are inherently interrelated and interdependent (7).

When the climate diagrams are taken into consideration, it can be seen that *C. communis* is found in both slightly arid and completely humid regions. Hence, it can be concluded that *C. communis* has relatively high ecological tolerance. From this it may be suggested that high plasticity may allow plant species to maintain dominance in various environments by increasing the number of tolerable habitats. Depending that fact it can be suggested that wide plasticity may allow plant species to maintain dominance in variable environments by increasing the number of tolerable habitats. Similar results were obtained by Dunn and Sharitz (2) Werner and Platt (14) with some plants belonging to the *Commelinaceae* and *Compositae* families.

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