



## **SOME BIOMETRIC CHARACTERISTICS AND SEED PRODUCTIVITY OF ANNUAL DROUGHT-RESISTANT FORAGE SPECIES FOR FOOTHILL REGIONS OF CENTRAL NORTHERN BULGARIA**

**DOI: 10.7904/2068-4738-V(9)-63**

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**Abstract.** During the period 2011–2013 in Research Institute of Mountain Stockbreeding and Agriculture, Troyan (Bulgaria) the comparative testing of some annual drought-resistant cereal and legume pure crops (bitter vetch, chickpea, foxtail millet, true millet) was accomplished. It was found that the determining parameters the quantity of seed yields (weight of seeds in 1 inflorescence and weight of 1000 seeds) in cereals had at smaller values than legume crops. In respect of the yield of seeds can be deemed that they amount to minimum values characteristic of the corresponding forage crop. The reasons for this are the typical soils (light-gray forest pseudopodzolic with acid reaction, poorly stocked with essential nutrients, especially nitrogen) for the region, drought climate in the region in recent years and the absence of fertilization in this experiment. For this reasons the foothill regions of the Central Balkan Mountains can be considered unsuitable for ecological seed production of studied annual forage crops.

**Key words:** botanical structural elements; seed productivity; Cereal and legume monocultures; drought-resistance; Central Balkan Mountains (Bulgaria).

### **Introduction**

In the last 10–20 years has increasingly seen the adverse effects of global warming on plant species both in Europe [CLINE, 2008; CISCAR, 2009; IGLESIAS *et al.*, 2009] and in Bulgaria in particular [ALEXANDROV and HOOGENBOOM, 2000; ALEXANDROV, 2008; IVANOVA and MISHEV, 2012].

This suggests timely establishment of herbage fodder species suitable for growing under dry conditions [WILKINS and VIDRICH, 2000].

The testing of different annual species is very important for the animal feeding in the dry summer period—respectively from June to August [WALTON, 1983].

In a changing of climate some researchers focus to examination of cereal and legume pure crops such as ensuring the receipt of sustainable and environmentally-friendly forageproduction [PAUL *et al.*, 2002].

Due to the specific soil and climatic conditions of the foothill regions of the Central Balkan Mountains over the last years was established suitability for use of

some annual cereals and legumes forage crops and mixtures but only for production of green forage.

According [YAKIMOVA *et al.*, 1986] experiments and practice in Bulgaria show that is most appropriate to seed production of annual field crops to be in intensive cereal flat areas with fertilized and sufficient moistened soils with acidified reaction. Therefore the foothill regions are not used until now for seed production from annual forage species.

In view a closing of the production cycle, the objective of this study was to determine the ability to produce of ecological seeds from some annual forage species under local conditions of the Central Balkan Mountains in Bulgaria.

### **Material and methods**

The experiment was carried out on an area situated at 384 m above sea level in the experimental field of Research Institute of Mountain Stockbreeding and Agriculture (RIMSA), Troyan during the 2011–2013 period. The soil-type of trial



area was light-gray forest (pseudopodzolic).

The soil-cultivating process included the following: ploughing (in autumn of 2009), disk harrowing and cutting (in spring of 2010). The trial area was pressed by rool pressors once after the sowing (at the end of April).

The experiment was accomplished in four repetitions. The different cereal and legume crops were accomplished broadcast by hand. All investigation crop variants had by 5 m<sup>2</sup> harvesting area and they were the following:

- 1) Bitter vetch (*Vicia ervilia* (L.) Willd.– as a Standard for legumes;
- 2) Chick-peas (*Cicer arietinum* L. ssp. *euroasiaticum*);
- 3) Foxtail millet (*Setaria italica* ssp. *mocharicum* Alef.);
- 4) (*Panicum miliaceum* L. ssp. *effusum* Al.–with branched panicle)–as a Standard 2 (for cereal crops).

The experimental area of each variant was harvest for fodder and seeds divided into two equal parts.

The studied forage crops were grown under irrigated conditions on generally accepted standard technologies in Bulgaria. [NIKOLOVA and TODOROVA, 1986; MOSKOV and TENOVA, 2005].

*Note:* Given the fact that in foothill and mountain regions of the Balkan Mountains are located the most of country's water supply zones, in this experiment was not applied annually fertilization

The preliminary soil cultivation of experimental area included autumn ploughing to a depth of 20–22 cm with treatments in spring to obtain garden soil condition.

Annually the sowing of studied crops was carried out in stages, depending on their biological characteristics and climate conditions of the year.

Because of unpretentiousness to the climatic conditions the legumes (chick-pea and bitter vetch) were first sown. Because of their thermophylic the sowing of foxtail millet and true millet was done later–in the event of permanent 10–12°C of soil temperature. Thus, in 2011,

the sowing was done to them respectively on 28<sup>th</sup> March and 10<sup>th</sup> May, in 2012–on 23<sup>rd</sup> March and 9<sup>th</sup> May and in 2013–on 12<sup>th</sup> April and 23<sup>rd</sup> April.

The sowing of the test cultures were done on inter-crop distances 12 cm with values as follows: for bitter vetch–140 kg.ha<sup>-1</sup> (300 germinable seeds m<sup>-2</sup>); for chick-pea–100 kg.ha<sup>-1</sup> (50 germinable seeds m<sup>-2</sup>), for foxtail millet–15 kg.ha<sup>-1</sup> (500 germinable seeds m<sup>-2</sup>); for true millet–25 kg.ha<sup>-1</sup> (400 germinable seeds m<sup>-2</sup>), and they were consistent with the purity and germination of seeds.

The care for the crops during vegetation period was limited to maintenance of the experimental areas free of weeds.

In the cereals harvesting for seed production was carried out at picking ripeness and in legume crops at 70–80% of complete ripeness.

*Note:* Due to the prolonged rainfall in March of 2013 the sowing of legume crops was delayed to the 1<sup>st</sup> decade of April.

This affected emergence of a successive phenophases in both legumes.

Of the other part the continuous intensive rainfall in the second decade of June (233.4 mm) made it impossible to tracing the productivity of seeds of studied forage crops, and associated structural components of yields.

Therefore, these indicators are written just two years–2011 and 2012.

## Results and discussion

*Analizing of some structural elements of the yield of seeds*–they are reflected in Table 1 for different crops per year and on average for the period 2011–2012.

In 2011, for seed production crops were harvested as follows: the bitter vetch, the chick-pea and foxtail millet –on 1<sup>st</sup> August and true millet–on 9<sup>th</sup> August.

In 2012 the harvesting for seeds was done as follows: the bitter vetch and the chick-pea–respectively on 5<sup>th</sup> July and on 8<sup>th</sup> July, and foxtail millet and true millet–on 1<sup>st</sup> August.



From Table 1 it is seen that in 2011 the highest habitus have developed the cereal crops as reached an average

height of 90.40 cm (the true millet) and 78.78 cm (the foxtail millet).

**Table 1.**

Parameters of some structural elements and yield of seeds ( $t\ ha^{-1}$ ) of annual forage species by year and average for the period 2011–2012

Variant (forage species)	Plant height (cm)	Seeds weight of 1 inflorescence (g)	Weight of 1000 seeds (g)	Seed yields ( $t\ ha^{-1}$ )
<b>2011</b>				
1. Bitter vetch	46.43	0.07	29.00	1.90
2. Chickpea	50.56	0.40	316.40	1.60
3. Foxtail millet	78.78	0.07	2.60	1.45
4. True millet	90.40	0.04	4.80	1.60
<b>2012</b>				
1. Bitter vetch	52.60	0.41	35.00	1.69
2. Chickpea	58.67	1.63	312.40	2.34
3. Foxtail millet	59.73	0.16	2.60	1.30
4. True millet	63.77	0.25	4.40	1.23
<b>Average for the period 2011–2012</b>				
1. Bitter vetch	49.52	0.24	32.00	1.79
2. Chickpea	54.62	1.02	314.40	1.97
3. Foxtail millet	69.26	0.12	2.60	1.38
4. True millet	77.09	0.15	4.60	1.42

LSD<sub>0.05</sub> – 14.41%; LSD<sub>0.01</sub> – 21.83%; LSD<sub>0.001</sub> – 35.06%

Comparatively lower stems had the legume crops—50.56 cm (the chick-pea) and 46.43 cm (the bitter vetch).

Depending on individual botanical specificities longest inflorescences had the true millet—19.20 cm. In other crops the inflorescences were smaller and slightly varied—from 2.10 cm (for bitter vetch) to 5.71 cm (for foxtail millet).

Greatest weight of seeds of 1 inflorescence (0.40 g) was established in the chick-pea, while in others studied fodder crops reached only 0.04 g (for true millet)—0.07 g (for foxtail millet and the bitter vetch). With the biggest absolute weight were seeds of chick-pea, reaching 316.40 g, and at least the foxtail millet—only 2.60 g. With regard of this indicator the other crops occupied an intermediate position. From the same table shows that in 2012 the highest habitus from cereals has developed once again the true millet—63.77 cm, while the foxtail millet reached an average height of 59.73 cm.

Slightly lower stems had the legumes—58.67 cm chick-pea and 52.60 cm bitter vetch. Depending on the individual botanical specificities the largest weight of seeds (1.63 g) in 1

inflorescence was found in chick-pea, while in other studied forage crops reached 0.16 g (foxtail millet) to 0.41 g (bitter vetch).

The greatest absolute weight (weight of 1000 seeds) had the chick-pea and amounted to 312.40 g, and at least foxtail millet—only 2.60 g. Similarly indicator other crops occupied an intermediate position. Average for 2-year period (2011–2012) highest plants had cereals—77.09 cm for the true millet and 69.26 cm for the foxtail millet while legumes were comparatively lower—49.52 cm for bitter vetch and 54.62 cm for chick-pea. Conversely, determining parameters of quantity of seed yields (weight of seeds in one inflorescence, and weight of 1000 seeds) in cereals had at smaller values than legume crops. Thus, their weight of seeds in 1 inflorescence reached only 0.12 and 0.15 g against 0.24 and 1.02 g, and absolute weight of seeds amounted respectively to 2.60 and 4.60 g against 32.00 and 314.40 g.

*Yield of seeds*—with regard to obtained yields of seeds can be considered that they amount to minimum values for the respective fodder crop.



Thus, in 2011 in chick-pea were obtained  $1.60 \text{ t.ha}^{-1}$ , and for bitter vetch– $1.90 \text{ t.ha}^{-1}$ , and in cereal crops– $1.45 \text{ t.ha}^{-1}$  in the foxtail millet and  $1.60 \text{ t.ha}^{-1}$  in true millet. In 2012, yields in chick-pea were higher than previous year– $2.34 \text{ t.ha}^{-1}$ , while bitter vetch and cereals were smaller–respectively  $1.69$ ,  $1.30$  and  $1.23 \text{ t.ha}^{-1}$ . Average for 2 year period (2011–2012) in bitter vetch were received  $1.79 \text{ t.ha}^{-1}$  seeds compared to average yields for country  $2.55 \text{ t.ha}^{-1}$ , in chick-pea– $1.97 \text{ t.ha}^{-1}$  against  $2.00$ – $3.00 \text{ t.ha}^{-1}$  in country, in foxtail millet– $1.37 \text{ t.ha}^{-1}$  against  $1.00$ – $2.00 \text{ t.ha}^{-1}$  and in true millet– $1.42 \text{ t.ha}^{-1}$  with an average yield  $1.41 \text{ t.ha}^{-1}$ . (National Statistical Institute, 2012)

### Conclusion

The comparative study of some annual nontraditional drought-resistant forage species for the conditions of foothill areas of the Central Balkan Mountains (Trojan region) showed the following:

In respect of the yield of seeds can be deemed that they amount to minimum values characteristic of corresponding forage crop. The reasons for this are typical soils (light gray pseudopodzolic with acid reaction, with weak stocks of essential nutrients, especially nitrogen) for the region, drought climate in recent years, and the failure to conduct of fertilization in this experiment, regard to the environmental conditions of region.

For this reasons foothill regions of Central Balkan Mountains can be considered unsuitable for ecological seed production of studied annual forage crops.

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Received: February 3, 2014

Accepted: May 4, 2014

