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Changes of Calendula Officinalis Raw Materials Yield and Of Weediness Of Sowings Depending on The Elements of Technology.

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ABSTRACT

In the conditions of the Middle Volga region, growth regulators have a positive effect on the field germination of the seeds of the marigold, and with the application of Zircon it increases by 7%, with Albite by 3% in relation to the control, and the safety increases by 3 and 2%, respectively. Their effectiveness rises from the first term to the third. The decrease in the number of weed plants on the second and third terms of sowing in relation to the first is due to additional cultivation of the soil before sowing. There was no significant effect of growth regulators on the number and mass of weeds. However, in the process of growth and development between the calendula and the weed component, competition arose for the use of the basic factors of life, with the cultivated plant occupying a dominant position in the later phases of development due to the intensive development of vegetative organs, which led to the suppression of some species of weeds. At three terms of sowing, the collection time of the raw material of calendula officinalis is 67 days, which corresponds to eight gatherings with an interval of 3-5 days. Adapting to the conditions of unstable hydration, a highly plastic plant is able to form the productivity of air-dry inflorescences in the range of 1453-1698 kg / ha. The quality of pharmacological raw materials is thus characterized as environmentally friendly.

Keywords: medicinal plant, weediness, productivity, growth regulators, sowing date, quality of raw materials.

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INTRODUCTION

At the beginning of the 20th century, medicinal plants constituted a significant part of all the medicinal products used, but then synthetic, antibiotic and hormonal preparations significantly pushed them. However, at present, despite the successful creation of valuable synthetic medicinal preparations, medicines from plants continue to occupy an important place in modern scientific medicine. In Russia the share of herbal drugs accounted for approximately 40% of the total amount of medication [1].

According to the World Health Organization, more than 80% of the world population uses traditional medicine, a large part of which are extracts and biologically active substances of plants. Stocks of natural resources do not completely satisfy the demand for raw materials, so there is an urgent need to increase their provision [4]. In addition, for a number of reasons, the collection of raw materials of some wild species is economically unprofitable. Consequently, in order to provide the medical and pharmaceutical industry with high-quality raw material of medicinal crops, commodity production must be created on the basis of their industrial cultivation. In this regard, the share of cultivated medicinal plants in the total production of medicinal raw materials is significantly increased.

One of such plants is calendula officinalis, which is a storehouse of valuable medicinal substances. It is included in the list of medicinal plants that are allowed to be used in wide medical practice. It is used to treat diseases of the gastrointestinal tract, ocular and ENT diseases, inflammations and dermatitis, parodentitis and stomatitis, burns, trophic ulcers, non-healing wounds, erosions, acute inflammation of superficial veins, and also recommended as an immunostimulating drug.

The obtaining of high-quality medicinal raw materials depends on compliance with all rules of environmental production, including the minimum use of protective equipment in combating weeds [6].
In this regard, studies have been conducted in the area of cultivation of calendula in terms of organic farming, namely, without the use of herbicides to produce safe and high quality raw materials in the Middle Volga in the experimental field of the SSI Penza Agricultural Research Institute.

MATERIALS AND METHODS

Experimental work was carried out in 2011-2013. The soil of the experimental site is leached medium-heavy medium loamy black soil. The humus content in the plow layer is 5.2% (according to I.V. Tyurin, State Standard 2613-91), pHsol - 5.6 (State Standard 26483-85), easily hydrolyzable nitrogen - 80-85 mg per 1 kg of soil (according to I. B.Tyurin and M.M. Kononova), mobile phosphorus 135-141 and exchange potassium 154-160 mg per 1 kg of soil (according to V.F. Chirikov in the modification of CRIAS(Central Research Institute of Agrochemical Services), State Standard 26204-91).

Factor A - sowing period: 1st sowing period (control) - when physical ripeness of the soil occurs (2011 - April 29, 2012 - April 27, 2013 - April 30); The second term of sowing is when the biological ripeness of the soil sets in, as weeds grow to the stage of "white threads" (2011 - May 8, 2012 - May 1, 2013 - May 4); The third term of sowing is 6-8 days after the second term (2011 - May 14, 2012 - May 9, 2013 - May 9).

Factor B - processing of seeds and crops with growth regulators: control (treatment of seeds and crops in the phase of the rosette (3-5 leaves) with water); Zircon, R, 0.1 g / l (seed treatment (0.15 ml / kg, working fluid flow rate 250 ml / kg) + spraying into the outlet phase (35 ml / ha, working fluid consumption - 300-400 l / ha)); Albite, TPN (seed treatment (2 g / kg, working fluid consumption - 1 l / kg) + spraying into the phase of the socket (30 g / ha, working fluid flow - 400 l / ha)).

The predecessor in the experiment is the vetch-oat mixture on the green mass. The repetition of the experiment is threefold. The plot area is 49.5 m2 (1.65 mx 30 m). The sowing was carried out with a seeder SN-11-16 with a row spacing of 50 cm. The norm of sowing seeds is 8 kg / ha, the depth of embedding is 2-3 cm, and the variety is Kalta.

The seeds were treated with Zircon and Albite by the method of wet etching according to the instructions for use, the spraying of the vegetating plants of the calendula was carried out in the phase of the rosette (3-5 leaves) with a manual sprayer, the raw material harvesting manually in the opening phase of at

least half of the ligulate flowers in terry forms and blossoming 2- 4 circles of tubular flowers in non-terry forms.

Maintenance work consisted of a single manual weeding between rows and one mechanized treatment with a cultivator KON-2,8.

The experience was laid in accordance with the methodological guidelines of B.A. Dospekhov, the State Commission for the Variety Testing of Agricultural Cultures and other scientific institutions [7, 9, 10]. Statistical processing of the research results was carried out using the method of variance analysis using MS Excel programs, StatgraphicsPlus 5.0.

In the forest-steppe zone of the Volga region, the potential yield and quality of agricultural crops are closely related to weather conditions, which during the years of research were different and differed significantly from the average annual, both for the ten-day distribution of precipitation and for the temperature regime. The hydrothermal coefficient (HTC) of the calendula vegetation period was 1.5 in 2011; in 2012 - 1,4; in 2013 - 1.0.

EXPERIMENTAL

In ecological farming, they do not aspire to cultivating the herbage of cultivated plants completely free of weeds. The purpose of combating weeds is to leave so many of them when they would rather promote the growth of cultivated plants than their oppression. In addition, weeds should not prevent the implementation of care and harvesting activities [12].

The most important element of agrocenosis is the number of plants per unit area, which varies throughout the growing season. In studies, the variability of field germination was determined by years and variants from 73 to 94%. The most favorable year was 2013, when the variability was 90% on average, and in 2012 it was reduced to 83% due to the lack of precipitation and high daily average temperature during the emergence of seedlings in the second and third terms of sowing.

Positive effect on field germination was provided by growth regulators, which is confirmed by other scientists [8, 13, 14]. On average, for three years from the application of Zircon germination rose by 7%, Albite - by 3% compared with the control option. During all the years of the research, the effectiveness of regulators increased from the first term to the third.

Depending on the variants of the experiment, the safety of plants ranged from 91 to 98%. During the vegetative period, there was a slight loss of plants. Partial death was noted at the time of emergence from damage by biting scoops and when traumatizing plants during interrowder treatments. The lowest safety of plants by the time of seed collection was noted in 2012, but with the crops of the first term it was 2% higher. The application of Zircon positively influenced resistance to unfavorable factors, which led to an increase in plant conservation by 3%, the application of Albite - by 2%.

A significant part of the sown calendula seeds does not participate in the formation of the crop: 7-21% (14% on average) is not realized when sprouting emerges, and 3-8% of the already emerged plants (an average of 5%) die during vegetation, which occurs less when using growth regulators.

When growing medicinal plants without chemical protection, to obtain environmentally friendly raw materials it is necessary to create more favorable growth conditions for them than for weed vegetation and to maximize their competitive ability. At the same time, we allow a certain level of weediness, not above the threshold of damage. Nikitina Z.V. (2005), summarizing the literature data, says that complete destruction of weeds is undesirable, since many of them actively absorb nutrients from the sub-plow layer and after they die leave them, the roots penetrating the subsoil layer make it more accessible to cultivated plants. In addition, weeds are an integral part of the agroecosystem, and their species composition plays an important role [5, 11]. In the marigolds during all the years of research, the composition of annuals is represented by early and late spring weeds: Chenopodium album, Polygonium convolvulus, Galeopsis speciosa, Panicum crusgalli, Setaria glauca, and Setaria viridis). Of perennials, the root-shoots mainly predominate: Convolvulus arvensis L. and Sonchus arvensis.

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The maximum amount of weeds in the phase of the formation of the rosette of leaves was noted in 2012 (86.7-122.6 pcs / m2). The species composition varied from year to year. After the arid conditions of 2010, perennial weeds were highly developed in 2011 - field bindweed, pink and yellow sow thistle - 4.4 pcs / m2 (their share in the total number was 6.9%), whereas in 2012 and 2013 years. - 3.0 and 3.5 pcs / m2 (2.9 and 3.6% respectively) (Table 1).

Table 1: Weediness of crops of calendula (2011-2013)

Sowing time	Growth regulator	10 days after sprouting		Mass flowering (end of July)			
		Number of weeds, pcs / m2		Number of weeds, pcs / m2		Weedmass, g / m2	
		annual	perennial	annual	perennial	annual	perennial
1 term	Control	106,7	5,5	47,0	2,3	119,1	15,3
	Zircon	102,5	5,4	45,1	2,2	114,6	14,7
	Albite	103,5	5,4	45,8	2,3	116,1	14,9
2 term	Control	88,2	3,1	39,1	1,6	97,2	8,4
	Zircon	84,7	3,.0	37,5	1,5	93,3	8,1
	Albite	85,6	3,0	38,0	1,5	94,2	8,2
3 term	Control	80,3	2,9	35,5	1,4	88,9	7,8
	Zircon	77,2	2,8	34,0	1,4	84,9	7,5
	Albite	78,.0	2,8	34,4	1,4	85,9	7,6

In the initial phase of development of calendula (ten days after emergence), the average number of weeds at the first seeding period was 104.2 pcs / m2 of annuals and 5.5 pcs / m2 of perennials on average for three years. On crops of the second and third terms, their number decreased in comparison with the first and it was 86.2 for annuals, 3.1 pcs. and 78.5 and 2.8 pcs / m2, respectively - for perennials. In this case, the proportion of perennial weeds in the total number decreases, which is associated with additional preseeding tillage at late planting times. There is a tendency to reduce the infestation in variants with the use of growth regulators. In the phase of formation of the rosette for each crop plant, there were two weeds. Therefore, during this period, calendula plants need protection.

During the mass flowering phase it was established that the weediness of crops had decreased. The number of annual weeds an average of - 39.6 per cent, of perennials - 1.7 pcs / m2, or one weed corresponded to one calendula plant.

Reducing the infestation of crops occurs as a result of two inter-row treatments (manual and mechanized), as well as the manifestation of the competitive ability of the drug culture. Plants of annual weeds, unable to withstand competition for the main factors of life, especially for moisture, with calendula, died. At this time, there is also a natural dying out of some weed plants. By the end of the full development of calendula, there is not only a decrease in the weediness, but its species composition also changes. The number of Chenopodium album and Convolvulus arvensis L. decreases strongly, which is due to the influence of various aphids, scythesomes, meadow moths. Of the late spring weeds, Panicum crusgalli, Setaria glauca and Setaria viridis mainly predominate. Such species composition and quantity of weeds does not interfere with the further development of cultivated plants.

Thus, before the budding phase calendula is inhibited by weeds and needs protection (manual or mechanical weeding). In later phases of development, it vegetates more intensively and suppresses some species of weeds.

The main feature determining the expediency of cultivating a crop is the yield, which, as the final resultant, is reflected by everything that occurs during the ontogenesis of the plant, and therefore, it is most susceptible to the influence of environmental factors.

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On average, for three years, the period of collection of calendula inflorescences was 67 days, the largest of which were the inflorescences of the first harvest. The size of the baskets and the swath of some inflorescences with each subsequent collection is reduced. Depending on the weather conditions, the intake of air-dried inflorescences was recorded in 3-5 days. The duration of flowering of one inflorescence ranged from 3 to 5 days and tended to increase from the first order of branching to IV and V. During the entire collection period, 14 to 16 counts were taken, depending on the influence of cultivation methods.

With the growth and development of plants, the increase in the number of sprouts, the amount of collected raw materials increases and the maximum yield at all planting dates is in the third decade of July. Especially it was manifested in 2012 at the first time of sowing - 570 kg / ha. In subsequent collections, the productivity of plants of all planting times is reduced and this is particularly noticeable at the first term. During the years of research, the weather in the second decade of July 2011 and 2013 and in the first decade of 2012 it was characterized by high air temperature and a large deficit of precipitation, which affected the yield of subsequent harvestings. Dry and hot weather conditions cause calendula stress, while the development of plants is accelerated, the flowering time decreases, the number of double flowers decreases and their yield decreases. But if the conditions are cool and damp, then there is a sharp increase in swath and an increase in the yield of inflorescences. This dependence was well observed in 2011.

After the rains at the end of July and the beginning of August, the yield of raw materials increased. It should be noted that the negative influence of weather conditions had a lesser impact on the yields of the inflorescences of late sowing periods. The collection of raw materials on these variants became higher than at the first sowing period, where the plants could not use the precipitation and realize their potential for productivity.

It could also be affected by the fact that in the early planting period the density of plants is higher. According to K.P. Grosheva and O.L. Voskresenskaya [3, 2], more thickened calendula seeds stimulate the formation of less productive plants with an earlier completion of ontogenesis, and sparse seeding stimulates the formation of more productive plants with a longer duration of ontogeny in the bulk of plants. This leads to the fact that in the second half of the summer the collection of flowers on the first term decreases more intensively, while in the second and third months it remains at a high level.

A highly elastic plant that adapts well to the existing weather and soil conditions of the Middle Volga region, depending on the methods of cultivation, is able to form a raw material yield within the range of 1453-1698 kg / ha (Table 2).

Table 2: Collection of raw calendula for decades and in total for vegetation, kg / ha of air-dried inflorescences (2011-2013).

Sowing Period	Growth Regulator	Harvesting time								
		20-30 June	1-10 July	11-20 July	21-31 June	1-10 August	11-20 August	21-31 August	1-10 September	amount
1	Control	3,7	134,3	198,7	430,3	316,3	213,3	173,0	31,7	1501
	Zircon	13,3	164,6	235,8	491,0	349,8	229,3	181,6	32,6	1698
	Albite	10,3	161,1	229,8	480,2	342,4	223,3	178,8	32,4	1658
2	Control	1,0	78,7	195,7	393,0	314,7	241,7	212,7	45,0	1482
	Zircon	4,7	101,9	233,3	453,1	353,0	261,5	223,0	45,9	1676
	Albite	3,7	96,4	228,1	443,8	346,0	255,5	219,9	45,8	1639
3	Control	0,0	37,3	202,0	394,0	301,3	240,3	232,3	46,0	1453
	Zircon	0,0	54,8	238,9	456,1	337,9	260,0	243,2	46,9	1638
	Albite	0,0	51,9	234,2	446,1	326,0	253,9	239,3	46,8	1598
HCP_{095} variants			4,5	9,3	22,6	16,3	10,7	11,0	2,0	76,5

The presence of a complex of biologically active compounds in the calendula's raw materials, namely carotenoids, flavonoids, triterpene saponins and a number of concomitant substances determine its medicinal properties. The raw materials obtained in the experiments contain 290 mg of carotene per 1 kg of absolutely dry substance and 3.8% of flavonoids, which confirms the compliance of local agroclimatic conditions for the formation of high quality of medicinal raw material of calendula.

When using preparations from plant raw materials in the human body, in addition to a complex of biologically active substances, potentially dangerous chemical compounds of technogenic origin, including heavy metals and radionuclides, can also enter.

On the basis of the studies, the plant raw materials of calendula poorly accumulate heavy metals and radionuclides of cesium-137 and strontium-90 (Table 3), that is, the content of toxic elements does not exceed the MPC (maximum permissible concentration) and therefore can be characterized as ecologically pure products and pharmacological raw materials, which corresponds to SanPin 2.3. 2.1078-01 (item 1.10.7) and OFS 42 -0013-03.

Table 3: Content of heavy metals and radionuclides

№	Analyzed index	Normative documentation for the test method	Measurement result (unit of measure)	MCP
	Heavy metals			
1	Lead	AUSS 301 78-96	0,17 mg/kg	6,0 mg/kg
2	Cadmium	AUSS 301 78-96	0,012 mg/kg	1,0 mg/kg
3	Mercury	MI 5178-90	0,0021 mg/kg	0,1 mg/kg
4	Arsenic	AUSS 26930-86	0,19 mg/kg	0,5 mg/kg
	Radionuclides			
1	Cesium - 137	MIMC 2.6. 1.1 194-03	3,0 Bq / kg	200 Bq / kg
2	Strontium - 90	MIMC 2.6. 1.1 194-03	1,7 Bq / kg	100 Bq / kg

(AUSS–GOST (State Standard) , MI - methodical instructions, MIMC - methodical instructions on methods of control)

CONCLUSIONS

The sowing of calendula of the medicinal variety Kalta on the natural background of leached black soil of forest-steppe of the Middle Volga region at different times makes it possible to create a uniform conveyor supply of ecologically pure medicinal raw materials during the entire possible collection period. Seed processing and foliar top dressing of plants with growth regulators Zircon and Albite significantly increase its productivity. During a period of mass flowering, calendula is able to constitute a serious competition for weed vegetation. At the initial stages of the development of a culture for controlling weeds, we can use two inter-row treatments without the use of chemical protection.

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