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ECOLOGICAL AND BIOLOGICAL FEATURES OF TROPICAL SPECIES OF THE GENUS *MOMORDICA* (*CUCURBITACEAE*) INTRODUCED UNDER THE CONDITIONS OF BELGOROD REGION (RUSSIA)*

Keywords: Momordica charantia, Momordica balsamina, grow rate, introduction, drought resistance, Middle Black Earth zone.

Abstract
Studies of *Momordica charantia* L. and *Momordica balsamina* L. species in the Botanical Garden of the BelSU allowed to estimate plant's growing rate and drought resistance of these perspective plants for introduction. It is established that all studied samples possess rather high degrees of relative drought resistance. It gives a chance to continue further researches on revealing of the most valuable plants of these species for their introduction in culture.

Introducation

The genus *Momordica* L. belongs to the family *Cucurbitaceae*; it includes ca. 40 species, which occur mostly in tropical and subtropical regions. The plants are cultivated throughout the tropics, especially in China, India, countries of East Africa, Central and South America.

Species of *Momordica* are herbaceous, climbing annuals; these fast-growing vines usually need to be trellised. Leaves broadly ovate to orbicular in outline, cordate, deeply palmately 3–7-lobed, cordate at base, apiculate at apex. Flowers yellow, solitary, male and female ones borne on the same plant in leaves axils. Fruit resembling warty gourds or cucumbers, usually oblong. Immature fruits emerald green, turning to orange-yellow when ripe; at maturity, opening into three irregular valves that curl backwards and release brown seeds encased in scarlet arils (Taylor, 2002).

Species of the genus *Momordica* are economically valuable because they are used in medicine and pharmacy (Abascal & Yarnell, 2008). *Momordica* species have a long history of medicinal use, especially in treatment of diabetes – (fresh or dried fruit, dried leaves, vine, whole plant), diarrhea – (leaves), fevers – (stem, vine, whole plant), fungal infections of the skin – (fresh leaves), hypertension – (vine, fresh juice). (Raman & Lau, 1996; Khan et al., 2005; Abascal & Yarnell, 2008).

In Russia, these plants are still quite exotic, even though they have a wide range of well-known gardeners. No specific data of studies of these promising plants in the European part of Russia have been found in literature. In Belgorod Region, the presented study was the first one.

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Climatic conditions of Belgorod Region, despite the rather high level of solar radiation and heat (150 kcal/см^2/year), are characterized by low annual rainfall (400 – 450 mm) in comparison to other regions of the Russian Federation, which leads to a lack of moisture in the air and soil (Belgorod Meteorological Station. http://meteocenter.net). However, species of the genus *Momordica* are usually adapted to tropical climate conditions. Therefore, among the limiting factors for their development are the conditions of temperature and humidity in the region where the plants are grown.

The aim of our study was to investigate two species of the genus *Momordica*, *M. charantia* L. and *M. balsamina* L., in the Botanical Garden of Belgorod State University to determine their growth rate and drought resistance. Evaluation of the studied plants will provide opportunities to discover and promote new exotic vegetable plants, promising to be introduced in Belgorod Region and adjacent areas.

Material and methods

The objects of the study were two species, *M. charantia* and *M. balsamina*, obtained from different habitats (Russia (Belgorod), Vietnam, and Germany).

Seeds of both species were planted in greenhouses on April 13, 2010 to a depth of 1-1.5 cm in warm (22-25^{O}C), moist soil. In order to maintain soil moisture, irrigation was performed every day. Plants were carried out to the open ground by May 17, when the temperature at a 5-cm soil depth reached 20^{O}C. Plants were transplanted carefully so as not to damage the root system, to prevent illness and death of plants. After transplanting, the plants were fed with a complete mineral fertilizer mixture every two weeks, and during the flowering and fruiting – every week, with low concentrations, one tablespoon (about 5g) of the fertilizer per 8l of water per plant.

The main morpho-physiological parameters of plant were registered for the entire vegetation period (leaf area, height), copse number, flowers appearance and ratio male:female flowers, increase rate of fruits number, in the meantime being also carried out biometrical measurements of fruits.

Accounting for morphological parameters and growth of plants was carried out following the method of Zlobin (Zlobin, 1989).

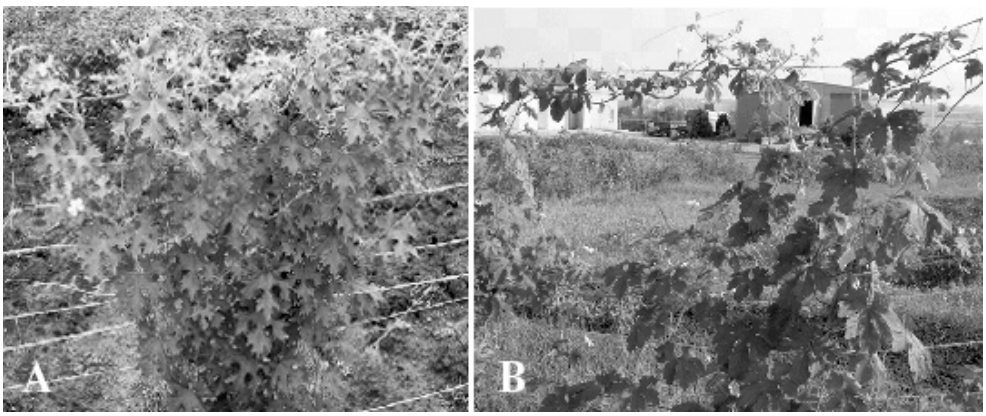

Fig. 1. Plants *M. balsamina* L. (A) and *M. charantia* L. (B)

Fig. 2. Flowers of *M. charantia* L.

Fig. 3. Flowers of *M. balsamina* L.

The most informative laboratory and field methods to assess drought resistance are those of studying the water regime of the leaves: determination of water content (total amount of water) in tissues and determination of water-holding capacity of leaves (Kushnirenko et al., 1970). Sampling was conducted in late July – early August, as this period was marked the hottest and most dry weather. Typical leaves were collected from all sides of the plants in the morning, then placed in plastic bags and transferred to the laboratory.

Results and Discussion

Both *M. charantia* and *M. balsamina* belong to a group of annuals. They are climbing vines that cling to supports with tendrils (Fig. 1). Plants are profusely branched.

The flowers are dioecious, with their corolla yellow or pale-yellow in color. Male and female flowers differ in their size, location and shape of bracts, and other characteristics (Fig. 2 & 3). Corolla diameter in male flowers is 2.5 to 3 cm, and that in female ones is 1.7

Table 1. Climatic data of Belgorod Region (Oblast) Meteorological Station (2010)

Months	4	5	6	7	8	9	10
The average temperature of the air, ^{O}C	9.8	17.4	22.3	25.3	25.3	14.7	4.8
The average temperature of the soil surface, ^{O}C.	11	22	28	30	29	15	5
Relative humidity, %	58	61	52	54	44	69	76
The amount of precipitation, mm	16.1	25.5	20.3	41.4	24.8	84.2	43.4

to 2 cm. The general formula for the flowers of both species can be presented as follows:

♂*Ca(5) Co5 A(2+2+1)

♀*Ca(5) Co5 G($\overline{3}$)

The flowers are pollinated by insects. Since the appearance of female flowers, the absence of pollinators does affect the formation of fruit and plant productivity in general. As the flowers rot and fall off very quickly (male flowers last 3 days after the opening of the bud, and female ones, up to 5 days).

These plants are characterized by the absence of clear delimitation between the phases of flowering and fruiting. The flowers open and then fall off, and the fruits are formed in the presence of pollinators during the period of opening the flowers. The process continues until the end of the growing season.

Ripening fruits gradually turn yellow and then become bright orange or red.

Climatic data (temperature, humidity, rainfall) were obtained from the meteorological station of Belgorod Region (Table 1).

The vegetation period of studied plants lasted from May to September, when the temperature was above 15°C. For samples of both species, the first shoots appeared on the 6th day after seeding. On the 10th day, the plants of *M. balsamina* had the first pair of true leaves, whereas in plants of *M. charantia* this stage of development occurred only on the 13th day. The study found that the development of *M. balsamina* is characterized by an early start (from seed germination to starting branching), but the late timing of entry into the generative phase (appearance of flowers and fruits). Flowering and fruiting in *M. balsamina* begin on the 84th and 91st day after seeding, while in *M. charantia* these developmental stages were registered already on the 69th and 81st day, respectively (Table 2).

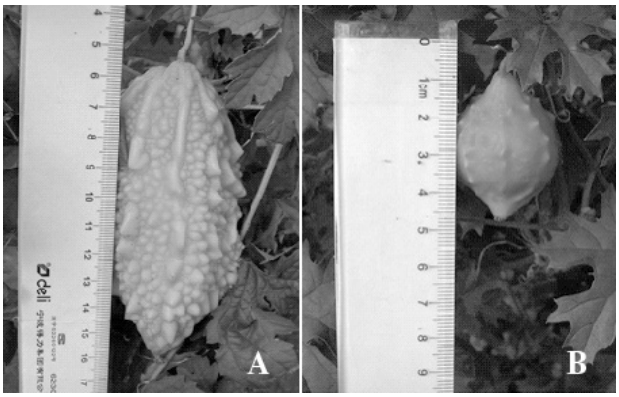

Fig. 4. Fruits of *M. charantia* L. (A) and *M. balsamina* L. (B)

In plants of *M. balsamina* we observed an intensive formation of the generative sphere. The number of flowers and fruits per plant was significantly higher than that of *M. charantia* (Table 3). Both *M. charantia* and *M. balsamina* are monoecious plant, i.e., one plant normally develops both female and male flowers. Male flowers appear first; female flowers appear 20—24 days after the male ones.

The fruits of these two species differ both in their form and size. The fruits of *M. charantia* are fusiform, 10—12 cm long, with numerous tubercles. In *M. balsamina* the fruits are oval in shape, 3-4.5 cm long, with broad conical beaks. When ripe, fruits gradually turn yellow and then become bright orange (*M. charantia*) or red (*M. balsamina*) (Fig. 4). The average weight values per fruit in *M. charantia* and *M. balsamina*, are, respectively, 59.5 g and 13.4 g. Fruits of *M. balsamina* become fully mature in 26 days after formation, whereas in *M. charantia*, after 23 days.

Both studied species of the genus *Momordica* were characterized by rapid growth during the branching phase before flowering. The absolute increase of major axis is 7.2 and 4.1 cm per day, respectively, in *M. charantia* and *M. balsamina*. After transplantation to the open ground conditions, the plants had no time to adapt to rapid changes in habitat conditions; because of this studied plants from transplant to the phase of active

Table 3. **Formation of generative sphere in species of *Momordica***

Species	Average number per plant		
	Male flowers	Female flowers	Fruits
M. charantia	68	21	12
M. balsamina	124	49	26

Table 2. **Phenological observations on species of *Momordica***

Species	Days after seeding				
	Emergence of seedlings	Appearance of the first true leaves	Beginning of branching	Beginning of flowering	Beginning of fruiting
M. charantia	6	13	56	69	81
M. balsamina	6	10	50	84	91

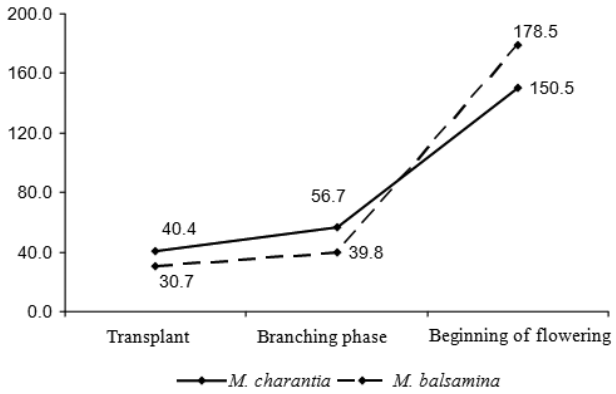

Fig. 5. Growing rate of vine

formation of lateral branches were observed only a small increase (0.4—0.5 cm/day) (Fig. 5).

The results of the study indicate that all studied plants have a high water content in tissues of leaves. The total water content in the leaves of *M. balsamina* is 77 % of wet weight, and that in the leaves of *M. charantia*, about 75 % (Table 4). These characteristics are evidence that the presence of water content in the leaves is sufficient for plant life supply of water provided to lack of moisture.

Water-holding capacity is used as the primary indicator of plant resistance to prolonged drought. In our research, the lowest rate of water loss was observed in leaves of *M. balsamina* – 0.56 % of the total mass after 1 hour of decay, while in the samples of *M. charantia* it was 1.25 % of the total mass (Table 5).

In such a way both studied species:, *M. charantia* and *M. balsamina*, have a high relative drought tolerance. They tolerate dry conditions rather well in Belgorod Region. For the whole period of the study, there has been no damage from lack of moisture in any plant.

Despite the fact that the investigated plants were originally adapted to the warm and humid tropical and subtropical conditions, they can be grown under conditions of lack of moisture and heat in the spring. This is an encouraging result, which allows continuing further studies on the introduction of *M. charantia* and *M. balsamina* in Belgorod Region.

Table 4. **Evaluation of relative degree of drought resistance by water content of tissue**

Species	Total water content	Degree of drought resistance
M. charantia	74.68	High
M. balsamina	77.06	High

Table 5. **Assessment of relative drought resistance by water-holding capacity of leaves**

Species	The average loss of water (1 hour), %	Degree of drought resistance
M. charantia	1.25	High
M. balsamina	0.56	High

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ЭКОЛОГИЧЕСКИЕ И БИОЛОГИЧЕСКИЕ ОСОБЕННОСТИ ВИДОВ РОДА *MOMORDICA* (CUCURBITACEAE) В ПРОЦЕССЕ ИНТРОДУКЦИИ В УСЛОВИЯХ БЕЛГОРОДСКОЙ ОБЛАСТИ

Исследование видов *Momordica charantia* L. и *Momordica balsamina* L. в Ботаническом саду НИУ «БелГУ» (г. Белгород) позволило оценить динамику роста и развития, засухоустойчивость этих перспективных для интродукции растений. Несмотря на то, что изученные виды рода *Momordica* адаптированы к условиям теплого и влажного климата тропической зоны, они могут выращиваться также при недостатке влаги и тепла в весенний период. Это дает возможность продолжить дальнейшие исследования по выявлению наиболее ценных форм этих видов для введения их в культуру в Белгороде.

Ключевые слова: динамика роста, интродукция, засухоустойчивость, Momordica charantia, Momordica balsamina.

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ЕКОЛОГІЧНІ ТА БІОЛОГІЧНІ ОСОБЛИВОСТІ ВИДІВ РОДУ *MOMORDICA* (CUCURBITACEAE) У ПРОЦЕСІ ІНТРОДУКЦІЇ В УМОВАХ Б І ЛГОРОДСЬКОЇ ОБЛАСТІ

Дослідження видів *Momordica charantia* L. і *Momordica balsamina* L. у Ботанічному саду НДУ «БілДУ» (м. Білгород) дало змогу оцінити динаміку росту і розвитку, посухостійкість цих перспективних для інтродукції рослин. Незважаючи на те, що вивчені види роду *Momordica* адаптовані до теплого і вологого клімату тропічної зони, вони також можуть вирощуватися в умовах нестачі вологи і тепла у весняний період.

Ключові слова: динаміка зростання, інтродукція, посухостійкість, Momordica charantia, Momordica balsamina.