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REVELATION IN THE COTTON PLANT OF CHROMOSOMES RESPONSIBLE FOR THE REGULATION OF PLANT GROWTH

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The monosomic nature of the dwarf line L-691 of the cotton plant has been established. The influence of various factors on the growth of the main stem of this line has been studied.

Dwarf mutants have been described for more 120 plant species: maize, wheat, tomato, radish, cotton, and many others, belonging to different families. Dwarfishness or nanism in a particular species and in different species is the result of the mutation of both allelic and nonallelic genes, and several genes for namism have been found in many species.

The influence of growth substances in dwarf mutants has been studied in many cultivated plants: maize [1], rice [2], tomatoes [3], peas [4], and cotton [5-8]. According to the literature, in the cotton plant nanism is connected with a change in the metabolism of endogenous phytohormones. The experiments were performed on disomic ($2n$-52) cotton plants; no similar experiments with monosomic ($2n$-51) cotton plants have been reported. In view of this, it is necessary to find individual chromosomes and genes localized in them responsible for the regulation of the growth and development of plants.

Every year, the mutant line studied in an experimental plot showed differentiation with respect to the height of the main stem in the dwarf phenogroup (L-691) and the norm (L-483) in a ratio of 2:1. According to the results of cytogenetic analysis in the dwarf plant during meiosis (M1) an average of from 0.6 ± 0.04 to 0.13 ± 0.07 univalents formed in the pollen cells although they are absent from normal plants, which shows the monosomic nature of the dwarf phenotypes of the plants of the L-691 line.

According to the results of laboratory analysis, the monosomic line L-691 in the germination phase showed segregation in a ratio of 1:2:1, and not the 2:1 observed under field conditions.

In a study of the germination of 485 seeds it was found that 1/4 (130 seeds) died (lethal), and 3/4 (355 seeds) gave normal shoots (355:130, $X^2 = 0.84$; $P = 0.50$). The mature plants were subsequently divided into two phenoclasses: dwarf and normal in a ratio of 2:1 (239:116, $X^2 = 0.06$; $P = 0.95$). On the whole, for this population the ratio of the phenoclasses was as follows: 1/4 — lethal (nullisomics, ($2n = 50$), 2/4 — dwarf (monosomics, $2n = 51$), and 1/4 norm (disomics, $2n = 52$) which, in absolute figures, was 130:239:116, $X_2 = 0.90$; $P = 0.50$.

We carried out special experiments to establish the influence of various factors on the phenotypic manifestation of nanism. The growth of the main stem of plants of the L-691 line in open soil in the budding phase averaged 21 cm (Table 1). According to the results of differentiated analysis of the phenotypic classes of dwarf and norm, the dwarf (monosomic) plants were almost three times behind the normal plants in all the phases of ontogenesis.

To establish the influence of the spectrum of sunlight on the growth of the main stem of plants of the L-691 line, we carried out an experiment in covered soil (glass hothouse, where infrared and ultraviolet rays did not penetrate). In all three phases of ontogenesis a stimulating effect was observed for both the dwarf and the normal plants.

At the end of ontogenesis, the difference between the results of the experiments in the open and covered soils amounted to 7-8 cm.

One of the indirect methods of identifying endogenous growth substances in plants is the phenocopy method, where the mutant plants are treated exogenously with growth substances, and their reactions indicate the deficiency of the substance

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TABLE 1. Influence of the Light Factor on the Height of the Main Stem of the Cotton Plant

Material	Height, cm		
	Budding	Flowering	Ripening
	Open soil		
Dwarf	10.96	30.68	37.56
Norm	32.35	75.68	80.32
Total	21.00	44.78	58.94
	Covered soil		
Dwarf	14.15	31.67	44.47
Norm	26.50	66.60	88.62
Total	20.32	48.93	66.54

in the mutant. The mutant phenotype of plants of the dwarf line L-691 showed a weak reaction to exogenous treatment with gibberellin A3 (interval between treatments, 10 days):

Treatment	Control, cm	Experiment, cm
1	14.60	14.90
2	16.30	18.60
3	22.00	26.00
4	24.50	30.10

On the basis of complex studies it may be concluded that the L-691 line of the dwarf class is monosomic, and the chromosome concerned and individual genes localized in it regulate the metabolism of the phytohormones participating in the growth of the main stem. This line may serve as a model for the study of the biologically active substances of the cotton plant and for the elucidation of molecular-genetic principles.

EXPERIMENTAL

Sowing was carried out manually in open and covered soils at a depth of 4-5 cm by a 60 × 30 × 3 scheme. The necessary agrotechnical measures were carried out during the vegetation period. The ratios of plants of the dwarf and norm classes were determined in the budding phase. The height of the main stem was recorded in three phases — budding, flowering, ripening.

The seeds were grown in Petri dishes in a thermostat at +30°C. The numbers of shoots and of ungerminated seeds were determined. The germinated seeds were transplanted into a desiccator and dwarf and normal plants were revealed.

For the analysis of meiosis, young buds (2-4 nm) were collected twice a week from each plant and were fixed in Clark's fixator as described by Z. P. Pausheva [9]. Then squashed preparations were made with the use of a 2% solution of acetocarmine. The acetocarmine was prepared as described by Darlington and La Cour [10].

For the exogenous treatment of the plant we used a 20% alcoholic solution of gibberellin A3. Treatment was carried out with a manual sprayer from the phase of 5-6 true leaves four times with an interval of 10 days. The growth of the plants was measured before each treatment. Numerical results were treated as described by Dospekhov [11].

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