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TOP SENESCENCE IN SOME MEMBERS OF AMARYLLIDACEAE FAMILY IN CENTRAL AND EAST BLACK SEA REGIONS OF TURKEY

HAMDİ GÜRAY KUTBAY AND MAHMUT KILINÇ

Department of Biology,
University of Ondokuz Mayıs, Faculty of Science and Arts,
55139, Kurupelit-Samsun, Turkey.

Abstract

In this study nitrogen (N), phosphorus (P) and potassium (K) analysis were carried out during vegetative and generative growth periods in some members of Amaryllidaceae family collected from the Central and East Black Sea Regions, on the north of Turkey. The above ground parts of plant were found to have higher macroelement concentrations as compared to below ground parts during vegetative growth period. However, below ground parts have higher macroelement concentrations during generative growth phase due to "top senescence". In addition to this there were significant and mostly negative correlations between plant and soil macroelement concentrations.

Introduction

Geophytes are the plants in which the perennating bud is borne on a subterranean storage organ and their annual growth cycle usually includes a dormant period. The reserves in geophytic plants in their storage organ support leaf growth at the beginning of the growing season and, to a varying degree, also reproduction (Méndez, 1999). Geophytic plants have quite interesting ecophysiological properties in respect to redistribution of macroelements between above and below ground parts at the beginning and at the end of their growing season. This redistribution is highly important for the economical use of nutrients (Feller & Fischer, 1994). Geophytic plants evade stress conditions such as shade, drought etc., by survival in below ground organs and they exhibit, some features of sun plants but also those of plants of shaded habitats (Goryshina, 1972). Besides, they have also interesting phenological properties such as flowering time (spring or autumn), the presence of protantherous, hysterantherous and synantherous taxa etc. (Rawal *et al.*, 1991).

Amaryllidaceae family is represented by eight genera in Turkey. *Agave* L., and *Polianthes* L., are used as ornamental plants and they are found as alien species and not naturalised in Turkey. *Ixiolirion* Fischer ex Herbert is not found in Central and East Black Sea Regions and it has a very limited distribution on the southern part of Turkey (Davis, 1984; Ekim *et al.*, 1989). Therefore the remaining five genera were examined in this study which have a great economical importance since they contain important alkaloids mainly galanthamine in their bulbs. In addition to this, *Pancratium maritimum* L., *Sternbergia lutea* (L.) Ker-Gawl. ex Sprengel and *Narcissus tazetta* L. subsp. *tazetta* contain some different alkaloids other than galanthamine. For example *P.maritimum* contains lycorine, hippeastrine, haemanthidine and vittatine and *S.lutea* and *N. tazetta* subsp. *tazetta* contain some vomitory alkaloids in their bulbs, most of them are not clearly identified (Baytop, 1984; Tato *et al.*, 1988). The studied natural taxa can also be used as ornamental plants and the bulbs of these taxa have been continuously exported so that the population density of these taxa have since decreased day by day (Ekim *et al.*, 1989).

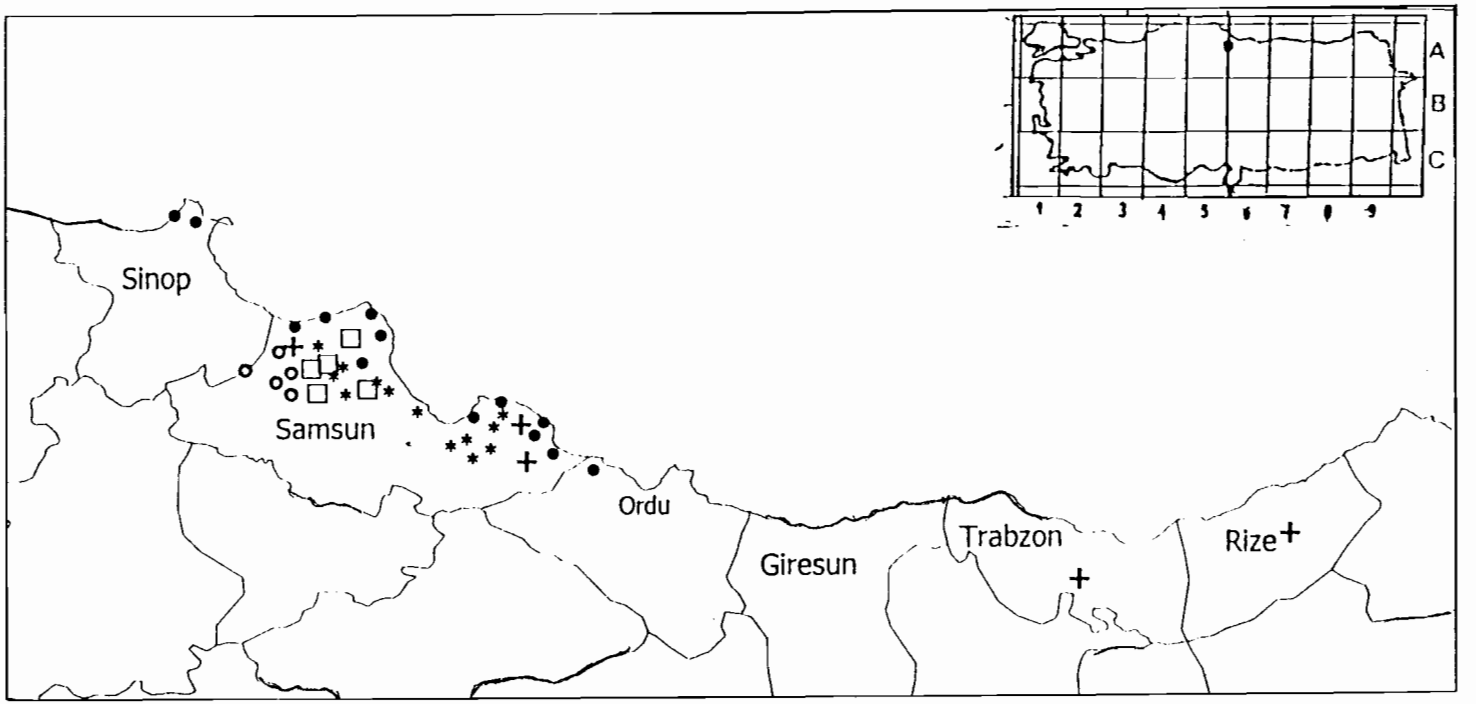

Fig. 1. The distribution of the studied taxa belonging to *Amaryllidaceae*
Pancratium maritinum L. + *Galanthus rizehensis* Stern. * *Leucojum aestivum* L.
o*Narcissus tazetta* L. subsp. *tazetta* □ *Sternbergia lutea* (L.) Ker-Gawl. Ex. Sprengel

In this study redistribution of some macroelements (N, P, K) between above and below ground parts and the correlations between plant and soil during vegetative and generative growth periods in some Amaryllidaceae members were investigated. The concentrations of nitrogen, phosphorus and potassium seem to be more closely controlled than other nutrients, which could reflect the specific amounts needed for biochemical function (Canadell & Vilà 1992). The main aim of the present study was to examine whether top senescence occurs in Amaryllidaceae members or not.

Materials and Methods

Study area: Plant samples were collected from Central and East Black Sea Regions which is situated in the northern part of Turkey. The study area is situated between A5 and A8 squares according to the grid systeme of Davis (1984). The studied taxa are situated in different habitats. *L. aestivum* and *N. tazetta* subsp. *tazetta* occured in lakesides and swamp and *Fraxinus angustifolia* Vahl. subsp. *oxycarpa* (Bieb. ex Willd.) Franco & Rocha in Afonso forests. *P. maritimum* occured in sand dunes. *G. rizehensis* and *S. lutea* occured in *Quercus cerris* L. var. *cerris* forest clearings. All of the taxa were collected at sea level. *L. aestivum* and *P. maritimum* specimens were collected from 13 sites. However, *G. rizehensis*, *S. lutea* and *N. tazetta* subsp. *tazetta* specimens were collected from 5 sites due to the narrower distribution of these species as compared to the *L. aestivum* and *P. maritimum* (Fig. 1).

Sampling design: Plant samples were harvested during vegetative and generative growth phases and separated into above and below ground parts. Sampling was repeated twice during vegetative and generative growth phases.

Vegetative growth phase samples of *L. aestivum* were taken in the second half of February. Vegetative growth phase samples of *G. rizehensis* and *P. maritimum* were taken during the first half of December and at the beginning of June, respectively. Vegetative growth phase samples of *S. lutea* and *N. tazetta* subsp. *tazetta* were taken in the first half of September and in the second half of October, respectively.

Generative growth phase samples of *L. aestivum* were taken at the beginning of April. Generative growth phase samples of *G. rizehensis* and *P. maritimum* were taken in the middle of January and during the second half of July, respectively. Generative growth phase samples of *S. lutea* and *N. tazetta* subsp. *tazetta* were taken in the second half of October and during the first half of December, respectively.

Method of chemical analysis: Plant samples after washing in deionized water were dried at 70°C to the constant weight and after grinding in a Wiley mill passed through a 20 mesh sieve. Nitrogen (%) was determined by the micro Kjeldahl method with a Kjeltec 1030 Analyser (Tecator, Sweden) after digesting the samples in concentrated H_2SO_4 with a selenium catalyst. For P (%) and K (%) analysis plant specimens were wet ashed in concentrated HNO_3 and $HClO_4$ and P was determined by using Jenway spectrophotometer and K was determined by Petracourt PFP-7 flame photometer (Allen *et al.*, 1986).

Soil samples were collected during vegetative and generative growth phases separately and soil and plant samples were taken simultaneously during vegetative and generative growth phases. Soil samples were taken using a 7 cm diameter auger to a depth of 30 cm. Five to thirteen soil cores were taken according to a fixed spatial arrangement after the plant samples were removed. Soil samples were air-dried and

sieved to pass through a 2 mm mesh prior to analysis. Soil texture was determined by Bouyoucus hydrometer method. Soil nitrogen (%) was determined by micro Kjeldahl method. Soil phosphorus (%) was determined spectrophotometrically following the extraction by ammonium acetate. Soil potassium (%) was determined by using a Petracourt PFP-7 flame photometer after nitric acid wet digestion. Organic matter (%) concentration was determined by Walkley-Black method (Bayraklı, 1987). The results of soil analysis were explained according to Chapmann & Pratt (1973) and Bayraklı (1987). Phenological observations were also carried out.

The differences were assessed by one-way ANOVA tests. Pearson correlation coefficients were also calculated. Statistical analysis were performed using MINITAB software package (Schaefer & Anderson, 1989).

Results

Phenological observations: All the taxa used in the study are protantherous. In other words, leaves appeared before the flowers (Rawal *et al.*, 1991). *L. aestivum*, *G. rizehensis* and *P. maritimum* are spring geophytes. However, *S. lutea* and *N. tazetta* subsp. *tazetta* are autumn geophytes.

Vegetative growth stage in *L. aestivum* begins during the second half of February. The flowering time is the second half of March. The appearance of fruits takes place at the end of April and by the end of May the seeds are dispersed.

The vegetative growth period in *G.rizehensis* begins during the first and second half of December. The vegetative growth stage is quite short and this species sharply switches from vegetative to reproductive growth. Flowering occured in the middle of January and continued up to the end of February. Fruit maturation begins at the end of March and seeds are dispersed during the second half of April.

In *P. maritimum*, vegetative growth stage occured at the beginning of June and July. During the second half of July first flowers appeared. At the end of August or at the beginning of September fruits begin to grow. Seed dispersion occured during the first half of October.

Vegetative growth stage in *S. lutea* begins during the first half of September. This species bears its flowers during the second half of October. Fruit maturation begins at the beginning of November. Seed dispersion occured during the second half of November.

The duration of vegetative growth period in *N. tazetta* subsp. *tazetta* is at the second half of October and during the first half of November. Flowering begins during the first half of December and continues up to the end of December. At the outset of January fruit ripening occured. The time interval for seed dispersion is between the second half of January to the middle of February.

The results of plant and soil analysis: *L. aestivum* occurs on sandy-loamy and clay-loamy soils. *P. maritimum* grows on sand dunes. *G. rizehensis* and *N. tazetta* subsp. *tazetta* prefer clay-loamy soils. *S. lutea* occurs on sandy-loamy soils. All of the species occur on the soils that have high nitrogen (%) concentrations. K (%) concentrations were also high for almost all species. However, P (%) concentrations were usually at medium levels (Chapmann & Pratt, 1973; Bayraklı, 1987). *P. maritimum* occur on the soils that have very low P(%) concentrations. This species also occur on the soils that have low organic matter (%) concentrations (Fig. 8). Although *S. lutea* also occur on the soils that have low organic matter (%) concentrations, it also occur on the soils that have high organic matter (%) concentrations (Fig. 11; Chapmann & Pratt, 1973; Bayraklı, 1987).

Mean above ground N (%) concentration varied from 1.03 (*S. lutea*)-2.83 (*L. aestivum*) and 0.61 (*S. lutea*)-2.16 (*P. maritimum*) in vegetative and generative growth phases, respectively. However, mean below ground N (%) concentration varied from 0.50 (*S. lutea*)-1.34 (*N. tazetta* subsp. *tazetta*) and 1.06 (*S. lutea*)-2.23 (*N. tazetta* subsp. *tazetta*) in vegetative and generative growth phases, respectively (Fig. 3-16).

The highest mean above ground and below ground P (%) concentration was observed in *P. maritimum* (0.41) and *S. lutea* (0.18), respectively during vegetative growth phase. However, the lowest above ground and below ground P (%) concentration was observed in *N. tazetta* subsp. *tazetta* (0.06-0.05) during vegetative growth phase. The highest mean above ground and below ground P (%) concentration was observed in *S. lutea* (0.21) and *P. maritimum* (0.37), respectively during generative growth phase. However, the lowest above ground and below ground P (%) concentration was observed in *N. tazetta* subsp. *tazetta* (0.04) and *S. lutea* (0.03), respectively, during generative growth phase (Fig. 3-16).

Mean above ground K (%) concentration varied from 0.28 (*N. tazetta* subsp. *tazetta*)-6.80 (*S. lutea*) and 0.21 (*N. tazetta* subsp. *tazetta*)-2.79 (*L. aestivum*) in vegetative and generative growth phases, respectively. However, mean below ground K (%) concentration varied from 0.10 (*N. tazetta* subsp. *tazetta*)-0.99 (*L. aestivum*) and 0.18 (*P. maritimum*)-5.41 (*S. lutea*) in vegetative and generative growth phases, respectively (Fig. 3-16).

N. tazetta subsp. *tazetta* had the lowest above ground and below ground P and K (%) concentrations as compared to the other species. *P. maritimum* had considerably lowest K (%) concentrations followed by *N. tazetta* subsp. *tazetta* in both growth periods. *S. lutea* had the lowest above and below ground N (%) concentration in both growth periods (Fig. 3-16).

In vegetative growth period, the above ground parts have higher nutrient concentrations as compared to below ground parts and below ground parts have higher nutrient concentrations during generative growth phase inversely in most of the studied taxa (Figs. 3-16). However, some differences were observed as for example N and K concentration in above ground parts of *L. aestivum* (Fig. 3), K concentration in above ground parts of *P. maritimum* (Fig. 9), P concentration in above ground parts of *G. rizehensis* (Fig. 6) are higher during generative growth phase in contrast to the general pattern. In addition to this, K concentration in above and below ground parts of *G. rizehensis* is very similar to each other during generative growth phase (Figs. 3-7).

There were significant differences between above and below ground macroelement concentrations in both vegetative and generative growth phases (Table 1). There were also significant differences in respect to soil factors in both vegetative and generative growth phases except soil organic matter concentration in *L. aestivum* and *G. rizehensis* (Table 2, Fig. 2 and 5), soil K concentration in *P. maritimum* (Fig. 8) and *G. rizehensis* (Fig. 5) and soil P concentration in *G. rizehensis* (Fig. 5) and *N. tazetta* subsp. *tazetta* (Fig. 14). There were also significant and mostly negative correlations between plant and soil macroelement concentrations in above and below ground parts in both growth periods (Table 3).

Table 1. Comparison of N, P and K (%) concentrations in above and below ground parts in studied Amaryllidaceae members by one-way ANOVA test during vegetative and generative growth phases.

Species	Growth Phase	E	F-value	P	S
L.aestivum	Vegetative	N	41.164	.000	**
L.aestivum	Generative	N	3.821	.062	NS
L.aestivum	Vegetative	P	1.828	.189	NS
L.aestivum	Generative	P	5.420	.029	*
L.aestivum	Vegetative	K	24.146	.000	**
L.aestivum	Generative	K	18.935	.000	**
P.maritimum	Vegetative	N	113.110	.000	**
P.maritimum	Generative	N	97.829	.000	**
P.maritimum	Vegetative	P	5.098	.033	*
P.maritimum	Generative	P	4.380	.047	*
P.maritimum	Vegetative	K	22.646	.000	**
P.maritimum	Generative	K	3.583	.070	NS
G.rizehensis	Vegetative	N	11.933	.009	**
G.rizehensis	Generative	N	1.131	.319	NS
G.rizehensis	Vegetative	P	4.134	.076	NS
G.rizehensis	Generative	P	.191	.674	NS
G.rizehensis	Vegetative	K	63.367	.000	**
G.rizehensis	Generative	K	.000	.994	**
S.lutea	Vegetative	N	4.063	.079	NS
S.lutea	Generative	N	16.129	.004	**
S.lutea	Vegetative	P	2.805	.133	NS
S.lutea	Generative	P	3.160	.113	NS
S.lutea	Vegetative	K	14.350	.005	**
S.lutea	Generative	K	8.215	.021	*
N.tazetta subsp.*tazetta*	Vegetative	N	8.816	.018	*
N.tazetta subsp.*tazetta*	Generative	N	13.546	.006	**
N.tazetta subsp.*tazetta*	Vegetative	P	3.883	.084	NS
N.tazetta subsp.*tazetta*	Generative	P	3.359	.104	NS
N.tazetta subsp.*tazetta*	Vegetative	K	.583	.467	NS
N.tazetta subsp.*tazetta*	Generative	K	.745	.413	NS

E: Element P: Probability S: Significance
*P<.05 **P<.01 NS: Not significant

Discussion

P. maritimum and *S. lutea* had considerably lowest K (%) concentrations as compared to the other species (Fig. 3-16). Both species usually prefer the soils that have high sand content as indicated early and such soils usually have low macroelement concentrations especially K (%) concentrations mainly due to elluviation (Bayraklı, 1987). *N. tazetta* subsp. *tazetta* had the lowest P (%) concentrations. However, the soils under *N. tazetta* subsp. *tazetta* had the higher organic matter (%) concentrations (Fig. 14) and in such soils most of the phosphorus compounds are bound to the organic matter (Bayraklı, 1987).

Table 2. Comparison between vegetative and generative growth periods in respect to soil factors.

Species	Soil factor	F-value	Probability	Significance
L.aestivum	N	4.922	0.036	*
L.aestivum	P	12.539	0.002	**
L.aestivum	K	6.309	0.019	*
L.aestivum	OM	0.510	0.482	NS
P.maritimum	N	4.878	0.037	*
P.maritimum	P	4.914	0.036	*
P.maritimum	K	0.617	0.440	NS
P.maritimum	OM	7.848	0.010	*
G.rizehensis	N	77.442	0.000	**
G.rizehensis	P	0.347	0.572	NS
G.rizehensis	K	0.082	0.782	NS
G.rizehensis	OM	0.976	0.352	NS
S.lutea	N	25.653	0.001	**
S.lutea	P	11.673	0.009	**
S.lutea	K	12.788	0.007	**
S.lutea	OM	35.126	0.000	**
N.tazetta subsp.*tazetta*	N	18.325	0.003	**
N.tazetta subsp.*tazetta*	P	3.374	0.104	NS
N.tazetta subsp.*tazetta*	K	12.340	0.008	**
N.tazetta subsp.*tazetta*	OM	6.483	0.034	*

N: Nitrogen P: Phosphorus K: Potassium OM: Organic Matter
*P<.05 **P<.01 NS: Not significant

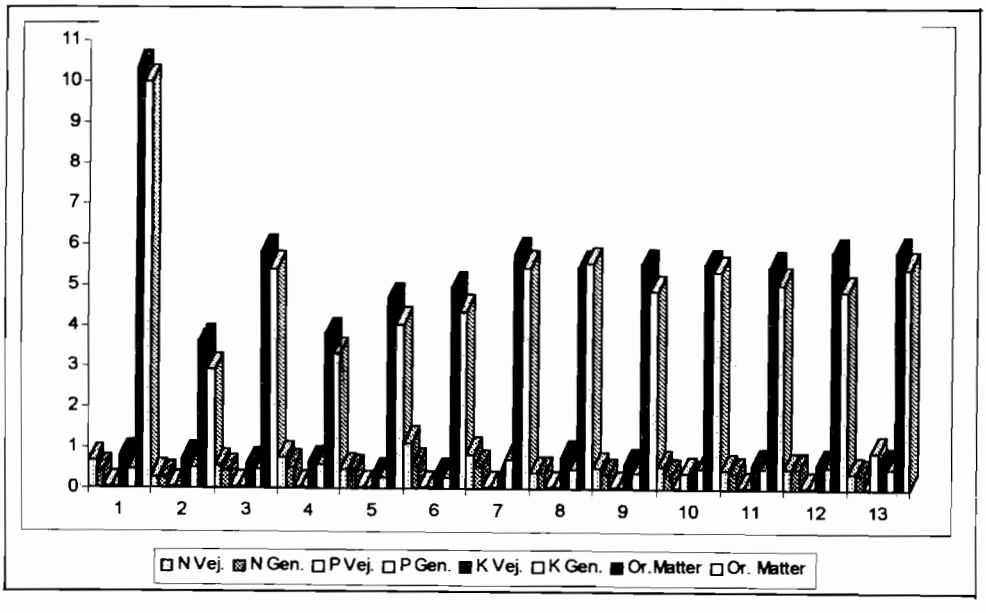

Fig. 2. Soil N, P, K and organic matter (%) concentrations during vegetative and generative growth phases in *L. as tivum*.

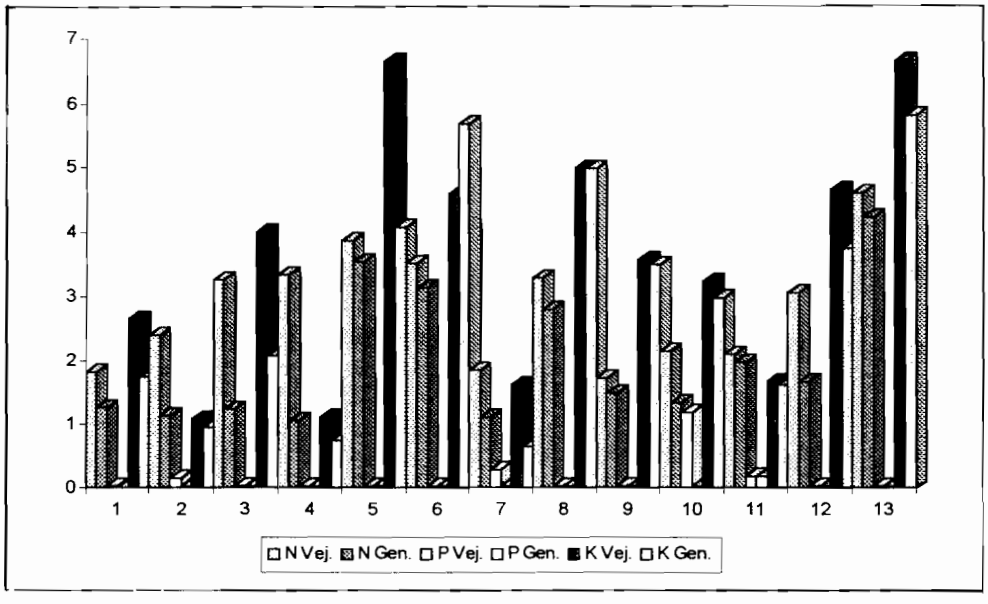

Fig. 3. N, P and K (%) concentrations in above ground parts of *L. aestivum*.

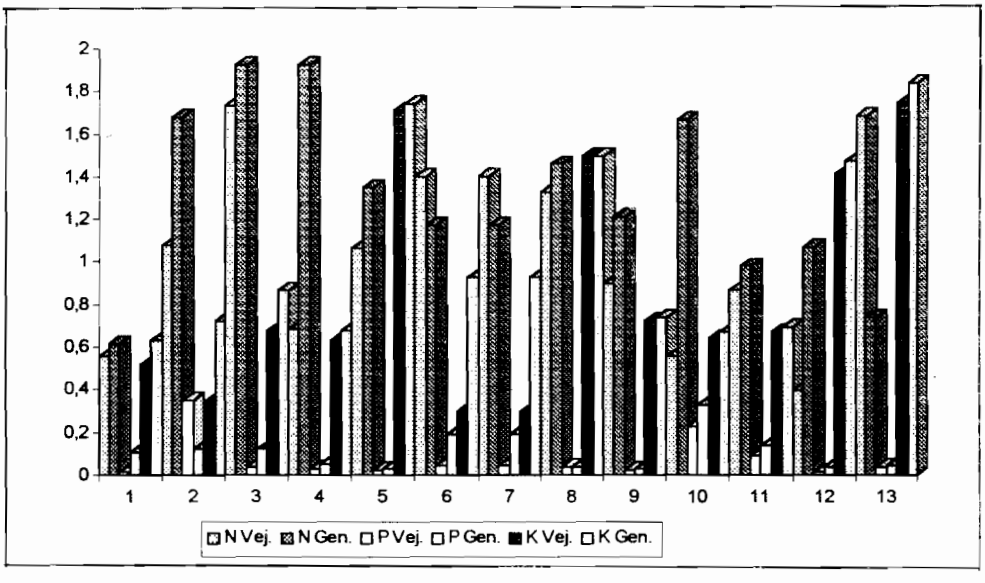

Fig. 4. N, P and K (%) concentrations in below ground parts of *L. aestivum*.

Table 3. Correlation between plant and soil N, P and K (%) concentrations during vegetative and generative growth phases in above and below ground parts in studied Amaryllidaceae members.

Species	Growth Phase	Element	Correlation Coefficient	Significance	Correlation Coefficient	Significance
			Above ground parts		Below ground parts	
L.as tivum	Vegetative	N	-.847	**	-.644	**
L.as tivum	Generative	N	-.733	**	-.727	**
L.as tivum	Vegetative	P	-.190	NS	.752	**
L.as tivum	Generative	P	.071	NS	-.428	*
L.as tivum	Vegetative	K	-.753	**	-.348	NS
L.as tivum	Generative	K	-.712	**	-.693	**
P.maritimum	Vegetative	N	-.955	**	-.840	**
P.maritimum	Generative	N	-.979	**	-.950	**
P.maritimum	Vegetative	P	-.693	**	-.453	*
P.maritimum	Generative	P	-.522	**	-.577	**
P.maritimum	Vegetative	K	-.746	**	-.337	NS
P.maritimum	Generative	K	-.716	**	-.613	**
G.rizshsn i	Vegetative	N	-830	**	-748	**
G.rizshsn i	Generative	N	-813	**	-599	NS
G.rizshsn i	Vegetative	P	-.963	**	-.807	**
G.rizshsn i	Generative	P	-.939	**	-.921	**
G.rizshsn i	Vegetative	K	-.959	**	-.258	NS
G.rizshsn i	Generative	K	-.680	**	-.754	**
S.lutsa	Vegetative	N	-.561	NS	.520	NS
S.lutsa	Generative	N	-.444	NS	-.885	**
S.lutsa	Vegetative	P	-.699	*	.152	NS
S.lutsa	Generative	P	-.925	**	-.890	**
S.lutsa	Vegetative	K	-.807	**	.769	NS
S.lutsa	Generative	K	-.404	NS	-.725	**
N tazstta subsp.*tazstta*	Vegetative	N	-.924	**	-.657	*
N tazstta subsp.*tazstta*	Generative	N	-.855	**	-.887	**
N tazstta subsp.*tazstta*	Vegetative	P	.518	NS	.855	**
N tazstta subsp.*tazstta*	Generative	P	.757	**	.228	NS
N tazstta subsp.*tazstta*	Vegetative	K	.465	NS	.759	**
N.tazstta subsp.*tazstta*	Generative	K	.459	NS	.013	NS

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

Macroelement concentrations in above ground parts are higher than below ground parts during vegetative growth phase in most of the studied taxa (Fig. 3-16). Similar results were obtained by Pirdal (1989) and Méndez (1999) in some members of geophytic plants. Anderson & Eickmeier (2000) stated according to vernal dam hypothesis that forest herbs or herbs occur on forest clearings including geophytes temporarily sequester nutrients in deciduous forests prior to canopy closure and return them to the below ground tissues following senescence of above ground tissues. Most of the studied taxa

occur on forest clearings except for *P. maritimum* and the findings were mostly in accordance with vernal dam hypothesis. However, some exceptional features were observed as indicated early. The differences in *P. maritimum* could be explained in respect to the different habitat of *P. maritimum*. This species occured on sand dunes. The differences in other taxa could be explained in two different ways. Firstly, there were some differences in respect to the phloem mobility of each macroelement (Panvini & Eickmeier, 1993). For example, phloem mobility of phosphorus is quite low and the lack of differences between above and below ground parts during generative growth phase may be explained due to this. Secondly, most of the studied taxa sharply switches from vegetative to reproductive growth.

However, in generative growth period, below ground parts have higher nutrient concentrations as compared to above ground parts and this situation is known as "top senescence as stated by Leopold (1980). In such plants the above ground parts senesce completely and new shoots appear at the beginning of the next season. Anderson & Eickmeier (2000) suggested that geophytes resorb nutrients from their leaves back to below ground tissues during senescence. The reserves in the vegetative storage organs allow a rapid growth during initial phase (Steinmann & Brandle 1984; Nooden, 1984; Berchtold *et al.*, 1993; Sahin, 1998). Senescence is an important process in the adaptation of higher plants to environmental conditions. This is a well controlled process and it is not a passive decay of a plant (Feller & Fischer, 1994). Senescence is allowed to the optimum usage of macroelements for a plant (Jayasekera 1993).

In addition to the "top senescence", monocotyledonous herbs have also adaptive advantages as compared to dicotyledonous herbs. For example, above ground parts of monocotyledonous herbs develop their leaves from a basal meristem. However, dicotyledonous herbs develop their leaves from an apical meristem. As a result of this meristematic tissues are at ground level in monocotyledonous herbs. This means that there is benefit of a basal meristem at ground level, in terms of effective usage of macroelements especially nitrogen, rapid transfer of nutrients between above and below ground parts and providing protection against damage through grazing, fire etc. (Werger & Hirose, 1991).

Canadell & Vilà (1992) found significant and negative correlation coefficients between plant and soil nutrients. Knops & Koenig (1997) found positive significant correlations between soil nitrogen and phosphorus and foliar nitrogen and phosphorus. Powers (1984) and Johnson *et al.*, (1987) also found positive correlation coefficients between soil and plant nutrient levels. Mostly negative correlation coefficients were obtained between plant and soil macroelement concentrations in above and below ground parts of the studied Amaryllidaceae members (Table 3).

These results suggest that soil nitrogen, phosphorus and potassium may influence plant nutrient levels in most plants. However, there was species-specific differences in this respect. Anderson & Eickmeier (2000) stated that plant macronutrients were often associated with soil nutrient availability. Ecosystems dominated by short or long-lived species develop soil over a multi-generational influencing soil to a small but eventually important degree (Knops & Koenig, 1997).

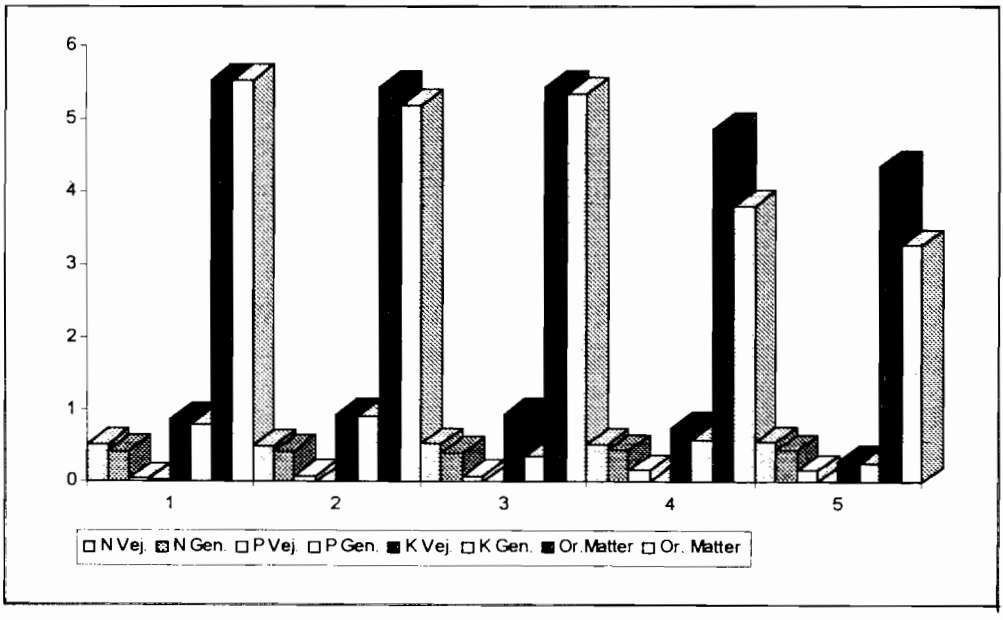

Fig. 5. Soil N, P, and K organic matter (%) concentrations during vegetative and generative growth phase in *G. rizehensis*.

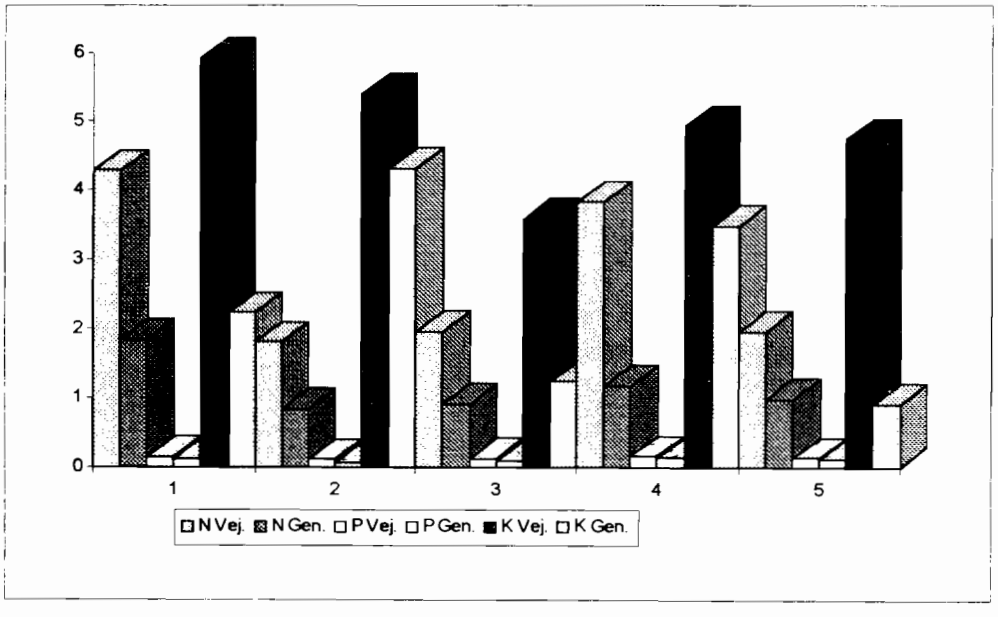

Fig. 6. N, P and K (%) concentrations in above ground parts of *G. rizehensis*.

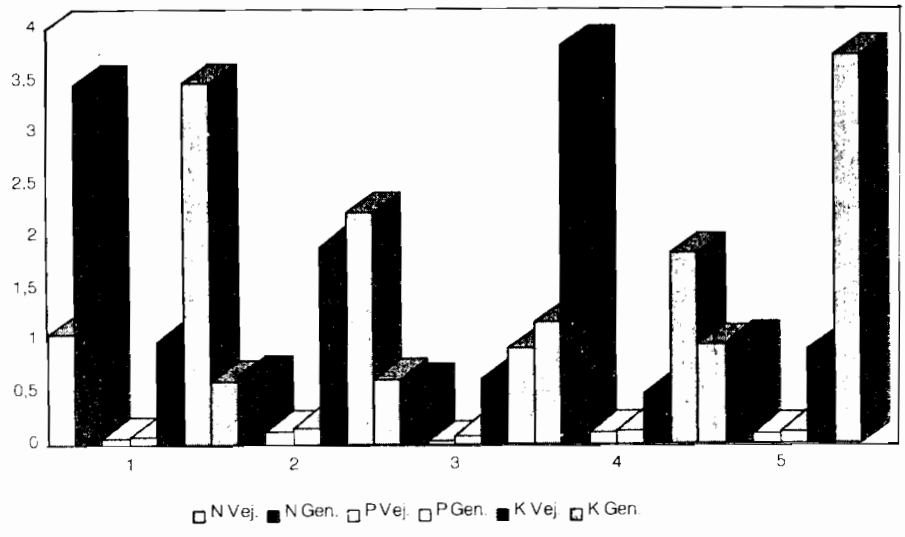

Fig. 7. N, P and K (%) concentrations in below ground parts of *G. rizehensis*.

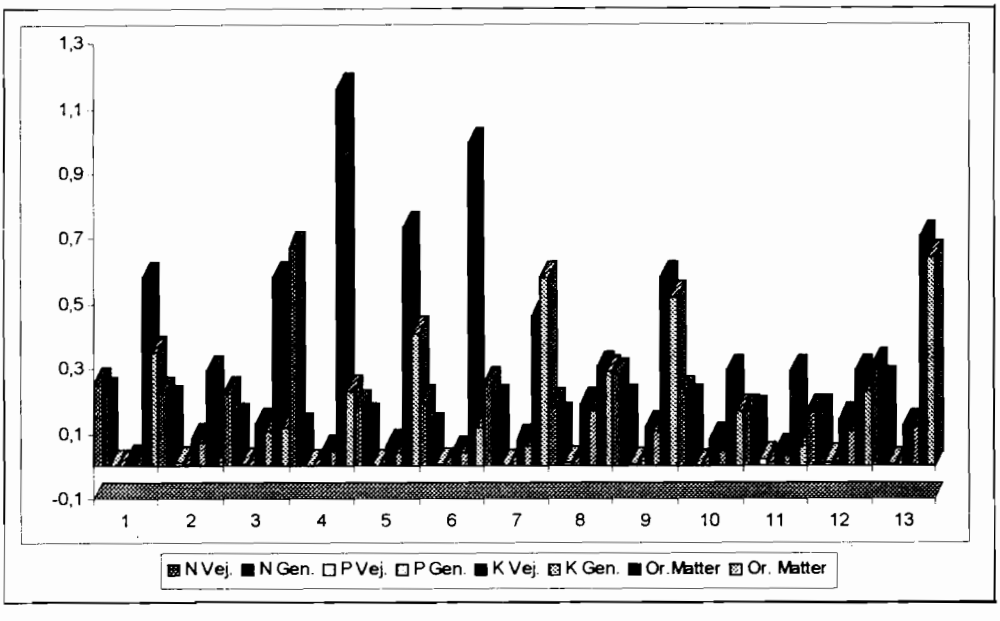

Fig. 8. Soil N, P, and K organic matter (%) concentrations during vegetative and generative growth phase in *P. maritimum*.

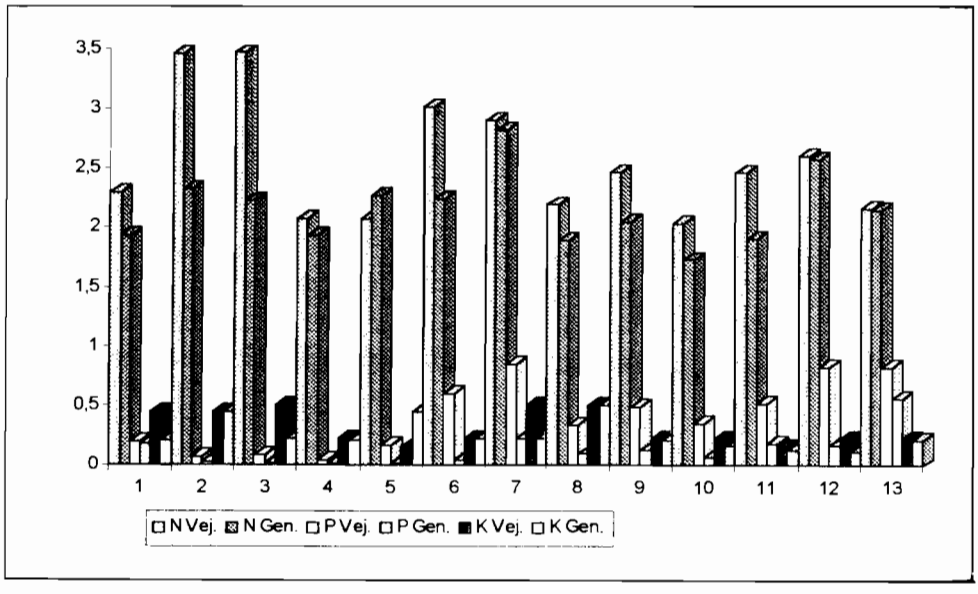

Fig. 9. N, P and K (%) concentrations in above ground parts of *P. maritimum*.

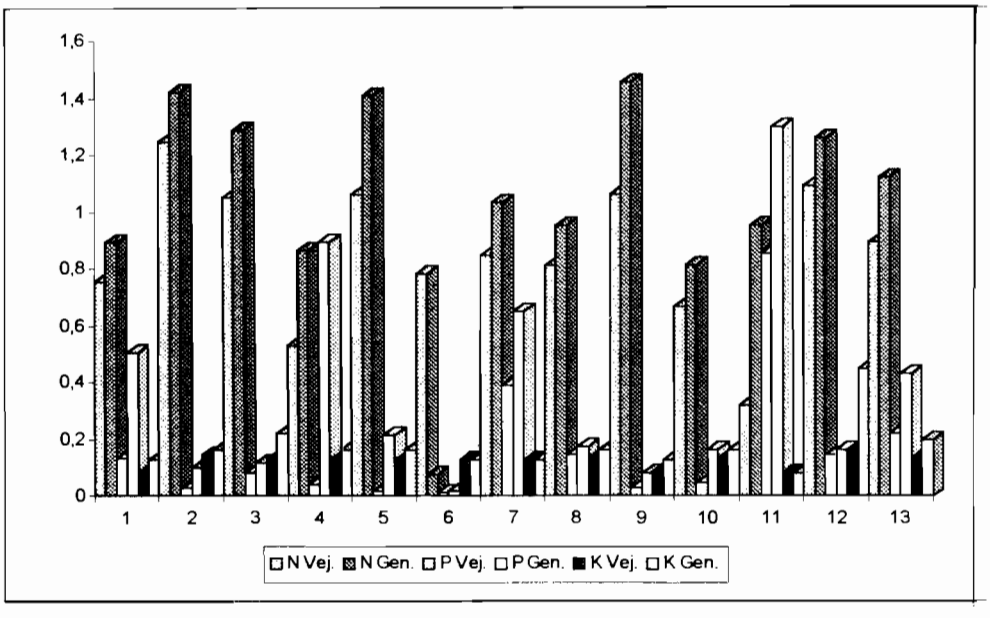

Fig. 10. N, P and K (%) concentrations in below ground parts of *P. maritimum*.

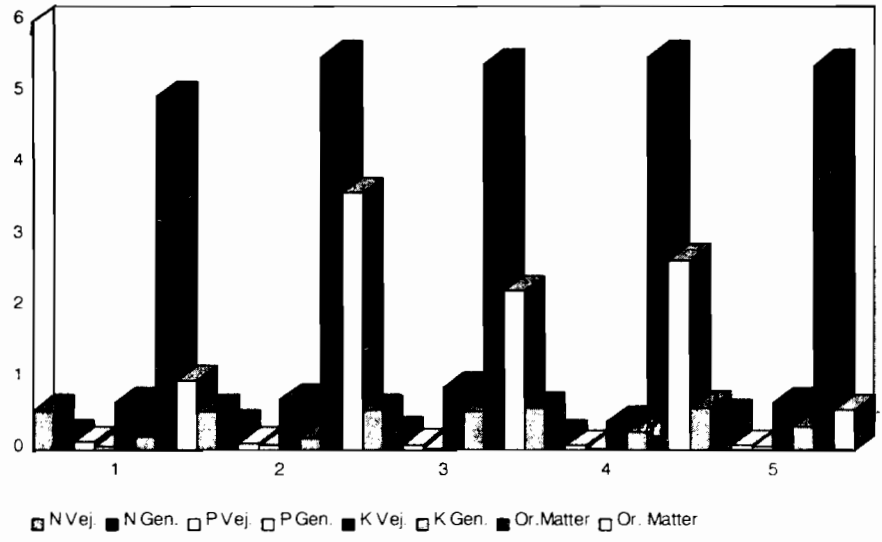

Fig. 11. Soil N, P, and K organic matter (%) concentrations during vegetative and generative growth phase in *S. lutea*.

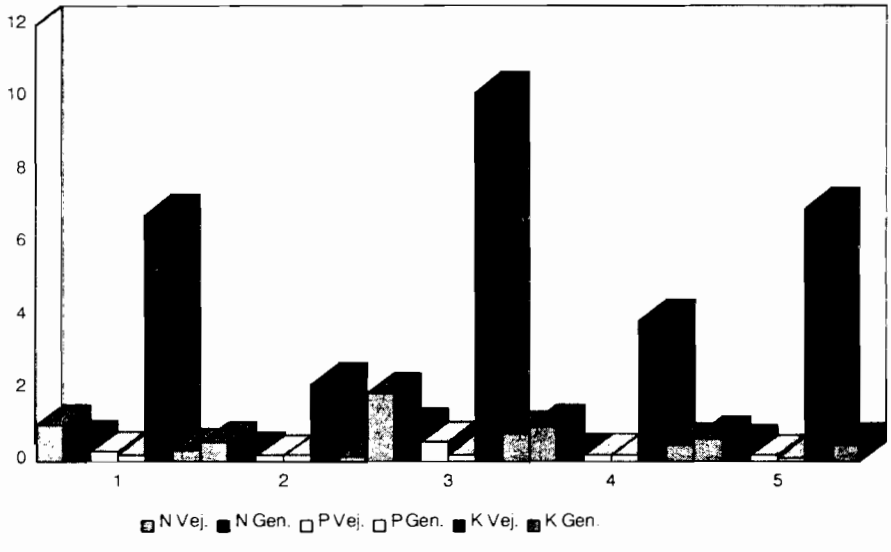

Fig. 12. N, P and K (%) concentrations in above ground parts of *S. lutea*.

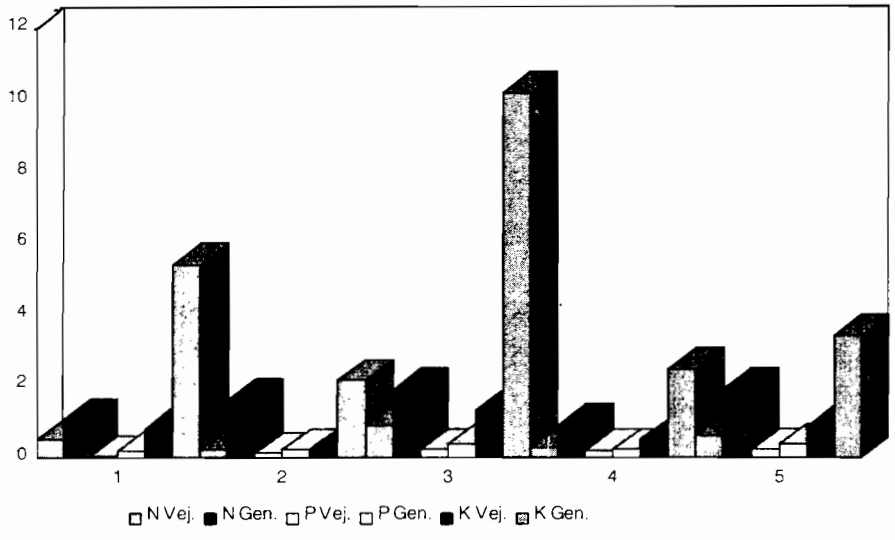

Fig. 13. N, P and K (%) concentrations in below ground parts of *S. lutea*.

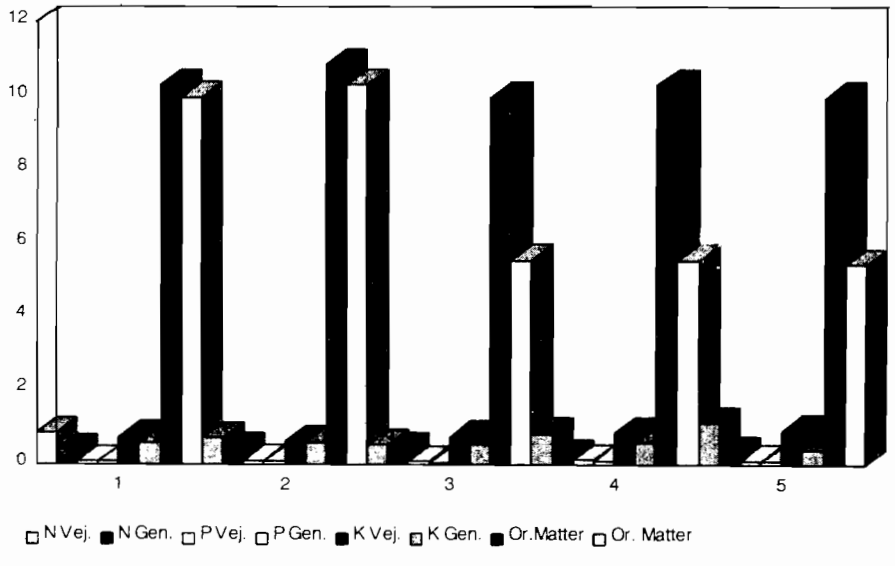

Fig. 14. Soil N, P, and K organic matter (%) concentrations drng vegetative and generative growth phase in *N. tazetta* subsp. *tazetta*.

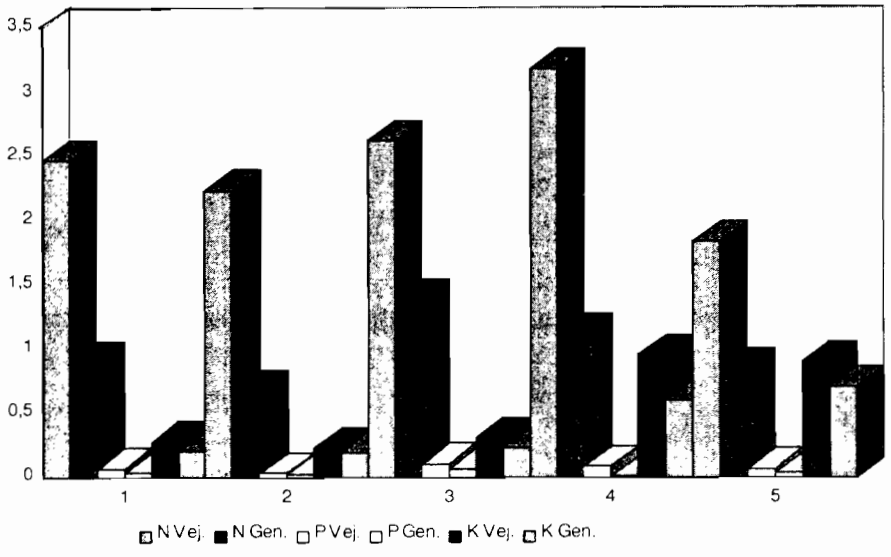

Fig. 15. N, P and K (%) concentrations in above ground parts of *N. tazetta* subsp. *tazetta*.

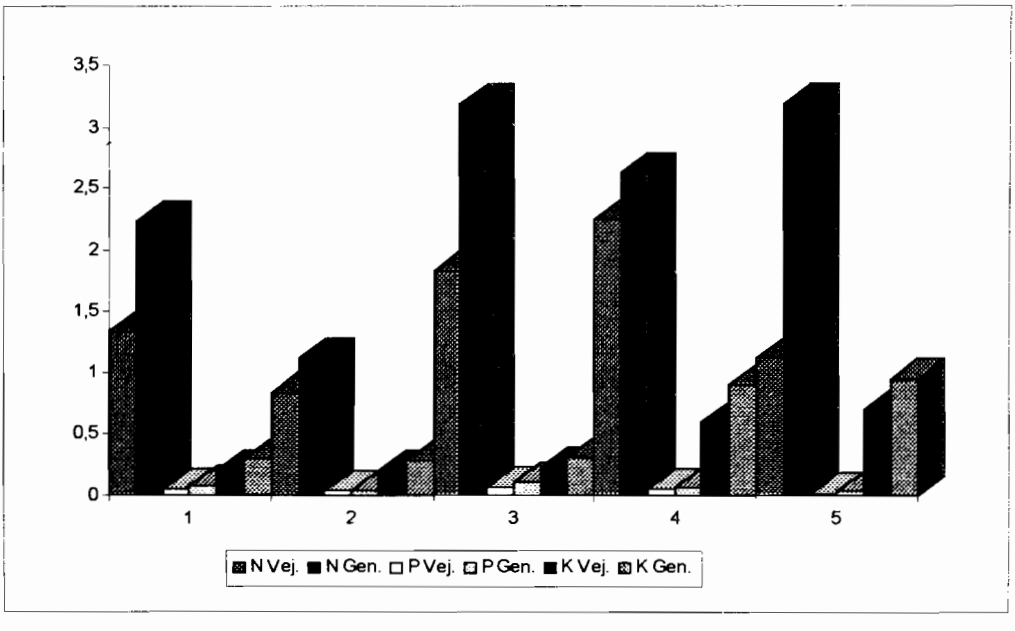

Fig. 16. N, P and K (%) concentrations in below ground parts of *N. tazetta* subsp. *tazetta*.

"Top senescence" is an important strategy to the adaptation of geophytic plants to environmental conditions and the main aim of this strategy is effective usage of nutrients. More research is needed on "top senescence" in geophytic plants for effective solution of that phenomenon. In addition to this the studied taxa have a great economical importance and the results of the present study can be evaluated in cultivation of Amaryllidaceae members.

References

Allen, S.E., H.M. Grimshaw, J.A. Parkinson, C. Quarmby and J.D. Roberts. 1986. Chemical Analysis. In: *Msthod in Plant Ecology*, (Ed.): S.B. Chapman. pp. 411-466. Blackwell Scientific Publications, Oxford.

Anderson, W. and W.G. Eickmeier. 2000. Nutrient resorption in *Claytonia virginica* L.: implications for deciduous forest nutrient cycling. *Canadian Journal of Botany*, 78: 832-839.

Bayrakli, F. 1987. *Plant and oil analy i* . University of Ondokuz Mayis, Faculty of Agriculture Publications, pp. 199, Samsun.

Baytop, T. 1984. *Phytothsrapy in Turksy From Pa t to Futurs*. Istanbul University, Department of Pharmacy Publications, Istanbul, pp. 520.

Berchtold, A., J.M. Besson and U. Feller. 1993. Effects of fertilization levels in two farming systems on senescence and nutrient contents in potato leaves. *Plant and Soil*, 78:779-783.

Canadeli, J. and M. Vilà. 1992. Variation in tissue element concentration in *Qusrcu ilsx* L. over a range of different soils. *Vsgstatio*, 99: 273-282.

Chapmann, H.D. and P.E. Pratt. 1973. *Msthod of analy i for oil , plant and watsr* . University of California Press, California.

Davis, P.H. 1984. *Flora of Turksy and ths Ea t Asgsan I land* . Vol. VIII, Edinburgh University Press, Edinburgh

Ekim, T., M. Koyuncu, S. Erik and R. İlarslan. 1989. *Li t of rars, thrsatsnsd and sndsmic plant in Turksy*. Turkish Association for Conservation of Nature and Natural Resources. pp. 227. Ankara.

Feller, U. and A. Fische:. 1994. Nitrogen metabolism in senescing leaves. *Critical Rsvisw in Plant Scisncs* , 13: 241-273.

Goryshina, T. K. 1972. Recherches écophysiologiques sur les plantes éphéméroides printanières dans les chênaies de la zone forêt-steppe de la Russie centrale. *Oscologia Plantarum*, 7: 241-258.

Jayasekera, R. 1993. Interelement relationships in leaves of tropical montane trees. *Vsgstatio*, 109: 145-151

Johnson, J.E., C.L. Haag, J. G. Bockheim and G.G. Erdmann. 1987. Soil-site relationships and soil characteristics associated with even-aged red maple (*Acsr rubrum*) stands in Wisconsin and Michigan. *Fors t Ecology and Managsmsnt*, 21: 75-89.

Knops, J.M.H. and W.D. Koenig. 1997. Soil fertility and leaf nutrients of sympatric evergreen and deciduos species of *Qusrcu* in central coastal California. *Plant Ecology*, 130:121-131.

Leopold, A. C. 1980. Aging and senescence in plant development. In: *Ssns csncs in Plant* . (Ed.): K.V. Thimann, CRC Press, California.

Méndez, M. 1999. Effects of sexual reproduction on growth and vegetative propagation in the perennial geophyte *Arum italicum* (Araceae). *Plant Biology*, 1: 115-120.

Nooden, L.D. 1984. Integration of soybean pod development and monocarpic senescence. *Phy iologica Plantarum*, 62: 273-284.

Panvini, A. D. and W.G. Eickmeier. 1993. Nutrient and water relations of the mistletoe *Phoradsndron Isucarpum* (Viscaceae) how tightly are they integrated? *Amsrican Journal of Botany*, 80: 872-878.

Pirdal, M. 1989. An autecological study on *A phodslu as tivu* Brot. *Turki h Journal of Botany*, 13: 89-101.

Powers, R.F. 1984. Estimating soil nitrogen availability through soil and foliar analysis. In: *Fors t oil and trsatmsnt impact* . (Ed.): EL. Stone, pp. 353-379. Knoxville, Tennessee.

Rawal, R.S., N.S. Bankoti, S.S. Samant and Y.P.S. Pangtey, Y.P.S. 1991. Phenology of tree layer species from the timber line around Kumaun in Central Himalaya, India. *Vsgstatio*, 93: 109-118.

Sahin, N. F. 1998. Morphological, anatomical and physiological studies on *Galanthu ikarias* Baker and *Galanthu rizshsn i* Stern (Amaryllidaceae) grown around NE Turkey. *Paki tan Journal of Botany*, 30: 117-131.

Schaefer, R.L. and R.B. Anderson.1989. *Ths tudsnt sdition of MINITAB,U sr' Manual.* Addison Wesley Publishing Company Inc., New York.

Steinmann, F. and R. Brandle. 1984. Carbohydrate and protein metabolism in the rhizomes of bulrush (*Schosnoplsctu lacu tri* (L.) Palla) in relation to natural development of the whole plant. *Aquatic Botany*, 19: 53-63.

Tato, M.P.V., L. Castedo and R. Riguera. 1988. New alkoloids from *Pancratium maritimum* L. *Hstsrocycls* , pp. 2833-2838.

Werger, M.J.A. and T. Hirose. 1991. Leaf nitrogen distribution and whole canopy photosynthetic carbon gain in herbaceous stands. *Vsgstatio*, 97: 11-20.

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