

## (*Medicago sativa* L.)

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### Phenotypic variation and relationships of important traits in elite alfalfa progenies (*Medicago sativa* L.)

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#### SUMMARY

The aim of present study was to determine phenotypic variation and the relationships between grass stand height, stems number per unit area and dry matter yield in progenies of eight elite alfalfa clones – Prista 2, 5 5, 5 7, 325, 8 Y-1, 97, 8 Y-2 and 10, of local origin. The study was carried out during 2002-2005, without irrigation in the experimental field of the Institute. The results showed that the variation in the phenotypic expression of the natural plant height traits, potential for stem formation and dry matter yield, as a quantitative traits with a high sensitivity to the environmental conditions varied more widely over the years of the study, than within elite alfalfa progenies and between them. Data showed a strong positive phenotypic correlation between dry matter yield and grass stand height, in all years of the study ( $r = 0,94$  – I<sup>st</sup> year,  $r = 0,74$  – II<sup>nd</sup> year,  $r = 0,31$  – III<sup>rd</sup>,  $r = 0,79$  – IV<sup>th</sup>) and weak relation for dry matter yield and stems number /m<sup>2</sup> ( $r = 0,04$  – I<sup>st</sup> yr,  $r = 0,05$  – II<sup>nd</sup> yr,  $r = 0,40$  – III<sup>rd</sup> yr and  $r = 0,28$  – IV<sup>th</sup>).

5, 5 7, 325, 8 -1, 97, 8  
-2 10,  
2005 ..  
2002-  
( $r = 0,94$  –  
.,  $r = 0,74$  –  
 $r = 0,79$  – V<sup>th</sup>)  
/m<sup>2</sup> ( $r = 0,04$  –  
.,  $r = 0,05$  –  
 $r = 0,28$  – V<sup>th</sup>).



Hart et al. (1988) (Monirifar, 2011).  
63%  
Ibrahim et al. (2014) o  
Mikolaskova, 1992).  
2008).  
Brummer, 2004; Petkova and Marinova, 2006; Davodi et al., 2011; Marinova and Petkova, 2013).

The stems number per unit area is the substantial indicator due to his relatively good variability, which makes it a successful criterion in selection for alfalfa forage yield increase (Monirifar, 2011).

Hart et al. (1988) claimed that the stems number per unit area is the most effective morphological trait for forage yield and reported that 63% of productivity changes are related to the variability of this component.

According Ibrahim et al. (2014) understanding the magnitude of the variability and the degree of the association between the different traits is important to provide a base for effective selection. It is known that the coefficient of variation is a useful expression of variability, indicating the degree of difference and the power of change of a given trait (Babinec and Mikolaskova, 1992).

The knowledge of relationships between important indicators provides the possibility of improvement of a larger number of traits at the same time (Tucak et al., 2008). The same authors also argued that the knowledge of correlations is especially important for traits of low genetic variability, in cases of which the progress in selection is achieved by indirect methods. In a number of studies positive correlation of dry matter yield with plant height, stems number, node number, and other traits was established (Riday and Brummer, 2004; Petkova and Marinova, 2006; Davodi et al., 2011; Marinova and Petkova, 2013).

The aim of present study was to determine phenotypic variation and the relationships between grass stand height, stand density and dry matter yield of eight elite alfalfa progenies created at IASS "Obraztsov chiflik" - Rousse.

## MATERIAL AND METHODS

The experiment was carried out from 2002 to 2005, without irrigation at the experimental field of Institute of Agriculture and Seed Science „Obraztsov chiflik” - Rousse. The progenies of eight

325, 8 -1, 97, 8 -2 10,

2002 .

10 m<sup>2</sup>.  
(cm)

5

m<sup>2</sup>,

0,250 m<sup>2</sup> (50 50 cm)  
( kg da<sup>-1</sup>)

(200 g)

105

kg da<sup>-1</sup>.

2 4

SPSS.

(2002-2005 .),

( 1).

elite alfalfa clones – Prista 2, 5 5,  
5 7, 325, 8 Y-1, 97, 8 Y-2  
and 10 of local origin were studied.

The experiment was sown in the  
spring of 2002 in a randomized block  
design with four replications and  
harvesting plot size 10 m<sup>2</sup>. Before every  
cutting, in early flowering stage, the grass  
stand height trait was recorded. It was  
done in 5 places in each harvesting plot  
for each variant from the soil surface to  
the top of the majority normally developed  
stems.

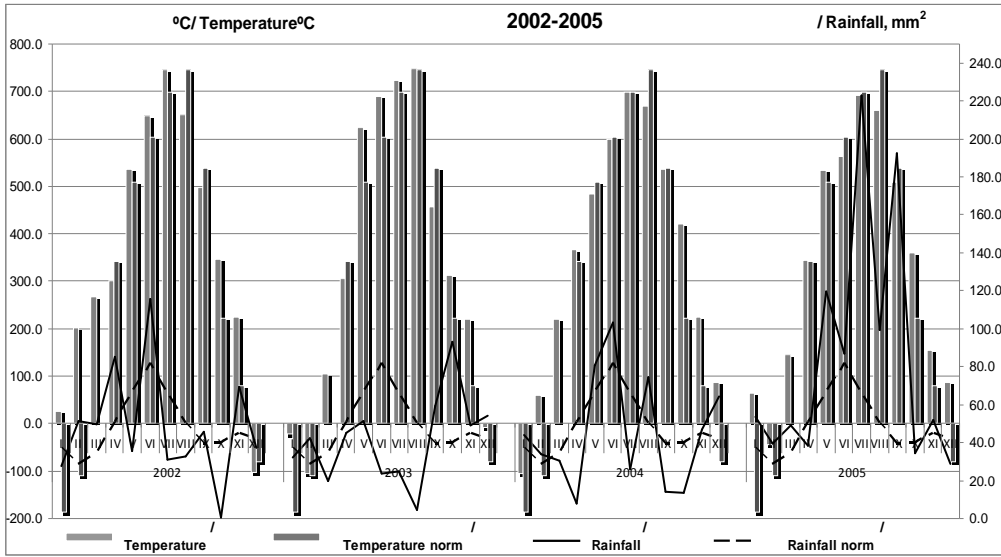
The grass stand density trait,  
expressed by stem number per m<sup>2</sup>, before  
every cutting in each harvesting plot for  
each variant by sampling plot with area  
0,250 m<sup>2</sup> (50 cm x 50 cm) was accounted.

The forage yields (kg da<sup>-1</sup>) were  
determined by regrowth, years and  
average for the study period in early  
flowering stage by weighing the green  
biomass. The dry matter content was  
calculated by drying the green mass  
sample (200 g) to constant weight in a  
drying chamber at 105°C. Data for green  
mass yield and dry matter content to dry  
matter yield determination (kg da<sup>-1</sup>) were  
used. The first experimental year 2  
cuttings were made, and in the next three  
years 4 cuttings.

Variation and correlation analysis  
has been used to establish the variation in  
forage productivity and related traits, as  
well as the relationship between them. For  
determination the variation coefficients  
and significance of correlations between  
dry matter yield and grass stand height  
and grass stand density trait  
morphological traits the SPSS software  
was used.

## RESULTS AND DISCUSSION

During the study period of elite  
progenies (2002-2005) significant  
differences in both temperature sums and  
the amount of rainfall and its distribution  
by months, years and long-term norm  
were observed (Figure 1).



**Fig. 1 Meteorological characteristic of 2002-2005**

mm) (227,4  
 2001-2002 . 215,5 mm ( - )  
 - 235,1 mm

2003-2004  
 69,5 mm.

2003  
 ( - )

165,4 mm),

Total rainfall (221,4 mm) for the autumn-winter (October 2001 - March 2002) was close to the long-term norm (235,1 mm) and provided good moisture supply. The sufficient moisture and high temperature in March ensured good germination and stand density of elite progenies. The following months (May, June, July and August) of alfalfa vegetation were characterized by temperature sums above the average for long-term period and rainfall below the average norm, which were unequally distributed. The vegetation of alfalfa stands were prolonged and was formed two regrowths.

In the coming years of the study, the amount of precipitation in the autumn-winter period was equal to the average the long-term norm and in 2003-2004 exceeded the norm by 69,5 mm. The good moisture supply provided a good start to alfalfa plants. In 2003, the active alfalfa growing season (April-August) was characterized by temperatures above the average long-term norm and rainfall significantly below norm (by 165,4 mm), which did not allowed alfalfa to manifest their yield potential.

2004 .

2005 .

21,2 mm 156,8

mm.

2002-2005 .

C

1,01% % CV=2,23%.

( ), 5 5 ( ) 8 -1

( ).

( 10%) ( 1).

(CV = 1,61%).

6,58%) (CV = 47,22%)

The amount of precipitation and the temperature sums for the period April-August 2004 did not deflected to the long-term norms. The favorable weather conditions ensured good growth and development of the studied elite progenies in all regrowths.

The spring and summer of 2005 were characterized by temperature sums close to the average the long-term norm and significant rainfall in May and July exceeding the norm by 21,2 mm and 156,8 mm, respectively. In conclusion, can be noted the meteorological conditions for the 2002-2005 period were relatively favorable for expression of productive potential of elite progenies.

There were found significant differences in phenotypic expression of the investigated traits during the study period. The values of variation coefficients showed that in the first year with the lowest variability regarding the natural plants height, the 97 progeny was distinguished, and with higher 10 CV = 1,01% and CV = 2,23 %, respectively. In the coming years, with better stability of the traits 325 and 8 Y-1 (second year), 5 5 (third) and 325 (fourth) were characterized. It can be noticed that the variation in phenotypic expression of the trait for all studied progenies were low (below 10%) and in relatively close range over the years (Table 1).

he results obtained, showed that the grass stand height varied more strongly over the years, compared to the variation within progenies and among them. In the present study, the lowest phenotypic coefficient of variation (CV = 1.61%) of the traits among progenies in the third growing season was established. The trait was demonstrated the lowest variability (CV = 6,58%) in the sowing year of experiment, and the highest (CV = 47,22%) in the last year.

1.

**Table 1. Variation coefficients for the natural plants height trait**

Variation coefficients for the trait within elite progenies								
	Prista 2 <sup>2</sup>	5 5	5 7	325	8 -1 8 Y-1	97	8 -2 8 Y-2	10
	2002							
CV,%	2,16	1,56	1,62	1,95	1,97	1,01	2,71	2,23
	2003							
CV,%	2,10	2,32	1,73	0,71	0,56	1,4	2,07	2,57
	2004							
CV,%	2,14	2,95	0,60	1,88	1,05	0,59	2,06	1,9
	2005							
CV,%	3,22	3,08	1,2	0,62	1,56	2,00	2,01	1,31
Variation coefficients for the trait among elite progenies								
	2002		2003		2004		2005	
CV%	2,86		4,35		1,61		3,83	
Variation coefficients for the trait by years								
	2002		2003		2004		2005	
CV%	6,58		29,13		24,14		47,22	

( 2). - Concerning the grass stand density trait, there were found differences in its phenotypical expression, by years, within evaluated progenies and among them (Table 2).

2.

**Table 2. Variation coefficients for the grass stand density trait**

Variation coefficients for the trait within elite progenies								
	Prista 2 <sup>2</sup>	5 5	5 7	325	8 -1 8 Y-1	97	8 -2 8 Y-2	10
	2002							
CV,%	8,44	7,71	7,83	7,19	3,32	5,77	4,02	5,87
	2003							
CV,%	2,62	5,31	3,12	2,93	3,44	3,21	3,07	5,77
	2004							
CV,%	2,52	7,83	5,65	3,53	2,50	4,31	2,4	3,52
	2005							
CV,%	6,58	7,20	8,40	7,19	2,86	2,32	5,34	3,75
Variation coefficients for the trait among elite progenies								
	2002		2003		2004		2005	
CV,%	7,45		5,98		10,25		13,91	
Variation coefficients for the trait by years								
	2002		2003		2004		2005	
CV,%	22,14		18,84		36,12		22,03	

T

20%),

(CV = 18,84%).

m<sup>2</sup>

(CV = 3,32%),

2 (CV = 4,02%).

/m<sup>2</sup>

Arab et al.

(2015)

(CV = 4,02%)

9,70%),

The tendency for more significant variation of the grass stand height over the years than within the elite progenies and among them was also observed for the grass stand density. The data showed a strong variation of the trait (CV > 20%) over the years, except the second year where a mean degree of variability was determined (CV = 18,84%). It was also established that the stems number per m<sup>2</sup> varied more strongly among elite progenies compared to the natural plants height.

The values of the phenotypic variation coefficients in the first year showed the best stability (CV = 3,32%) of the trait within 8 Y-1 progeny, followed by 8 Y-2 (CV = 4,02%). The tendency was kept in the coming years of study. For all elite progenies the degree of variability for stems number /m<sup>2</sup> was the lowest in the second and third growing seasons.

It can be noticed that the natural plants height and the potential for stems formation are quantitative traits and its degree of sensibility or response to the environmental conditions is determined by the genetic character of the individual plant or the population of plants.

Arab et al. (2015) also report that the variation for grass stand height and stems number per unit area is due to a genetically determined response to environmental conditions changing.

In respect of dry matter yield, the values of variation coefficients for the years of study determined the variability of the trait within the progenies as low (Table 3). Data showed a relatively higher phenotypic variability of the trait within progenies during the first growing season, ranging from (CV = 4,02%) to (CV = 9,70%) for 97 and 8 Y-1, respectively.



3.

**Table 2. Variation coefficients for dry matter yield**

Variation coefficients for the trait within elite progenies								
	Prista 2 <sup>2</sup>	5 5	5 7	325	8 <sup>8</sup> 8 Y-1	97	8 <sup>8</sup> 8 Y-2	10
	2002							
CV,%	7,19	8,83	5,87	9,15	9,7	4,7	9,5	5,92
	2003							
CV,%	2,03	2,14	4,13	6,70	2,2	8,75	4,65	2,85
	2004							
CV,%	2,28	8,21	4,09	2,06	2,98	3,9	3,04	3,82
	2005							
CV,%	3,69	8,8	2,26	3,24	2,46	3,17	2,37	2,63
Variation coefficients for the trait among elite progenies								
	2002		2003		2004		2005	
CV,%	12.14		8.47		4,17		7.61	
Variation coefficients for the trait by years								
	2002		2003		2004		2005	
CV,%	11,47		55,80		30,39		55,04	

(CV = 12,14%).

(CV = 55,80%),

(CV = 11,47%).

(Tucak et al., 2008).

- The low phenotypic variation coefficients of dry matter yield among progenies was also established except the first year when the trait was showed an average degree of variability (CV = 12,14%). Similar to the results for variation of plants height and grass stand density, the analyzed trait was varied more significantly over the years than within progenies and among them, except the first growing season. For the study period the highest variation coefficient in the second year (CV = 55,80%), and the best stability of the trait in the first year (CV = 11,47%) were established.

- Data from the present study confirm the well-known fact that differences in forage yield stability were probably caused by cultivar – environmental interaction whose intensity depends on genetic composition of variety and on intensity of effects of certain environmental factor (Tucak et al., 2008).

The results for the phenotypic correlation showed that the degree of the relationship between dry matter yield and

( 4).

natural plant height and grass stand density morphological traits was kept in the study years (Table 4).

4.

**Table 4. Mean phenotypic correlation between forage productivity, natural plant height and grass stand density in elite progenies**

/ Traits	Dry matter yield	Stems number/m <sup>2</sup>	Grass stand height
2002			
Dry matter yield	1		
Stems number/m <sup>2</sup>	0,04	1	
Grass stand height	0,94**	0,09	1
2003			
Dry matter yield	1		
Stems number/m <sup>2</sup>	0,05	1	
Grass stand height	0,75**	0,34*	1
2004			
Dry matter yield	1		
Stems number/m <sup>2</sup>	0,40*	1	
Grass stand height	0,31	0,13	1
2005			
Dry matter yield	1		
Stems number/m <sup>2</sup>	0,28	1	
Grass stand height	0,79**	0,30	1

\*\* , \* P 0.01 and P 0.05

\*\* , \* significant at P 0.01 and P 0.05, respectively

During the first growing season, a strong correlation between dry matter yield and natural plant height ( $r = 0,94^{**}$ ) was found. Data in table 4 showed that the stems number/m<sup>2</sup> has not influenced on dry matter yield formation ( $r = 0,04$ ). In the following year, the results for the relationship of the morphological traits to dry matter yield are similar with those in the first one. The correlation coefficient

During the first growing season, a strong correlation between dry matter yield and natural plant height ( $r = 0,94^{**}$ ) was found. Data in table 4 showed that the stems number/m<sup>2</sup> has not influenced on dry matter yield formation ( $r = 0,04$ ). In the following year, the results for the relationship of the morphological traits to dry matter yield are similar with those in the first one. The correlation coefficient

( $r = 0,40^*$ )  
 ( $r = 0,31$ )  
 ( $r = 0,79^{**}$ )  
 ( $r = 0,28$ )  
 (Julier et al., 2000,  
 Tucak et al., 2008).

values in the third growing season of elite progenies showed an average positive relationship ( $r = 0,40^*$ ) between forage productivity and plant height and weak ( $r = 0,31$ ) with grass stand density. The established phenotypic correlation between the studied traits in the last year confirmed the strong positive relationship ( $r = 0,79^{**}$ ) of dry mass yield with grass height and the weak relation ( $r = 0,28$ ) with the stems number per unit area. Similar results for a strong positive correlation between plants height and forage yield were reported by many authors (Julier et al., 2000, Tucak et al., 2008).

## CONCLUSIONS

The phenotypic expression of the traits natural plant height, stems formation ability and dry matter yields, as quantitative traits with a high sensitivity to environmental conditions, varied widely over the years of study than within elite alfalfa progenies and between them.

The studied progenies were characterized by low variability of the grass stand height, grass stand density and dry matter yield in all years of study.

Among the progenies of the elite clones, the stems number per  $m^2$  varied more widely than the grass stand height.

There was found a strong positive correlation between dry matter yield and natural plants height.

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## (*Medicago sativa* L.)

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### Competitive variety testing on morphological and economic qualities of alfalfa synthetic populations (*Medicago sativa* L.)

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#### SUMMARY

The aim of present study was a comparative test on some morphological and economic traits of seven alfalfa synthetic populations - Syn<sub>1</sub>-72, Syn<sub>1</sub>-73, MM, 6R88, Oc/MM, SS 7, created at IASS "Obraztsov chiflik" – Rousse, to be made. The study was carried out without irrigation in the experimental field of the Institute during 2007-2009. Regarding grass stand height the results showed that the highest potential and excess to the standard Prista 2 variety and mean values of populations in all years of study were determined for SS 7 and Os/MM synthetic populations. Concerning stand density trait in synthetics were detected close values, as with a better stems formation and excess to the standard SS 7 and Syn<sub>1</sub>-72 were characterized. The total productivity of synthetic populations varied widely. With the highest dry matter yield SS 7 synthetic population was distinguished, exceeding



half-sib full-sib  
(Kertikova, 2000; Kertikova, 2008; Annicchiarico et al., 2015).

(Petkova et al., 2005; Kertikova, 2001; Marinova and Petkova, 2004).

2007-2009  
Syn<sub>1</sub>-72, Syn<sub>1</sub>-73, MM, 6R88, Oc/MM, SP<sub>05</sub>, (SS 7).  
(20 ) 2007 .  
5 m<sup>2</sup>.  
(cm)  
5  
m<sup>2</sup>,  
0,250 m<sup>2</sup> (50 50 cm)  
( kg da<sup>-1</sup>)

varieties fodder legumes, including alfalfa, have been suggest d a number of selection systems: selection of the initial material based on assessment of the clones, selection of the half-sib or full-sib progenies or selfed progenies of different generations of self-pollination (Kertikova, 2000; Kertikova, 2008; Annicchiarico et al., 2015). Numerous experiments including foreign and local varieties and breeding forms under soil and climatic conditions in our country have demonstrated the advantages of Bulgarian breeding programmes (Petkova et al, 2005; Kertikova, 2001; Marinova et al, 2004).

The aim of present study was a comparative test on some morphological and economic traits of seven alfalfa synthetic populations, created at IASS "Obraztsov chiflik" – Rousse, to be made.

## MATERIAL AND METHODS

The competitive variety testing was carried out from 2007 to 2009, without irrigation at the experimental field of Institute of Agriculture and Seed Science „Obraztsov chiflik” – Rousse. Seven alfalfa synthetic populations – Syn<sub>1</sub>-72, Syn<sub>1</sub>-73, MM, 6R88, Os/MM, SP<sub>05</sub>, as well as the new synthetic population (SS 7) were examined. The Prista 2 variety as a standard was included. The experiment was sown in the spring (20 March) of 2007 in a randomized block design with four replications and harvesting plot size 5 m<sup>2</sup>.

Before every cutting, in early flowering stage, the grass stand height trait was recorded. It was done in 5 places in each harvesting plot for each variant from the soil surface to the top of the majority normally developed stems.

The grass stand density trait, expressed by stem number per m<sup>2</sup>, before every cutting in each harvesting plot for each variant was accounted. For the stem number per unit area determination the sampling plot with area 0,250 m<sup>2</sup> (50 cm x 50 cm) was used.

The forage yields (kg da<sup>-1</sup>) was determined by regrowth, years and average for the study period in early flowering stage by weighing the green biomass.

The dry matter content was

(200 g)  
 105  
 da<sup>-1</sup>.  
 - 3.  
 (ANOVA),  
 e a  
 Duncan's multiple  
 range test.  
 SPSS Statistics 19.

calculated by drying the green mass sample (200 g) to constant weight in a drying chamber at 105°C. Data for green mass yield and dry matter content to dry matter yield determination (kg da<sup>-1</sup>) were used.

The first and the second experimental year 4 cuttings were made, and the third year – 3.

For weather characterization the data for precipitations and average monthly air temperatures from meteorological station of the Institute were used.

The data for dry matter yield, grass stand height and grass stand density were analysed by the One-way analysis of variance (ANOVA) method. Significance of differences was tested by Duncan's multiple range test (DMRT). The SPSS Statistics 19 software product was used.

## RESULTS AND DISCUSSION

With respect to the weather conditions, autumn-winter (October-March) period of the economic 2006-2007 was characterized by total rainfall below the long-term norm and temperature sum (1258,2°), considerably higher than the average long-term norm (Figure 1).

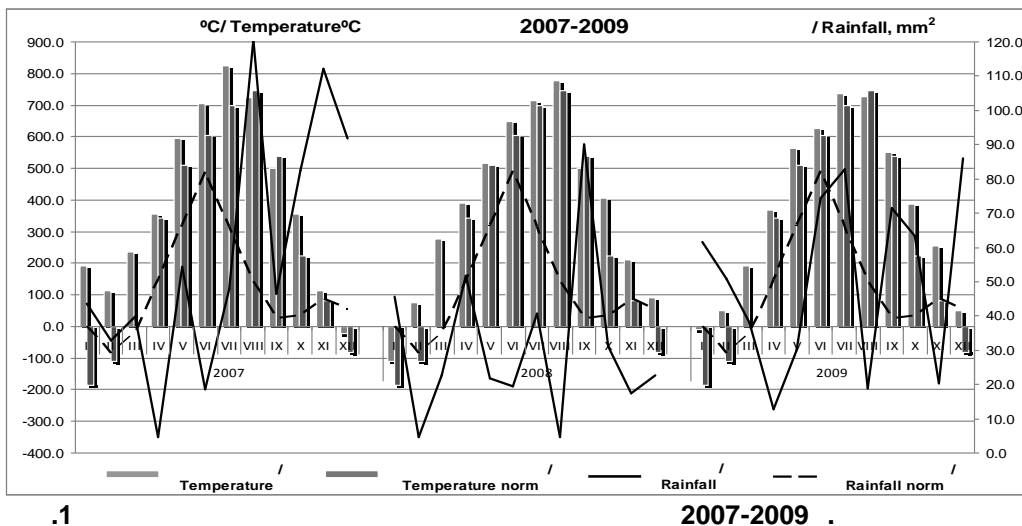


Fig. 1 Meteorological characteristic of 2007-2009





SS 7. -

7 6R88, Oc/MM SS

2.

SS 7

1,

- 49,0 cm.

SS 7,

2,

(465,65 /m<sup>2</sup>) SS 7

84,35 /m<sup>2</sup> ( 98,25 2).

The results indicated that there were statistically significant differences between synthetic populations and established superiority of SS 7. During the second growing season the trait varied in a narrower range and populations in various statistical groups had relatively equal potential. Regarding the grass stand height for the synthetic populations 6R88, Os/MM and SS 7 the similar values were ascertained and they considerably exceeded the standard Prista 2 variety.

With respect to the natural plant height the data in the third year showed keeping the tendency of high potential for SS 7 in the first and second growing seasons. For the year, based on the values obtained, the populations fall into different statistical groups. There were found significant differences between them. The summarized data for the period of study showed significant differences between all synthetics (Table 1).

The lowest values (49,0 cm) for the MM synthetic population were recorded. With the highest potential concerning the grass stand height SS 7 was distinguished, exceeding significantly both Prista 2 standard and other populations studied.

The results in the first year of the study regarding the grass stand density, expressed by stem number per unit area indicated that synthetic population 7 SS (465,65 stems/m<sup>2</sup>) significantly exceed in value of the trait both standard and the mean value for the populations with 98,25 and 84,35 stems/m<sup>2</sup>, respectively (Table 2).

With the lowest grass stand density for the growing season MM population was differed. Concerning phenotypic expression of the trait the synthetic populations into different statistical groups was distributed, and significant differences between them were established.

2.  
2007-2009 .

**Table 2. Grass stand density of alfalfa synthetic populations for 2007-2009**

Synthetic populations	/ Stem number per unit area, m <sup>2</sup>			
	2007	2008	2009	/ Mean
2 / Prista 2	451.75 de	578.25 de	479.33 abc	503.11 cd
Syn <sub>1</sub> -72	437.50 e	589.00 cde	496.67 ab	507.73 bc
Syn <sub>1</sub> -73	476.50 bc	661.00 ab	447.33 c	528.28 b
6R88	435.00 e	612.50 cd	466.67 bc	504.73 cd
Oc/MM / s/MM	490.00 b	605.00 cd	470.67 bc	521.89 bc
SS 7	453.50 cd	628.50 bc	462.00 bc	514.67 bc
05 / SP <sub>05</sub>	550.00 a	686.25 a	506.33 a	580.86 a
/ Mean	431.00 e	548.50 e	474.67 abc	484.73 d
SE	465.65	613.63	475.46	518.25
	14.08	16.15	6.67	10.25

LSD 99,5% -

LSD 99,5% - values in the columns followed by the same letter are not significantly different

548,50 /m<sup>2</sup>  
05  
686,25 SS 7,  
SS 7  
Syn<sub>1</sub>-72, 496,67 /m<sup>2</sup>.  
, SS 7  
/m<sup>2</sup>,  
SS 7  
Syn<sub>1</sub>-73.  
7,  
2

The obtained data showed a significant variability of the trait in the second year and significant differences between synthetics were found. The recorded values were in the range of 548,50 stems/m<sup>2</sup> for SP<sub>05</sub> synthetic population to 686,25 stems/m<sup>2</sup> for SS 7. The SS 7 population with considerably high potential for stem formation was again determined. During the third year, similarly to the results for grass stand height, the data showed keeping the tendency of the best grass stand density for SS 7 population of the previous two year was established. A high potential for stems number per unit area for Syn<sub>1</sub>-72 synthetic population (496,67 stems/m<sup>2</sup>) was also found. The mean values for the year indicated that SS 7 considerably exceed other synthetic populations studied.

Analysis of the results for the period of study showed that the most number of stems/m<sup>2</sup> SS 7 and Syn<sub>1</sub>-73 synthetic populations were formed. The synthetic population SS 7, significantly exceed standard Prista 2 variety and other populations, both in years and average for the period of study.

The results for the phenotypic expression of the dry matter yield, in the period of study showed that the trait

varied widely between synthetic populations (Table 3). The values for total yield from 1079,00 kg da<sup>-1</sup> to 693,00 kg da<sup>-1</sup> was ranged in the sowing year of the competitive variety experiment. The synthetic populations were distributed into different statistical groups, and significant differences between them were established. With good forage productivity Syn<sub>1</sub>-73 population (981,00 kg da<sup>-1</sup>) was differed, compared to the reported yield to Prista 2 variety – 979,00 kg da<sup>-1</sup>. The data indicated that the synthetic population SS 7 significantly exceeded both standard Prista 2 and other populations in the first year of the study.

3).  
1079,00 kg da<sup>-1</sup>  
693,00 kg da<sup>-1</sup>.  
Syn<sub>1</sub>-73 – 981,00 kg da<sup>-1</sup>,  
2 – 979,00 kg da<sup>-1</sup>.  
SS 7  
2,

**3.  
2007-2009**

**Table 3. Dry matter yield of alfalfa synthetic populations for 2007-2009**

Synthetic populations	/ Dry matter yield, kg da <sup>-1</sup>				
	2007	2008	2009	/ Mean	%
2 /Prista 2	979.00 b	1350.50 b	981.75 bc	1103.75 b	100.00
Syn <sub>1</sub> -72	92.00 bc	1291.00 bc	862.25 d	1015.08 c	91.96
Syn <sub>1</sub> -73	981.00 b	1296.25 bc	853.50 d	1043.17 bc	94.51
6R88	693.00 e	1163.00 d	749.75 e	868.92 d	78.72
Oc/MM / Os/MM	885.00 bc	1300.00 bc	904.25 cd	1031.42 c	93.45
SS 7	823.00 cd	1367.50 b	1051.75 ab	1080.75 bc	97.61
05/ SP <sub>05</sub>	1079.00 a	1498.00 a	1125.50 a	1232.17 a	111.64
/ Mean	736.00 de	1227.00cd	727.25 e	908.42 d	82.30
SE	883.50	1350.50	981.75	1071.92	
	46.03	35.23	49.38	40.95	

LSD 99,5% -

LSD 99,5% - values in the columns followed by the same letter are not significantly different

SS 7  
2.  
1367,50 kg da<sup>-1</sup>  
1051,75 kg da<sup>-1</sup>  
1163,00  
749,75 kg da<sup>-1</sup>  
Oc/MM MM.

In the second and third growing season the tendency for high forage productivity at SS 7 was kept. The population significantly exceeded the Prista 2 variety. In other synthetics the total dry matter yield ranged from 1367,50 kg da<sup>-1</sup> to 1163,00 kg da<sup>-1</sup> in the second year and from 1051,75 kg da<sup>-1</sup> to 749,75 kg da<sup>-1</sup> in the third growing season for Os/MM and MM, respectively. There was found a considerable variation of the trait and significant differences

SS 7, 1232,17 kg da<sup>-1</sup>, 2 11,64%

between synthetics.

It can be noted that the forage productivity varied a more widely between synthetic populations and the lowest yield for the period of study for MM and SP<sub>05</sub> was established. All studied synthetics fall into statistically different groups and there were statistically significant differences among them regarding the values of the indicator. The highest dry matter yield (1213,17 kg da<sup>-1</sup>) for SS 7 synthetic population was established, significantly exceeding Prista 2 variety (11,64%) and other populations studied.

### CONCLUSIONS

For alfalfa synthetic populations significant differences concerning the grass stand height were established as with the highest plants SS 7 is distinguished.

Regarding the grass stand density trait SS 7 synthetic population significantly exceeded the standard Prista 2 variety and synthetics studied.

The synthetic populations into different statistical groups were distributed concerning dry matter yield, and significant differences between them were found. The highest dry matter yield (1213,17 kg da<sup>-1</sup>) for SS 7 synthetic population was established, significantly exceeding Prista 2 variety (11,64%) and the other populations studied.

SS 7.  
SS 7  
2  
SS 7  
1232,17  
kg da<sup>-1</sup>  
2 11,64%

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## Influence of organo-mineral products on the yield of Durum wheat variety Predel

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### SUMMARY

2014-2016 .  
-  
(3000 ml/ha)  
ml/ha)  
10 m<sup>2</sup>.  
:  
-  
-  
(3000 ml/ha),  
593 kg/ha (16.9 %)

During the period 2014-2016, in the Study, Experimental and Implementation Base of the Department of Plant growing of the Agricultural University – Plovdiv a field experiment is carried out that explores the influence of two organo-mineral products: Megafol (3000 ml/ha) and Megafol protein (3000 ml/ha) on the productivity of the Durum wheat variety Predel. The treatment is done in the phases of tillering, stem elongation and ear emergence. The experiment is performed after predecessor chickpea, according to three factor experiment by the method of split plots, repeated four times, with dimensions of the land plot 10m<sup>2</sup>.

As a result of the conducted experiment, the following is found out: The tested organo-mineral products have positive influence on the productivity of the Durum wheat Predel.

The highest grain yield obtained from the Durum wheat Predel is achieved in the variant treated in the phase of tillering with the organo-mineral product Megafol (3000 ml/ha), in which the increase of the productivity average for the period of study is with 593 kg/ha (16.9 %) more than the untreated control.

18 000 ha,  
 ha - 15 % 25 %  
 (Kolev and Dechev, 2014).

(Petr, 2005; Wolber and Seemann, 2006)  
 (Delibaltova et al., 2009; Kolev et al., 2011).

(Delchev et al., 2001; Delchev et al., 2011, Kolev et al., 2015).

2014–2016  
 (3000 ml/ha)  
 ml/ha), (3000

The new organo-mineral products contribute for the higher values of the structural elements of the yield, such as: number of the spikelet per spike, number of the grains per spike, mass of the grains per spike in one plant.

**Key words:** Durum wheat, organo-mineral products, yield

## INTRODUCTION

With the acceptance of Bulgaria into the European Union we observe an upsurge of the production of Durum wheat. The lands sown with hard wheat here in Bulgaria in the last several years reach up to 18 000 ha, while the harvested yield from one hectares is with 15% to 25% lower than the ordinary wheat (Kolev and Dechev, 2014). The positive influence of the use of biologically active substances to increase the productive capacity of a number of grain cultures is proven in experiments performed abroad (Petr, 2005; Wolber and Seemann, 2006) and in our country as well (Delibaltova et al., 2009; Kolev et al., 2011). Scientific literature presents data about preparations that increase the resistance of the plants towards various stress factors such as high and low temperatures (Delchev et al., 2001; Delchev et al., 2011, Kolev et al., 2015).

In this survey we set ourselves the objective to find out what the influence is of new organo-mineral products on the productivity of Durum wheat variety Predel.

## MATERIAL AND METHODS

In the Study, experimental and implementation base of the Department of Plant growing of the Agricultural University – Plovdiv a field experiment is carried out during the period 2014-2016, which explores the influence of the following organo-mineral products: Megafol (3000 ml/ha) and Megafol protein (3000 ml/ha). The treatment is performed in the phase of tillering, stem



10 m<sup>2</sup>.

20.10 05.11. 500  
/m<sup>2</sup>  
120 kg/ha 80 kg/ha  
,  
1/2 ,  
(Yanev et al., 2008).  
:  
,  
t/ha.  
,  
t/ha.  
SPSS.

elongation and ear emergence. The experiment is performed after predecessor chickpea, according to three factor experiment by the method of split plots, repeated four times, with dimensions of the land plot 10m<sup>2</sup>.

The sowing of the Durum wheat is done within the optimal period, i.e. from 20.10 to 05.11, with sowing rate 500 germinating seeds/m<sup>2</sup> and mineral fertilization with 120 kg/ha nitrogen and 80 kg/ha phosphorus, where the entire quantity of phosphor fertilizer and 1/2 of the nitrogen fertilizer are inserted before sowing, while early in the spring the remaining quantity of the nitrogen fertilizer is inserted as a nutrition. All elements are observed of the established technology for growing Durum wheat (Yanev et al., 2008). The treatment was performed with a back sprayer.

The structural elements of the productivity are reported, namely: number of the spikelet per spike, number of the grains per spike, mass of the grains per spike (g) and grain yield (t/ha). To measure the structural elements, measurements of all variables were taken, repetitions and the values of the surveyed parameters were determined. The grain yield is reported in four variants, recalculated in t/ha. The values obtained are mathematically processed through SPSS software.

## RESULTS AND DISCUSSION

The rainfall quantity during the vegetation period of the Durum wheat is as follows: year 2014/2015 – 655.8 mm, 2015/2016 – 388.5 mm, while for the thirty-year period this amount is 419,0 mm. Among the experimental years favourable for the growth and development of the Durum wheat, with good distribution of rainfalls is the harvest year 2016.

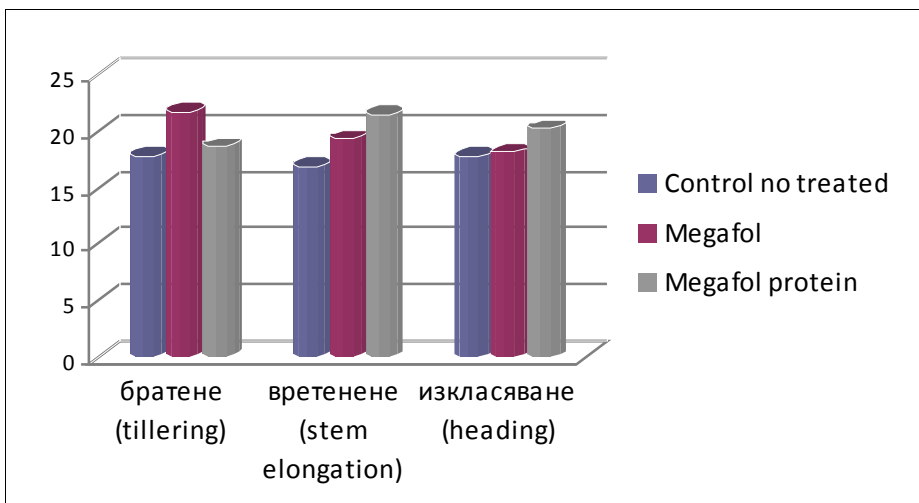
This year, even higher yields of grain were obtained from all variants. Unfavourable for the development of the plants is the first year 2014/2015 due to the drought in the month of April, when the structural elements of the yield are formed.

: 2014/2015 . –  
655.8 mm, 2015/2016 . – 388.5 mm  
419,0 mm  
2016 .  
2014/2015

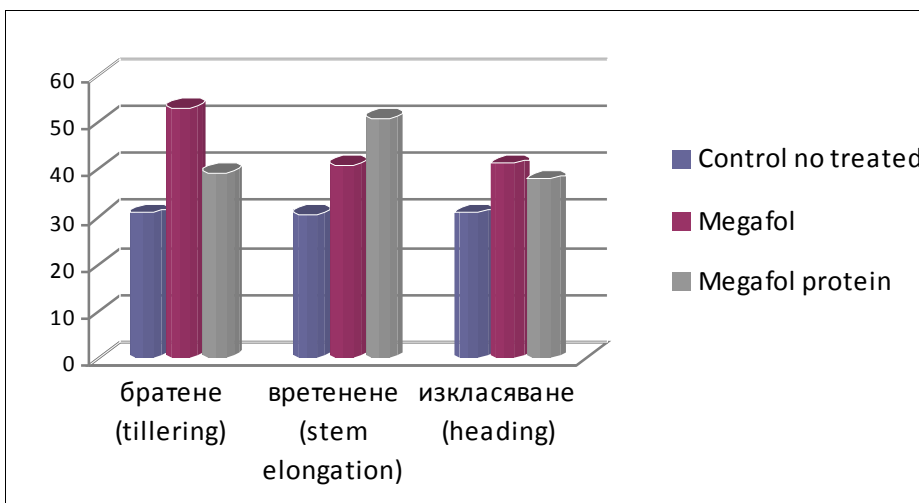
1, 2 3

(g).

- Due to the common tendency of the data during the experimental period, Figure 1, 2 and 3 shows the obtained average values of the measured biometrical indicators.
- The tested organo-mineral products influence positively for the increase of the values of the reported structural elements of the yield – number of the spikelet per spike, number of the grains per spike, mass of the grains per spike (g).



. 1. ( )  
**Fig. 1. Number of spikelets per spike (mean)**



. 2. ( )  
**Fig. 2. Number of grains per spike (mean)**

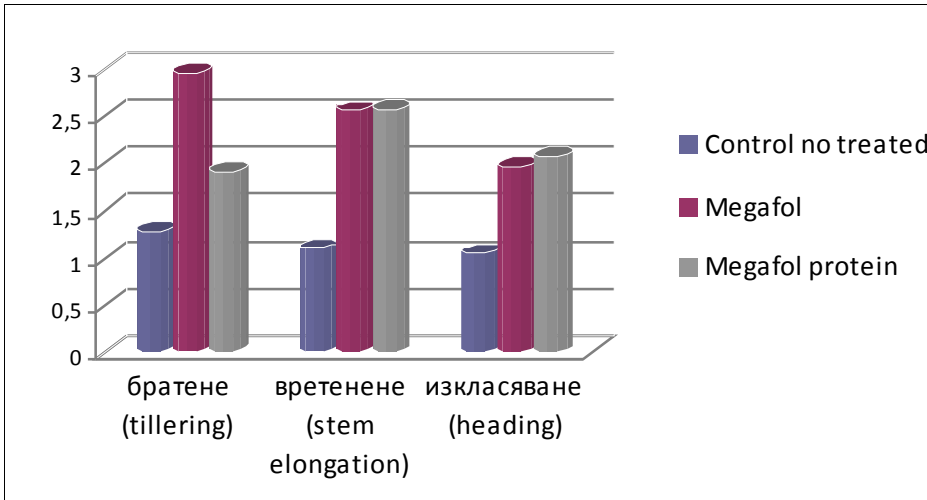


Fig. 3. Mass of grains per spike, g (mean)

3000 ml/ha, 3,9 , 22,3 . 1,677 g.

3000 ml/ha.

0,3 , 10,4 , 0,926 g.

2,4 , 7,1 , 1,029 g.

1

(3000 ml/ha).

605 kg/ha 2016 . 580 kg/ha

2015 . 593 kg/ha (16,9 %)

The largest number of the spikelet per spike, number of the grains per spike, mass of the grains per spike is achieved in the variant treated with the organo-mineral product Megafol with a dosage of 3000 ml/ha respectively with 3.9 pieces; 22.3 pieces and 1.677 g. more than the untreated control crops. On the second place is positioned the variant sprayed with the Megafol protein, but in phase of stem extension with dosage 3000 ml/ha. The smallest increase in the values of the structural elements of the yield is achieved under the influence of the tested organo-mineral products at the treatment in phase ear emergence respectively, by 0.3, 10.4, 0.926 g. with Megafol and 2.4, 7.1, 1.029 g. with Megafol protein.

Table 1 shows the data about the obtained yield for the different years and averagely for the period. The increase of the productivity of the Durum wheat variety Predel is most significant when it is treated in the phase of tillering with the organo-mineral products: Megafol (3000 ml/ha). For the different years the increase of the yield of grains for this variant varies from 605 kg/ha for the year 2016 to 580 kg/ha in the year 2015 or averagely for the period of the experiment with 593 kg/ha (16,9 %) more than the untreated control crops.

a  
3000 ml/ha  
497 kg/ha (14.4 %)

Next follow the variants sprayed with Megafol protein (3000 ml/ha) in the phase stem elongation averagely for the period of the experiment. The excess being 497 kg/ha (14.4%) over the control.

T 1.

, t/ha

**Table 1. Grain yield when treated with organo-mineral products of Durum wheat variety Predel, t/ha**

Phases of treatment	Products	2015	2016	Average	%
Tillering	Control	3,425	3,600	3,512	100,0
	Megafol	4,005	4,205	4,105	116,9
	Megafol protein	3,993	4,002	3,997	113,8
Stem elongation	Control	3,430	3,460	3,445	100,0
	Megafol	3,610	4,098	3,854	111,9
	Megafol protein	3,754	4,130	3,942	114,4
Heading	Control	3,255	3,545	3,400	100,0
	Megafol	3,589	3,953	3,771	110,9
	Megafol protein	3,552	3,936	3,744	110,1
GD 5 %		0,494	0,580	0,502	

The productivity of the Durum wheat variety Predel is due to the positive influence of the tested organo-mineral products on the structural elements of the yield. Regarding the climatic characteristics of the years during which the experiment is implemented, the highest yields from all variants are achieved in the harvest year 2016, which is favorable for the growth and development of the Durum wheat.

## CONCLUSIONS

The tested organo-mineral products influence positively the productivity of the Durum wheat variety Predel.

The highest grain yield from the

-	-
(3000 ml/ha)	593 kg/ha
(16,9 %)	-
(3000/ha)	-
497 kg/ha (14.4 %)	-
-	-
-	-
:	,
.	.

Durum wheat variety Predel is achieved in the variant treated in the phase of tillering with the organo-mineral product Megafol (3000 ml/ha), where the increase of the productivity averagely for the experimental period is with 593 kg/ha (16,9 %) more than the untreated control crops. Next follow the variants sprayed with Megafol protein (3000 ml/ha) in the phase stem elongation averagely for the period of the experiment with 497 kg/ha (14.4 %) more than the control crops.

The new organo-mineral products help for the increase of the values of the structural elements of the grains, such as: number of the spikelet per spike, number of the grains per spike, mass of the grains per spike of one plant.

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1, 2\*, 2  
 1, 5835  
 2, 4000  
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## Effectiveness of systems of herbicides in maize cultivated at agroecological conditions of Northwest Bulgaria

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### SUMMARY

2015 . 2016 .  
 6  
 435 –  
 400-500 FAO,  
 9  
 480 ( ) 42 ml/da;  
 330 ( )  
 400 ml/da 960 (s -  
 ) 150 ml/da  
 4- - 5-  
 : 600 (2,4 )  
 110 ml/da; ( )  
 - ) 200 ml/da  
 600 (2,4  
 ) 120 ml/da.

In 2015 and 2016 is displayed on an attempt by block method with 6 herbicides in the experimental field of the Institute of maize in town of Knezha. The studies are performed with a maize hybrid Knezha 435 – group 400-500 by FAO, cultivated without irrigation after predecessor – maize. Were studied 9 systems of herbicides, which include three soil preparations: Merlin Flex 480 SC (isoxaflutole) at a dose of 42 ml/da; Stomp NEW 330 EC (pendimethalin) at a dose of 400 ml/da and Dual Gold 960 EC (s-metolachlor) at a dose of 150 ml/da and three foliar preparations, applied in a phase fourth-fifths leaf of the crop, after the soil ones: Mat n 600 EC (2,4 D ester) at a dose of 110 ml/da; Laudis OD (tembotrione + isoxadifen-ethyl) at a dose of 200 ml/da and Aminopielik 600 SL (2,4 D amine salt) at a dose of 120 ml/da. Of the tested soil herbicide preparations with highest efficacy is Merlin Flex 480 SC,

80,72%.

4- - 5-

0

83,46%.

480 42 ml/da

200 ml/da -

87,68%

:

50 60% (Slavova, 2015; Tonev, 2000; Tonev, et al., 2007; Tsankova, 1998).

(Altukova, 2005; Mirskas and Tsolis, 2002; Yamakova and Dimitrov, 2002 ).

that reduces the sensitive weeds with 80.72%. Of the studied leaf herbicides – Laudis OD, applied in a phase fourth-fifths leaf of the maize is with the highest efficiency. It controls very well Johnson Grass from seeds and from rhizomes as destroys this weed to 83.46%. Under the test conditions, the herbicidal system Merlin Flex 480 SC at a dose of 42 ml/da and Laudis OD at a dose of 200 ml/da is the most efficient, destroying 87.68% of the common weeds.

**Key words:** maize, weeds, herbicides, biological efficacy

## INTRODUCTION

The chemical method is the most widespread method of combating the weeds.

It has some important advantages - high effectiveness, a fast and easy implementation. It decreases the energy and fuel costs, the risk of soil compaction, erosion processes and more. The use of herbicides decreases the costs for weed control from 50 to 60% (Slavova, 2015; Tonev, 2000; Tonev et al., 2007; Tsankova, 1998).

For maize, most commonly, the use of a soil herbicide is binding under a weed infestation with annual weeds. Foliar herbicides are applied mainly to combat perennial weeds – Creeping thistle, Johnson grass from rhizomes and more. (Altukova, 2005; Mirskas and Tsolis, 2002; Yamakova and Dimitrova, 2002).

The purpose of the present work is a survey of the biological efficacy of systems of soil and foliar herbicidal preparations for control of the weed infestation in a maize, cultivated at the agro-meteorological conditions of Northwest Bulgaria.

## MATERIAL AND METHODS

For clarifying the intended objective in 2015 and 2016 is displayed an attempt in the trial field of the Institute of maize in

400-500 , FAO, 435 –

Shanin, 1973).

25 m<sup>2</sup> (Barov and

1. 480  
600 (2,4 ) 42 ml/da +  
110 ml/da;

2. 480  
( ) 42 ml/da +  
( ) 200 ml/da;

3. 480  
( ) 42 ml/da +  
600 (2,4  
) 120 ml/da;

4. 330  
( ) 400 ml/da +  
600 (2,4 ) 110  
ml/da;

5. 330  
( ) 400 ml/da +  
( + - )  
) 200 ml/da;

6. 330  
( ) 400 ml/da +  
600 (2,4  
) 120 ml/da;

7. 960 (S-  
) 150 ml/da +  
600 (2,4 ) 110 ml/da;

8. 960 (S-  
) 150 ml/da +  
( + - )  
) 200 ml/da;

9. 960 (S-  
) 150 ml/da +  
600 (2,4  
) 120 ml/da;

10. – ( )  
) ;

11. – ( 2  
) .

the town of Knezha.

The studies are performed with a maize hybrid n zh 435 – group 400-500 by FAO, cultivated without irrigation after predecessor – maize.

The trials are pledged by a block method in 4 repetitions with a size of the experimental plot 25 m<sup>2</sup> (arov and Shanin, 1973).

The trial includes nine variants with herbicidal preparations and two controls:

1. Merlin Flex 480 SC (isoxaflutole) at a dose of 42 ml/da + Mat n 600 EC (2,4 D ester) at a dose of 110 ml/da;

2. Merlin Flex 480 SC (isoxaflutole) at a dose of 42 ml/da + Laudis OD (tembotrione + isoxadifen-ethyl) at a dose of 200 ml/da;

3. Merlin Flex SC 480 (isoxaflutole) at a dose of 42 ml/da + Aminopielik 600 SL (2,4 D amine salt) at a dose of 120 ml/da;

4. Stomp NEW 330 EC (pendimethalin) at a dose of 400 ml/da + Mat n 600 EC (2,4 D ester) at a dose of 110 ml/da;

5. Stomp NEW 330 EC (pendimethalin) at a dose of 400 ml/da + Laudis OD (tembotrione + isoxadifen-ethyl) at a dose of 200 ml/da;

6. Stomp NEW 330 EC (pendimethalin) at a dose of 400 ml/da + Aminopielik 600 SL (2,4 D amine salt) at a dose of 120 ml/da;

7. Dual Gold 960 EC (S-metolachlor) at a dose of 150 ml/da + Mat n 600 EC (2,4 D ester) at a dose of 110 ml/da;

8. Dual Gold 960 EC (S-metolachlor) at a dose of 150 ml/da + Laudis OD (tembotrione + isoxadifen-ethyl) at a dose of 200 ml/da;

9. Dual Gold 960 EC (S-metolachlor) at a dose of 150 ml/da + Aminopielik 600 SL (2,4 D amine salt) at a dose of 120 ml/da;

10. Control – zero (without hoeing, without herbicides);

11. Control – production (with 2 hoeings, without herbicides).



0,25 m<sup>2</sup> 4 (Dimitrova, et al., 2004).

14- 28-

20- 40-

400-500 : 435 -  
 FAO, 2015 – 2016  
 : (*Sorghum halepense*(L.) Pers.); (*Cirsium arvense* (L.) Scop.); (*Convolvulus arvensis* L.); (*Digitaria sanguinalis* (L.) Scop.); (*Setaria viridis* (L.) P. Beauv.); (*Setaria glauca* (L.) P. Beauv.); (*Amaranthus retroflexus* L.); (*Chenopodium album* L.); (*Solanum nigrum* L.); (*Abutilon theophrasti* Medicus); (*Datura stramonium* L.).

m<sup>2</sup>, 40 47 1  
 21 29 1 m<sup>2</sup>  
 1 m<sup>2</sup>, 13 15

he weeds are reported through a quantitative method, by counting on the species in plots with size of 0,25 m<sup>2</sup> at 4 repetitions (Dimitrova et al., 2004).

The first recording is committed on the 14th day and the second one on the 28th day after the treatment with the soil herbicidal preparations.

The efficacy of the foliar herbicidal preparations is recorded on the 20th and on the 40th day after the treatment.

The percentage of the destroyed weeds is calculated on the basis of the production control.

## RESULTS AND DISCUSSION

The results of the study on species composition of weeds in the experimental field of the Institute of maize, at non irrigated land with a maize hybrid Knezha 435 - group 400-500 by FAO show that in the period 2015-2016 year the common weeds are Johnson grass (*Sorghum halepense*(L.) Pers.); Creeping thistle (*Cirsium arvense* (L.) Scop.); Field bindweed (*Convolvulus arvensis* L.); Red finger-grass (*Digitaria sanguinalis* (L.) Scop.); Green bristle-grass (*Setaria viridis* (L.) P. Beauv.); Yellow bristle-grass (*Setaria glauca* (L.) P. Beauv.); Common amarant (*Amaranthus retroflexus* L.); Fathen (*Chenopodium album* L.); Black nightshade (*Solanum nigrum* L.); Velvetleaf (*Abutilon theophrasti* Medicus) and Thorn-apple (*Datura stramonium* L.).

There is not a significant difference in the density of weeds between the zero and production control at the first reporting of the weed infestation, because the production control has not yet committed entrenchment (Table 1). In these with a highest density average of the two years of study are perennial weeds from 40 to 47 pcs./m<sup>2</sup>, followed by annual broadleaf from 21 to 29 pcs./m<sup>2</sup> and the annual cereal from 13 to 15 pcs./m<sup>2</sup>, respectively in the zero and the production control. At the second reporting of weed infestation in the

controls, the number of weeds was significantly more compared with the first one (Table 2).

1.  
14-

**Table 1. Efficacy of the studied soil herbicidal preparations on the 14th day after their application**

Variants	Year	Weeds (pcs./m <sup>2</sup> )				% Efficacy %
		Annual cereal	Annual broadleaf	Multi-annual	Total weeds	
Zero control	2015	11	29	35	75	
	2016	15	30	45	90	
	average	13	29,5	40	82,5	
Production control	2015	14	19	43	76	
	2016	16	24	52	92	
	average	15	21,5	47,5	84	
480 42 ml/da Merlin Flex 480 SC	2015	7	8	14	29	61,33
	2016	3	4	6	13	85,56
	average	5	6	10	21	73,44
330 400 ml/da Stomp NEW 330 EC -	2015	2	5	16	23	69,33
	2016	5	9	18	32	64,44
	average	3,5	7	17	27,5	66,89
960 150 ml/da Dual Gold 960 EC -	2015	3	8	19	30	60,00
	2016	7	10	22	39	56,67
	average	5	9	20,5	34,5	58,33

480  
73,44%  
( 1 2).

80,72%

480

From the soil preparations, Merlin Flex SC 480 is with a highest efficiency with 73.44% destroyed weeds at the first reporting and 80.72% destroyed weeds at the second reporting (Table 1 and Table 2). This is due to the fact that it destroys as many cereal weed species, also and a part of the annual broadleaf weeds. Merlin Flex 480 SC controls very well Johnson grass from seeds and from rhizomes. The leaves of the weed turn white due to degradation of chlorophyll under the influence of isoxaflutole. Johnson grass is severely hindered or completely dies, that's why the weed does not adversely affect to the growth

2015 . 4,18%.

480

5-6 ( 5-6 cm) 10-12

2.

and the development of the maize. It is striking that in 2016 at the second reporting, the effectiveness of the preparation is higher than in 2015 with 4.18 percent. This is due to a fallen rain in the period between the first and second reporting, and as it is known the herbicidal activity of Merlin Flex SC 480 is activated by rain.

The advantage of the preparation is that after prolonged droughts, the first fallen rain activates it and even do grow, but not too grown weed plants (with a height of 5-6 cm) after 5-6 days to turn white and they perished after 10-12 days.

28-

**Table2.Efficacy of the studied soil herbicidal preparations on the 28th day after their application**

Variants	Year	./m <sup>2</sup>				% Efficacy %
		Annual cereal pcs./m <sup>2</sup>	Annual broadleaf pcs./m <sup>2</sup>	Multi-annual pcs./m <sup>2</sup>	Total weeds pcs./m <sup>2</sup>	
Production control	2015	17	43	57	27	
	2016	24	37	67	28	
	c average	20,5	40	62	27,5	
Zero control	2015	16	41	52	89	
	2016	18	43	78	109	
	c average	17	42	65	99	
480 - 42 ml/da Merlin Flex 480 SC - 42 ml/da	2015	5	8	12	25	78,63
	2016	7	4	11	22	82,81
	average	6	6	11,5	23,5	80,72
330 - 400 ml/da Stomp NEW 330 EC - 400 ml/da	2015	8	11	31	50	57,26
	2016	11	18	41	70	45,31
	c average	9,5	14,5	36	60	51,29
960 - 150 ml/da Dual Gold 960 EC - 150 ml/da	2015	4	12	26	42	64,10
	2016	14	24	31	69	46,09
	average	9	18	28,5	55,5	55,10

480 | Moreover Merlin Flex SC 480 is not phytotoxic to the researched maize

(Marinov-Serafimov and Golubanova, 2015 ) (Marinov-Serafimov and Golubanova, 2015b) (21 ml/da, 42 ml/da 63 ml/da) 480 ( 8-9), ( 9, Vercors, Kazitachi, Piper True).

330 (66,89 % 51,29 % 960 (58,33 % 55,10 %) ( 1 2), 960

2016 . /m<sup>2</sup>, /m<sup>2</sup>. 2015 52 75 ( 3 4). ( . 2, . 5 . 8), 87,68 %, 73,67 % 67,51 20- 83,46 %, 70,43 % 63,10 % 40- ( 3 4).

hybrid, but it is phytotoxic to others cereals. According to the studies of Marinov Serafimov and Golubanova (2015 and 2015b) II tested doses (21 ml/da, 42 ml/da and 63 ml/da) of the herbicidal preparation Merlin Flex SC 480, applied in Sudan grass has a strong phytotoxic effect (score 8 - 9) and after that a lethal effect on all tested varieties of Sudan grass (*Voronezhskaya* 9, *Vercors*, *Kazitachi*, *Piper* and *True*).

The other soil herbicides also showed a good efficacy. The efficacy of the Stomp New 330 EC (66.89% destroyed weeds at the first and 51.29% destroyed weeds in the second reporting) is higher, compared with that of Dual Gold 960 EC (58.33% destroyed weeds and 55.10% destroyed weeds) (Table 1 and Table 2). That is due to a certain extent type of the weed infestation. At the areas, dominated by broadleaf weeds, thus Dual Gold 960 EC as a preparation mainly for control of annual cereal weeds failed to show a sufficiently high efficacy at an observed type weed infestation.

When it is reporting the effectiveness of the foliar herbicidal preparations, the density of the weeds in the production control is high. Average for 2015 and 2016 at the first reporting it is 52 pcs./m<sup>2</sup>, and at the second reporting it is 75 pcs./m<sup>2</sup>. This is due to the two hoeings in the period between the second reporting and the treatment, but without an applying of herbicides (Table 3 and Table 4).

The leaf herbicidal preparation Laudis OD is with a highest efficacy. At all the three variants (lime. 2 lime. 5 and lime. 8) in which it starred, the percentage of destroyed weeds is greatest, respectively 87.68%, 73.67% and 67.51 on the 20th day after the treatment and 83.46%, 70.43% and 63.10% on the 40th day after the treatment (Table 3 and Table 4).

## 3.

## 20-

**Table 3. Efficacy of the explored systems of soil and foliar herbicidal preparations on the 20th day after the vegetative treatment**

Variants	Year	/m <sup>2</sup>					% Efficacy %
		Annual cereal pcs./m <sup>2</sup>	Annual broadleaf pcs./m <sup>2</sup>	Multiannual pcs./m <sup>2</sup>	Total weeds pcs./m <sup>2</sup>		
Production control	2015	6	13	28	47		
	2016	5	10	42	57		
	c average	5,5	11,5	35	52		
Merlin Flex 480 SC 42 ml/da + Mat n 600 EC 110 ml/da	2015	5	2	18	25	69,51	
	2016	3	2	26	31	74,17	
	average	3	2	22	28	71,84	
+ Merlin Flex 480 SC - 42 ml/da + Laudis OD - 200 ml/da	2015	2	1	9	12	85,37	
	2016	1	0	11	12	90,00	
	average	1,5	0,5	7	12	87,68	
Merlin Flex 480 SC - 42 ml/da + Aminopielik 600 SL - 120 ml/da	2015	5	3	20	28	65,85	
	2016	3	2	29	34	71,67	
	average	4	2,5	24,5	31	68,76	
Stomp NEW 330 EC 400 ml/da + Mat n 600 EC 110 ml/da	2015	4	2	27	33	59,76	
	2016	4	3	32	39	67,50	
	c average	4	2,5	29,5	36	63,63	
Stomp NEW 330 EC - 400 ml/da + Laudis OD - 200 ml/da	2015	2	1	19	22	73,17	
	2016	3	2	26	31	74,17	
	average	2,5	1,5	22,5	26,5	73,67	
Stomp NEW 330 EC 400 ml/da + Aminopielik 600 SL - 120 ml/da	2015	5	4	20	29	64,63	
	2016	4	3	38	45	62,50	
	c average	4,5	3,5	29	37	63,57	
Dual Gold 960 EC - 150 ml/da + Mat n 600 EC 110 ml/da	2015	8	4	20	32	60,98	
	2016	6	3	38	47	60,83	
	average	7	3,5	29	39,5	60,90	
Dual Gold 960 EC - 150 ml/da + Laudis OD - 200 ml/da	2015	3	12	13	28	65,85	
	2016	2	14	21	37	69,17	
	average	2,5	13	17	32,5	67,51	
Dual Gold 960 EC - 150 ml/da + Aminopielik 600 SL - 120 ml/da	2015	7	4	22	33	59,76	
	2016	6	3	35	44	63,33	
	c average	6,5	3,5	28,5	38,5	61,54	

## 4.

## 40-

**Table 4. Efficacy of the explored systems of soil and foliar herbicidal preparations on the 40th day after the vegetative treatment**

Variants	Year	/m <sup>2</sup>		/m <sup>2</sup>		%
		Annual cereal pcs./m <sup>2</sup>	Annual pcs./m <sup>2</sup>	Multianual pcs./m <sup>2</sup>	Total weeds pcs./m <sup>2</sup>	
Production control	2015	9	15	48	72	
	2016	8	14	56	78	
	average	8,5	14,5	52	75	
+ 480 - 42 ml/da 600 110 ml/da Merlin Flex 480 SC - 42 ml/da + Mat n 600 EC - 110 ml/da	2015	7	4	23	34	68,22
	2016	6	4	32	42	67,19
	average	6,5	4	27,5	38	67,71
+ 480 42 ml/da + 200 ml/da Merlin Flex 480 SC - 42 ml/da + Laudis OD - 200 ml/da	2015	1	0	16	17	84,11
	2016	0	0	22	22	82,81
	average	0,5	0	19	19,5	83,46
+ 480 - 42 ml/da 600 120 ml/da Merlin Flex 480 SC - 42 ml/da +Aminopielik 600 SL - 120 ml/da	2015	6	6	27	39	63,55
	2016	5	6	35	46	64,06
	average	5,5	6	31	42,5	63,81
+ 330 - 400 ml/da + 600 110 ml/da Stomp NEW 330 EC - 400 ml/da+ Mat n 600 EC -110 ml/da	2015	6	1	33	40	62,62
	2016	9	3	43	55	57,03
	average	7,5	2	38	47,5	59,82
+ 330 - 400 ml/da + 200 ml/da Stomp NEW 330 EC - 400 ml/da + Laudis OD - 200 ml/da	2015	5	4	20	29	72,90
	2016	7	6	28	41	67,97
	average	6	5	24	35	70,43
+ 330 400 ml/da + 600 120 ml/da Stomp NEW 330 EC 400 ml/da + Aminopielik 600 SL - 120 ml/da	2015	7	4	27	38	64,49
	2016	5	5	42	52	59,38
	average	6	4,5	34,5	45	61,93
+ 960 150 ml/da + 600 110 ml/da Dual Gold 960 EC - 150 ml/da + Mat n 600 EC - 110 ml/da	2015	9	4	26	39	63,55
	2016	9	6	49	64	50,00
	average	9	5	37,5	51,5	56,78
+ 960 150 ml/da + 200 ml/da Dual Gold 960 EC - 150 ml/da+ Laudis OD - 200 ml/da	2015	3	2	33	38	64,49
	2016	5	3	41	49	61,72
	average	4	2,5	37	43,5	63,10
+ 960 150 ml/da + 600 - 120 ml/da Dual Gold 960 EC - 150 ml/da + Aminopielik 600 SL - 120 ml/da	2015	8	4	23	35	67,29
	2016	11	5	48	64	50,00
	average	9,5	4,5	35,5	49,5	58,64

600

600

The leaf herbicidal preparations Maton 600 EC and Aminopielik 600 SL, under the test conditions are with a good



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## Floristic study of the „Chivira“ protected area, Mt Sredna Gora, Bulgaria

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### SUMMARY

The species composition, phytogeographical elements and conservation value of higher plants in the protected area 'Chivira' Mt Sredna Gora, was conducted using the methods of floristic analysis. From the established 174 higher plants, belonging to 116 genera and 39 families, 16 have conservation value. The comparative analysis shows that the perennial herbaceous plants are dominating in the studied area with 72% of the established species. In the biological spectrum of the PA, prevail live form is Hemicryptophyta. Regarding to phytogeography spectrum majority have the Euro-Asiatic species.

The horological analysis shows that the 15 species, have not mentioned to be found either in the floristic region Sredna Gora (East). The analysis of the anthropogenic impact on the protected area shows that it is more intensive in the centre of the investigated area, than in the entire territory. The existing permanently

- impact had summary effect, expressing in the invasion of the species, closely connected with the human activities.

**Key words:** flora, protected area, species composition, flora, conservation value

## INTRODUCTION

- Currently the protected areas are the only place in Bulgaria where flora and vegetation can be conserved.

- For this reason, it is important to identify and study the plants in them, especially the rare species (Vladimirov, 2014).

- Systematic phytoecological studies in the protected areas of Mt Sredna Gora floristic region have not been carried out. In that aspect 'Chivira' area has not been explored. It was declared a protected area by Order No. RD-326 of 31 March 2003 of the Ministry of Environment and Waters.

- In one of the oldest descriptions of vegetation, Toshev (1903) divided Mt Sredna Gora into 4 zones according to vegetation: 1. *Paliurus* zone; 2. *Eichenzone* zone; 3. *Fagus sylvatica* zone, to which the scarce zone of coniferous trees was also assigned; 4. Lower Alps zone. Spread of *Fagus sylvatica* zone is prevailing.

- Ganchev (1965) described vegetation only on the eastern slopes of Mt Sredna Gora, underlining the comparatively limited plant species diversity.

- Velchev (1971) and Kochev (1969) determined common fir, hornbeam and black pine as subdominant in common beech associations of a mixed tree stand.

- Velchev et al. (1968) contributed to the study of flora in Sashtinska and Ihtimanska Sredna Gora Mt. They identified both rare and widespread plants in this floristic region. The identified rare relict species *Paeonia mascula* (L.) Miller and the endemic species *Verbascum nobile* Vel. were an important contribution

326

31.03.2003 .

, Toshev (1903),  
4 : 1.  
*Paliurus*; 2. *Eichenzone*; 3.  
*Fagus sylvatica*,

; 4.

Ganchev (1965)

Velchev (1971) Kochev (1969)

Velchev et al. (1968).

*Paeonia mascula* (L.) Miller,  
*Verbascum nobile* Vel.  
*Alkanna primuliflora* Griseb.  
*Crocus olivieri* J. Gay.  
*Adonis autumnalis*  
 L.  
 Stanev (1973;  
 1975),  
*Oryzopsis holciformis* (M.B.) Hack.; *Rumex*  
*tuberosus* L.; *Silene trinervia* Seb et Mauri;  
*Lathyrus aureus* (Stev.) Brandza; *Hypericum*  
*hirsutum* L.; *Amelanchier ovelis* Med.; *Carex*  
*depauperata* Good.; *Ophris cortuna* Stev.;  
*Iris sintenisii* Jka.

to the study. The northernmost distribution of the species *Alkanna primuliflora* Griseb. and *Crocus olivieri* J. Gay. in Bulgaria was also established. *Adonis autumnalis* L. species was mentioned for the first time for that floristic region.

In the published by Stanev (1973; 1975) floristic materials about Eastern Sredna Gora Mt. were mentioned some new and rare plant species for that floristic region – *Oryzopsis holciformis* (M.B.) Hack.; *Rumex tuberosus* L.; *Silene trinervia* Seb et Mauri; *Lathyrus aureus* (Stev.) Brandza; *Hypericum hirsutum* L.; *Amelanchier ovelis* Med.; *Carex depauperata* Good.; *Ophris cortuna* Stev.; *Iris sintenisii* Jka. etc.

The aim of the present study was to enrich modern scientific information about the flora in 'Chivira' protected area as part of Mt Sredna Gora floristic region and evaluate the conservation value of the established plant species in the protected area and to analyze the anthropogenic effect on them.

## MATERIAL AND METHODS

The protected area belongs to Natura 2000 Network as part of Sredna Gora zone, which was included in the list of protected areas for the conservation of natural habitats and of wild flora and fauna by Decision No. 661 of 16 September 2007 of the Council of Ministers, under Directive 92/43/EEC on the conservation of natural habitats (Figure 1).

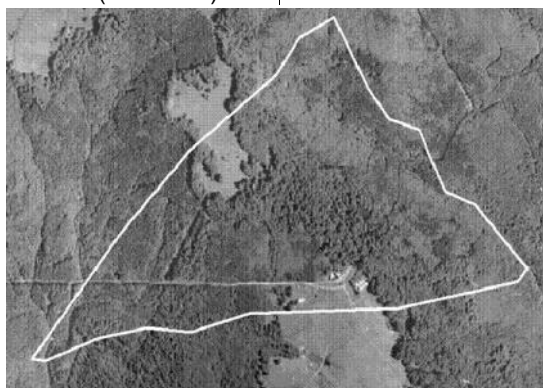


Fig.1. Ortho-photography of 'Chivira' protected area, Mt Sredna Gora, Bulgaria

2016 . (III - XII).

(Delipavlov et al., 1992).

The International Plant Names Index (IPNI). (<http://ipni.org/ipni/plantnamesearchpage.do>).

Raunkiaer (1937)

(Asyov and Petrova, 2012).

” 2011);

2009);

(Petrova and Vladimirov,

The study of the species composition of flora in ‘Chivira’ protected area was carried out by field surveys over a network of routes for maximum coverage of the area. The seasonal dynamics in the species composition of coenoses was determined by descriptions repeated at several stages during the vegetation season of 2016 (March through December). Following the transect routes the established taxa were recorded in field lists. Chorological information including the date, habitat, altitude and exposure of the site was collected for each identified species.

When there were difficulties in identifying some plant species on the site, herbarium materials were collected for subsequent identification. Systematization of the field lists, the identification of the collected materials and processing of the data obtained during fieldwork were carried out under laboratory conditions.

The following sources were used as a taxonomic basis for identification of the plant species: Flora of the Republic of Bulgaria, vol. I-X (Yordanov, 1963-1967); Guidebook to the plants in Bulgaria (Delipavlov et al., 1992).

Names of the species were updated according to ‘The International Plant Names Index: IPNI: (<http://ipni.org/ipni/plantnamesearchpage.do>).

The biological spectrum of the live form was determined on the methods of Raunkiaer (1937).

For determining the chorology and floral elements of the flora in the protected area ‘Chivira’ was used ‘Synopsis of Higher Flora of Bulgaria’ (Assyov and Petrova, 2012)

As reference books and documents for identifying the species with conservation value were used: RB – ‘Red Book of the Republic of Bulgaria’ (Peev, 2011); ABA – Applications of the Biodiversity Act (2002); RLVPB – Red List of Vascular Plants in Bulgaria’ (Petrova and Vladimirov, 2009); the Applications of

(CITES, 1975); – the Convention on International Trade with Endangered Species of Wild Fauna And Flora (CITES, 1975); ECE – the List of Rare, Endangered and Endemic Plants in Europe (Lucas, 1983); the Red List of IUCN (2015) and the BC – Berne Convention (1979). The plant species with conservation value are indicated in Table 1 with “+” in the presence of the respective normative document.

## RESULTS AND DISCUSSION

Observations performed at different stages of the vegetation season made it possible to identify a relatively large number of plant species, i.e. 174, belonging to 114 genera and 39 families. Taking into account comparatively limited diversity of plant species in the associations of *Fagus sylvatica* L., referred to in a number of publications – Michalik (1985), Apostolova (1987), Velchev et al. (2000) (Appendix 1).

1.

“ ”,

### Appendix 1. List of the established plant species in ‘Chivira’ protected area in Mt Sredna Gora, Bulgaria

<b>Apiaceae</b>	Anthriscus	<i>A. sylvestris</i> (L.) Hoffm.
	Conium	<i>C. maculatum</i> L.
<b>Apocynaceae</b>	Vinca	<i>V. herbacea</i> Walds. et Kit.
<b>Asteraceae</b>	Achillea	<i>A. millefolium</i> L. <i>A. setacea</i> Walds. et Kit.
	Artemisia	<i>A. vulgaris</i> L.
	Centaurea	<i>C. pannonica</i> Hayek
	Cirsium	<i>C. phrygia</i> L. <i>C. arvense</i> (L.) Scop.
	Crepis	<i>C. praemorsa</i> (L.) Tausch. <i>C. tectorum</i> L.
	Hieracium	<i>H. hoppeanum</i> Waiir. ex Nyman <i>H. villosum</i> Lapeyr
	Lactuca	<i>L. serriola</i> L.
	Lapsana	<i>L. communis</i> L.
	Mycelis	<i>M. muralis</i> Dummort.
	Tanacetum	<i>T. corymbosum</i> (L.) Sch.-Bip <i>T. macrophyllum</i> Simonk.
	Taraxacum	<i>T. officinal</i> F.H.Wigg.
	Tussilago	<i>T. farfara</i> L.

<b>Betulaceae</b>	Betula	<i>B. pendula</i> Roth
	Carpinus	<i>C. betulus</i> L.
<b>Boraginaceae</b>	Cynoglossum	<i>C. hungaricum</i> Simonk.
	Myos tis	<i>M. alpestris</i> F.W.Schmidt
	Pulmonaria	<i>P. rubra</i> Schott
	Symphytum	<i>S. bulbosum</i> K.F.Schimp. <i>S. tuberosum</i> L.
<b>Brassicaceae</b>	Alliaria	<i>A. petiolata</i> ( <i>M.Bieb.</i> ) Cavara et Grande
	Arabis	<i>A. turrita</i> L.
	Barbarea	<i>B. longirostris</i> Velen.
	Brassica	<i>B. nigra</i> (L.)W.D.J.Koch
	Capsella	<i>C. bursa-pastoris</i> (L.) Med.
	Cardamine	<i>C. flexuosa</i> With.
		<i>C. hirsut</i> L.
		<i>C. impatiens</i> L.
Dentaria	<i>D. bulbifera</i> L.	
Rorippa	<i>R. austriaca</i> Spach	
<b>Campanulaceae</b>	Campanula	<i>C. macrostachya</i> Willd. <i>C. persicifolia</i> L.
<b>Caryophyllaceae</b>	Arenaria	<i>A. biflora</i> L.
	Holosteum	<i>H. umbellatum</i> L.
	Lychnis	<i>L. coronaria</i> (L.) Desr.
	Scleranthus	<i>S. annuus</i> L.
	Silene	<i>S. italica</i> (L.)Pers.
		<i>S. vulgaris</i> (Moench.) Garcke
	Stellaria	<i>S. holostea</i> L.
<i>S. media</i> Sibth.		
Viscaria	<i>V. vulgaris</i> Roehl.	
<b>Cistaceae</b>	Helianthemum	<i>H. nummularium</i> Grosser
<b>Cupressaceae</b>	Juniperus	<i>J. sibirica</i> Burgsd.
<b>Cyperaceae</b>	Blysmus	<i>B. compressus</i> Panz.
		<i>C. divulsa</i> Stokes
	Carex	<i>C. hirta</i> L.
		<i>C. pseudocyperus</i> L.
		<i>C. spicata</i> Huds.
		<i>C. sylvatica</i> Huds.
<b>Dioscoreaceae</b>	Thamus	<i>T. communis</i> L.
<b>Dipsacaceae</b>	Scabiosa	<i>S. columbaria</i> L.
<b>Euphorbiaceae</b>	Euphorbia	<i>E. amygdaloides</i> L.
		<i>E. salicifolia</i> Host.
<b>Ericaceae</b>	Vaccinium	<i>V. vitis-idaea</i> L.
<b>Fabaceae</b>	Astragalus	<i>A. glycyphyllos</i> L.
	Chamaecytisus	<i>C. albus</i> (Hacg.) Rothm.
	Chamaespartium	<i>C. sagitale</i> (L.) Gibbs
	Dorycnium	<i>D. herbaceum</i> Vill.
		<i>L. hirsutus</i> L.
	Lathyrus	<i>L. laxiflorus</i> Kuntze
<i>L. laxiflorus</i> Kuntze		

	Robinia	<i>R. pseudoacacia</i> L.
	Trifolium	<i>T. alpestre</i> L.
		<i>T. badium</i> Schreb.
		<i>T. medium</i> L.
		<i>T. montanum</i> L.
		<i>T. pratense</i> L.
		<i>T. repens</i> L.
	Vicia	<i>V. villosa</i> Roth
<b>Fagaceae</b>	Fagus	<i>F. sylvatica</i> L.
	Quercus	<i>Q. cerris</i> L.
<b>Geraniaceae</b>	Geranium	<i>G. bohemicum</i> L.
		<i>G. dissectum</i> L.
		<i>G. macrorrhizum</i> L.
		<i>G. robertianum</i> L.
		<i>G. sanguineum</i> L.
<b>Hypericaceae</b>	Hypericum	<i>H. elegans</i> Stephan ex Willd. <i>H. perforatum</i> L.
<b>Hypolepidaceae</b>	Pteridium	<i>P. aquilinum</i> (L.) Kuhn
<b>Juncaceae</b>	Luzula	<i>L. forsteri</i> Lej.
		<i>L. luzuloides</i> (Lam.) Dandy
<b>Lamiaceae</b>	Ajuga	<i>A. genevensis</i> L.
		<i>A. reptans</i> L.
	Ballota	<i>B. nigra</i> L.
	Clinopodium	<i>C. vulgare</i> L.
	Melittis	<i>M. melissophyllum</i> L.
	Mentha	<i>M. longifolia</i> (L.) Huds.
	Prunella	<i>P. vulgaris</i> L.
		<i>P. sylvatica</i> L.
	Stachys	<i>S. germanica</i> L.
		<i>S. sylvatica</i> L.
<i>S. scordium</i> L.		
Teucrium	<i>T. chamaedrys</i> L.	
	<i>T. montanum</i> L.	
	<i>T. scordium</i> L.	
Thymus	<i>T. pulegioides</i> L.	
<b>Liliaceae</b>	Lilium	<i>L. martagon</i> L.
<b>Onagraceae</b>	Circea	<i>C. lutetiana</i> L.
	Epilobium	<i>E. montanum</i> L.
<b>Orchidaceae</b>	Neottia	<i>N. nidus-avis</i> (L.) Rich.
<b>Oxalidaceae</b>	Oxalis	<i>O. acetosella</i> L.
<b>Pinaceae</b>	Abies	<i>A. alba</i> Mill.
	Picea	<i>Picea abies</i> (L.) H.Karst.
	Pinus	<i>Pinus sylvestris</i> L.
<b>Poaceae</b>	Agrostis	<i>A. capillaris</i> L.
	Anthoxanthum	<i>A. odoratum</i> L.
	Bromus	<i>B. tectorum</i> L.
	Dactylis	<i>D. glomerata</i> L.
	Festuca	<i>F. drymeja</i> Mert. & W.D.J.Koch
		<i>F. gigantea</i> (L.) Vill.
		<i>F. pratensis</i> L.

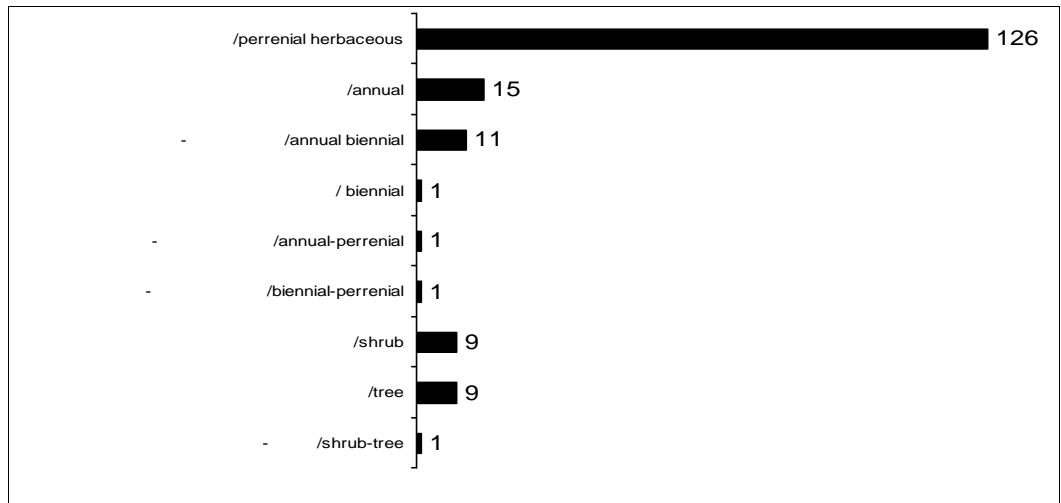
		<i>F. rubra</i> L.
	Holcus	<i>H. lanatus</i> L.
	Lerchenfeldia	<i>L. flexuosa</i> Schur
	Melica	<i>M. uniflora</i> Retz.
	Molinia	<i>M. c erulea</i> (L.) Moench.
		<i>P. annua</i> L.
	Poa	<i>P. bulbosa</i> L.
		<i>P. nemoralis</i> L.
		<i>P. pratensis</i> L.
<b>Polygonaceae</b>	Polygonum	<i>P. aviculare</i> L.
		<i>R. acetosella</i> L.
	Rumex	<i>R. crispus</i> L. <i>R. patientia</i> L.
<b>Primulaceae</b>	Primula	<i>P. veris</i> L.
	Lysimachia	<i>L. vulgaris</i> L.
<b>Plantaginaceae</b>	Plantago	<i>P. major</i> L. <i>P. lanceolata</i> L.
<b>Ranunculaceae</b>	Anemone	<i>A. nemorosa</i> L. <i>A. sylvestris</i> L.
	Helleborus	<i>H. odorus</i> Waldst. & Kit. ex Willd
	Hepatica	<i>H. nobilis</i> Mill.
	Ranunculus	<i>R. bulbosus</i> L. <i>R. polyanthemos</i> L. <i>R. repens</i> L.
<b>Rosaceae</b>	Aremonia	<i>A. agrimonoides</i> (L.) DC.
	Fragaria	<i>F. vesca</i> L.
	Geum	<i>G. urbanum</i> L.
		<i>P. argentea</i> L.
	Potentilla	<i>P. micrantha</i> Ramond ex DC. <i>P. patula</i> Waldst. & Kit.
	Prunus	<i>P. cerasifera</i> Ehrh.
	Rosa	<i>R. canina</i> L. <i>R. dumalis</i> Bechst.
Rubus	<i>R. canescens</i> DC. <i>R.hirtus</i> Waldst. & Kit.	
Sanguisorba	<i>S. minor</i> Scop.	
<b>Rubiaceae</b>	Asperula	<i>A. capitata</i> Kit. ex Reichb.f.
	Cruciata	<i>C. glabra</i> (L.) Ehrend <i>C. pedemontana</i> (Bellardi) Ehrend. <i>C. laevipes</i> Opiz.
	Galium	<i>G. aparine</i> L. <i>G. glaucum</i> L. <i>G. odoratum</i> (L.) Scop.
<b>Salicaceae</b>	Populus	<i>P. tremula</i> L.
<b>Saxifragaceae</b>	Chrysosplenium	<i>C. alternifolium</i> L.
	Digitalis	<i>D. viridiflora</i> Lindl.
	Linaria	<i>L. vulgaris</i> Mill.
	Verbascum	<i>V. longifolium</i> Ten.



<b>Scrophulariaceae</b>	Veronica	<i>V. nigrum</i> L.
		<i>V. phlomoides</i> L.
		<i>V. chamaedrys</i> L.
		<i>V. officinalis</i> L.
		<i>V. hederifolia</i> L.
		<i>V. serpyllifolia</i> L.
<b>Urticaceae</b>	Urtica	<i>U. dioica</i> L.
<b>Violaceae</b>	Viola	<i>V. arvensis</i> Murray
		<i>V. canina</i> L.
		<i>V. tricolor</i> L.
<b>39</b>	<b>114</b>	<b>174</b>

, ” ” -  
 - 128 . 72%  
 (  
 2), - 15  
 8%, - 11 .  
 6%. 9  
 . 5% .  
 - .

The highest share among the ten biological groups of plants in ‘Chivira’ protected area is occupied by perennial herbaceous plants – 72% of the identified plants (Figure 2), followed by annual plants – 8%, annual-biennial – 6%. Trees and shrubs are 5% of the total number of species. Species of the transitional shrub/tree form were not established in the studied area.



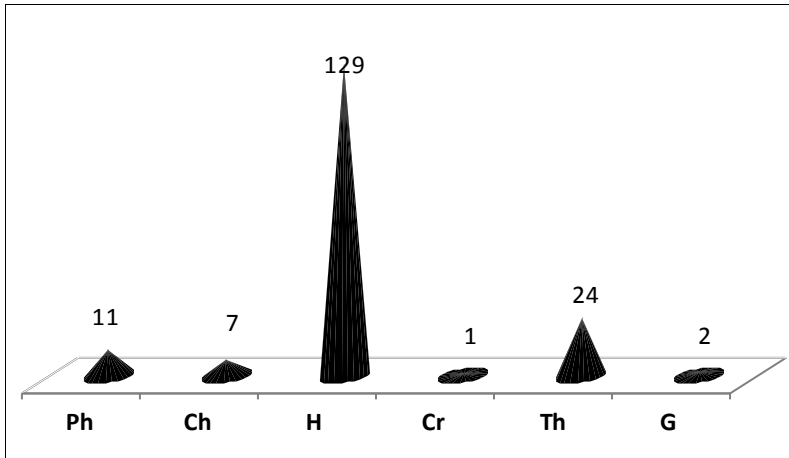
**Fig. 2. The distribution of the plants by biological types in protected area ‘Chivira’ Mt Sredna Gora, Bulgaria**

(Lyubenova et al., 2011). The high percentage of perennial plants is a typical characteristic of the forest communities (Lyubenova et al., 2011).

74,4 %

- 13,6 %  
- 6,25 % (3)  
(3,9%)  
Raunkiaer (1934)

The predominant life-form in the biological spectrum of the studied area is that of hemicryptophytes – 74,4% of the total number of plants, followed by therophytes – 13,6% and phanerophytes – 6,25% (Figure 3). Hamephytes also represent a comparatively high percentage (3,9%). According to Raunkiaer (1934) such distribution is called a ‘climate of hemicryptophytes’ which is typical of the temperate and cold zones.



3. Ph – ; Ch – ; H – ; Cr – ; Th – ; G –

**Fig. 3. Live forms of the plant species in in protected area ‘Chivira’ Mt Sredna Gora, Bulgaria: Ph – phanerophyta; Ch – chamephyta; H – hemicryptophyta; Cr – criophyta; Th – herophyta; G – geophyta**

Bondev (1991),

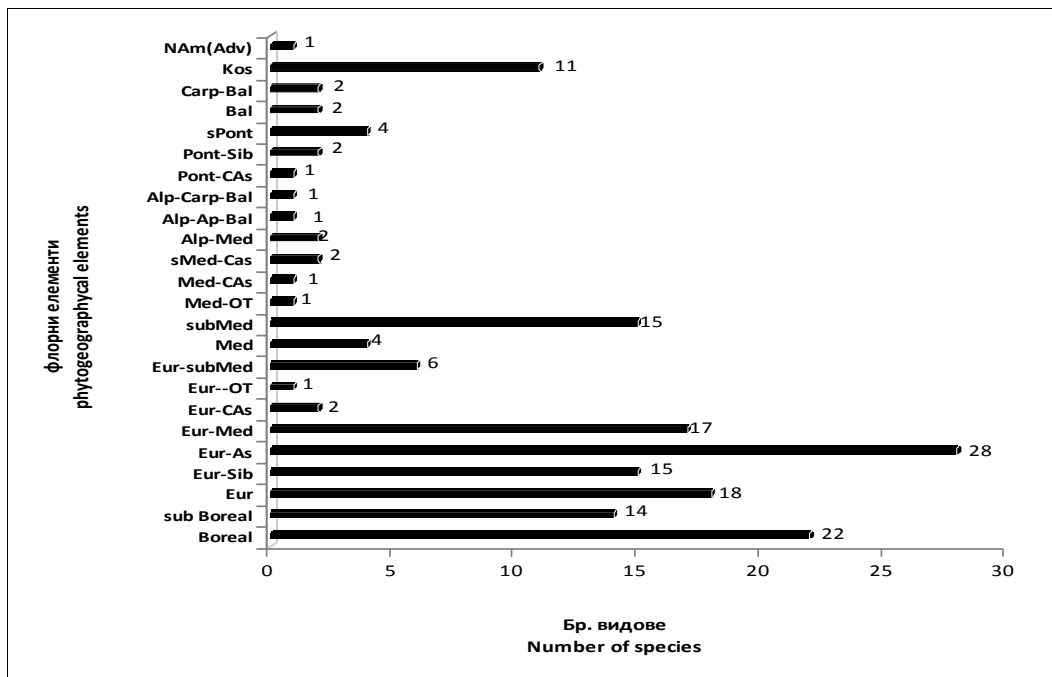
(15,9%),

Comparing the biological spectra of ‘Chivira’ protected area and the whole territory of Bulgaria (Bondev, 1991), it can be concluded that they are similar and they are typical of the temperate continental flora.

A wide diversity of flora elements is found in the phytogeographical spectrum of the protected area ‘Chivira’ which is due to the special geographical location of the territory and the landscape characteristics. The predominant phytogeographical element is Eurasian (15,9%), which indicates that the flora is typical of the transitional continental climate of the region and it is consistent with the major trends of the spread of the

(12,5%),  
 (10,2%) ( 4).  
 (10,2)

- flora of Central Bulgaria. The Boreal elements also occupy a significant share (12,5%), as well as the European (10,2) and European-Mediterranean species (10,2%) (Figure 4).



4  
 Fig. 4. Phytogeographical elements in flora of protected area 'Chivira' in Mt Sredna Gora, Bulgaria

174  
 " 16  
 9%  
 14  
 7.9%  
 " " ( 1).  
 IUCN  
 (ECE),  
 2,2%  
 Neottia nidus-avis (L.) Rich. ( )  
 2

A total of 174 higher plant species were identified in 'Chivira' protected area, 16 of them being of conservation value, i.e. 9% of the total number of the species found. 14 of them are included in the Red List of Endangered Plants of the International Union for the Conservation of Nature (IUCN), which is 7.9% of all the species identified in 'Chivira' protected area (Table 1). Four species, i.e. 2,2% of the species identified in the present study, are included both in the Red List of IUCN and in the List of Rare, Threatened and Endemic Plants in Europe (ECE). *Neottia nidus-avis* (Bird's-nest orchid) is found in both lists, as well as in Appendix 2 to the Convention on International Trade in Endangered Species of Wild

(CITES).

2

*Geranium bohemicum* L. (  
) *Anemone sylvestris* L. (  
)

Fauna and Flora (CITES). Two of the identified species are included in the Biodiversity Act of Bulgaria – *Geranium bohemicum* (Bohemian geranium) and *Anemone sylvestris* (snowdrop anemone).

1.

“ “ ,

**Table 1. Conservation value of the established higher plants in ‘Chivira’ protected area in Mt Sredna Gora, Bulgaria**

Taxon	IUCN	ECE	RB	ABA	CITES
<i>Abies alba</i> Mill.;	+				
<i>Anemone sylvestris</i> L.				+	
<i>Betula pendula</i> Roth;	+				
<i>Blysmus compressus</i> Panz.	+				
<i>Carex pseudocyperus</i> L.	+	+			
<i>Carpinus betulus</i> L.	+				
<i>Geranium bohemicum</i> L.				+	
<i>Lathyrus hirsutus</i> L.	+	+			
<i>Lysimachia vulgaris</i> L.	+				
<i>Mentha longifolia</i> (L.) Huds.	+				
<i>Neottia nidus-avis</i> (L.) Rich.	+	+			+
<i>Picea abies</i> (L.) H.Karst.	+				
<i>Pinus sylvestris</i> L.	+				
<i>Poa annua</i> L.	+				
<i>Rorippa austriaca</i> Spach	+	+			
<i>Trifolium pratense</i> L.	+				

9. ( ). : 15

*Arenaria biflora* L.; *Asperula capitata* Kit. ex Reichb.f.; *Blysmus compressus* Panz.; *Cardamine flexuosa* With.; *Cardamine impatiens* L.; *Carex pseudocyperus* L.; *Galium glaucum* L.; *Hieracium villosum* Lapeyr; *Hypericum elegans* Stephan ex Willd.; *Potentilla patula* Waldst. & Kit.; *Ranunculus bulbosus* L.; *Rumex crispus* L.; *Rumex patientia* L.; *Trifolium badioides* Schreb.; *Trifolium montanum* L.

Jager (1988) Berezutskiy (1999),

Chorological data of the identified species show that 15 of them have not been listed in floristic region 9. Sredna Gora Mt. (Eastern). They are: *Arenaria biflora* L.; *Asperula capitata* Kit. ex Reichb.f.; *Blysmus compressus* Panz.; *Cardamine flexuosa* With.; *Cardamine impatiens* L.; *Carex pseudocyperus* L.; *Galium glaucum* L.; *Hieracium villosum* Lapeyr; *Hypericum elegans* Stephan ex Willd.; *Potentilla patula* Waldst. & Kit.; *Ranunculus bulbosus* L.; *Rumex crispus* L.; *Rumex patientia* L.; *Trifolium badioides* Schreb.; *Trifolium montanum* L.

According to Jager (1988) and Berezutskiy (1999), the anthropogenic transformation level of flora can be evaluated indirectly by using qualitative and quantitative characteristics of the anthropogenic effect on flora in the protected area. Announcing the studied

*Rubus canescens* DC., *Artemisia vulgaris* L., *Cirsium arvense*(L.) Scop., *Lactuca seriola* L., *Taraxacum officinale* F.H.Wigg., *Capsella bursa-pastoris* (L.) Medik., *Cardamine hirsuta* With., *Stellaria media* Sibth., *Pteridium aquilinum* (L.) Kuhn, *Ballota nigra* L., *Dactylis glomerata* L., *Poa bulbosa* L., *Rumex crispus* L., *Plantago major* L., *Geum urbanum* L., *Galium aparine* L., *Veronica hederifolia* L., *Urtica dioica* L.

area as protected and the relatively remote distance from settlements is a precondition for preserving the diversity (composition, structure and age) of native vegetation. The discovery of the Thracian tomb near the village of Starosel and the development of rural tourism, equestrian tourism in particular, are the reasons for establishing a tourist site at the foot of the protected area. The 'Chivira' rest-house located on the ridge plateau of the protected area necessitates the use and maintenance of several forest roads in the area. All those human activities represent serious threats to phylogenetic resources in the protected area. Although anthropogenic activity is more intense in the periphery rather than in the protected area itself, the existing permanent influence has a cumulative effect. Among the plants in the studied cenoses, which distribution is closely related to human activities, are: *Rubus canescens* DC., *Artemisia vulgaris* L., *Cirsium arvense* (L.) Scop., *Lactuca seriola* L., *Taraxacum officinale* F.H.Wigg., *Capsella bursa-pastoris* (L.) Medik., *Cardamine hirsuta* With., *Stellaria media* Sibth., *Pteridium aquilinum* (L.) Kuhn, *Ballota nigra* L., *Dactylis glomerata* L., *Poa bulbosa* L., *Rumex crispus* L., *Plantago major* L., *Geum urbanum* L., *Galium aparine* L., *Veronica hederifolia* L., *Urtica dioica* L. etc.

174                      39                      , 116

## CONCLUSIONS

Plant species composition in the studied area comprises 39 families, 116 genera and 176 species, identified in the present study.

Perennial herbaceous plants of boreal and European origin are prevailing.

The biological spectrum of the studied area is typical of the temperate and cold zones, as the hemicryptophytes and therophytes represent the highest percentage.

Sixteen species of conservation importance were identified in 'Chivira' protected area. Fourteen of them are

	16.	14	included in the Red List of Endangered Plants of the International Union for the Conservation of Nature. Four species are included both in the Red List of IUCN and in the List of Rare, Threatened and Endemic Plants in Europe (ECE). <i>Neottia nidus-avis</i> (L.) Rich. (Bird's-nest orchid) is found in both lists, as well as in Appendix 2 to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).
	IUCN		
	(ECE)	<i>Neottia</i>	
<i>nidus-avis</i> (L.)	Rich.	(	
) e			
	2		
(CITES).			Two of the identified species – <i>Geranium bohemicum</i> L. (Bohemian geranium) and <i>Anemone sylvestris</i> L. (snowdrop anemone) are included in the Biodiversity Act of Bulgaria.
		2	
<i>bohemicum</i> L. (		– <i>Geranium</i>	
<i>Anemone sylvestris</i> L. (		)	
		)	
		15	As a result of the study, 15 new species were identified in Mt Sredna Gora floristic region (Eastern).
( )			
			An anthropogenic effect, although not particularly strong, was detected in the protected area. Its expression is the penetration of apophytic and anthropophytic species.

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