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ASPECTS REGARDING MITOTIC ACTIVITY IN SOME PEA GENOTYPES CULTIVATED ON CHERNOZEM SOIL AT SCDA CARACAL

Maria Alexandra EANA[1], Elena BONCIU[2], Cătălin Aurelian ROȘCULETE[2], Elena ROȘCULETE[2]

[1]University of Craiova, Doctoral School of Animal and Plant Resources Engineering (IRAV), 13 A.I. Cuza Street, Craiova, Romania; eana.alexandra@yahoo.com
[2]University of Craiova, Faculty of Agronomy, 19 Libertății Street, Craiova, Romania; elena.agro@gmail.com; catalin_rosculete@yahoo.com; rosculeta2000@yahoo.com

Corresponding author email: elena.agro@gmail.com

Abstract

Mitotic division is the process of cell growth and division that allows a plant to develop from a single cell into a mature plant. This study presents several aspects regarding mitotic activity in some pea genotypes cultivated on chernozem soil at SCDA Caracal. The mitotic index can fluctuate throughout the day, often showing peaks at certain times due to daily rhythms in cell division activity.

The mitotic activity in pea root meristems was variable, and indicate values ranging from 4.6% to 8.9%, depending on the genotype and time. Thus, the most intense mitotic activity was recorded around 8 am, while the lowest value was recorded at 2 pm. The increased mitotic activity in the morning indicates that cell division is most active during this period, potentially in response to light or other diurnal cycles. The lowest rate of cell division at 2 pm suggests a period of relative dormancy for the meristematic cells. The observed pattern is typical for plants, as many biological processes, including cell division, are regulated by a circadian rhythm. Factors like light and temperature fluctuations can also play a role in regulating this rhythm. The mitotic index can be used to assess the growth potential of different pea genotypes.

***Key words**: pea, genotypes, mitotic activity, variable*

INTRODUCTION

World population growth increases the need to ensure food security (Bonciu et al., 2021; Dihoru et al., 2023; Paunescu et al., 2021, 2023; Rosculete et al., 2018).

Food security is a critical issue that is influenced by a variety of factors, including climate changes, tillage practices, crop management techniques, the pandemics and plant diseases epidemics, food waste or food loss (Paraschivu and Cotuna, 2021; Paraschivu et al., 2022). Climate changes can lead to fluctuations in temperature and precipitation patterns, affecting crop yields and food production (Velea et al., 2021). Crop management practices and changes in tillage practices, such as reduced tillage or conservation tillage, can impact soil health and the availability of nutrients for crops (Cotuna et al., 2022; Partal et al., 2023). These various factors interact with each other in complex ways, making it essential for policymakers, researchers, and farmers to consider holistic approaches to ensure food security for all.

Pea (*Pisum sativum* L.) is one of the most common legumes that is popular and economically important both nutritionally and agronomically due to their rich nutrient profile for human health and their beneficial effects on soil and crop systems. In this context, peas contribute to food security by being a nutritious and affordable food source, improving soil health through nitrogen fixation, and supporting climate-resilient agriculture.

Thus, peas are an excellent source of plant-based protein, with dried peas containing 20–25% protein. They provide all nine essential amino acids, making them a satisfying component of a plant-based diet. Pea protein is also extracted for use in supplements and food products, which supports healthy digestion, helps regulate blood sugar, and promotes good gut health.

Peas contain high levels of essential vitamins and minerals (Kumari and Deka, 2021), including: vitamins: C, K, A, and several B vitamins (folate, thiamine, and niacin); minerals: iron, magnesium, potassium, zinc, and phosphorus; flavonoids, phenolic acids, and carotenoids, which have antioxidant properties.

As agronomic importance, pea plant forms a symbiotic relationship with soil bacteria called *Rhizobia*. The bacteria live in nodules on the pea's roots and convert inert atmospheric nitrogen into a usable form for the plant. This process, called nitrogen fixation, naturally enriches the soil, reduces the need for synthetic nitrogen fertilizers, and lowers production costs.

Crop rotation is a central component of sustainable agriculture, referring to a planned sequence of different crops grown in the same field across seasons to improve soil health and productivity (Al-Musawi et al., 2025). Peas are an important component of crop rotation systems. By breaking disease and pest cycles associated with cereal crops, they improve soil health and increase the yield of the subsequent crop. The leftover nitrogen in the soil provides a significant fertility boost for the next crop.

The ability of peas to fix nitrogen makes them a key crop for more sustainable and environmentally friendly farming practices (Abi-Ghanem et al., 2013; Dhillon et al., 2022). Biological nitrogen fixation potential of pea lines derived from crosses with nodulation mutants. By reducing the need for chemical fertilizers, they help decrease agricultural greenhouse gas emissions and pollution.

Peas are a valuable source of healthy food for animals, providing vitamins, minerals, protein, and fiber, while also serving as a natural alternative to antibiotics that can pose a public health risk. Using alternative feed ingredients can reduce reliance on antibiotics in animal feed, which is used to prevent disease and promote growth. Research shows that alternative feeds can enhance sustainability and animal health (Cola and Cola, 2021, 2022, 2023).

Mitotic division is the process of cell growth and division that allows a plant to develop from a single fertilized cell into a mature plant. This continuous process, essential for growth, tissue repair, and the development of new organs, occurs in specific regions (Bonciu, 2020). The areas of the pea plant that undergo rapid cell division through mitosis are the meristems,

Mitosis ensures that each new cell receives an identical set of genetic material from the parent cell (De Souza and Bonciu, 2022 a,b). This is critical for maintaining the plant's genetic integrity and function (Bonciu et al., 2021). As the pea plant grows, mitotic division is integral to cellular differentiation, the process where cells become specialized.

The pea karyotype has a relatively low chromosome number (2n=14) and the chromosome lengths range from of 3 to

6 µm. The genome of *P. sativum* is rather large (1C = 4.45 Gbp), and repetitive sequences make up 50-60 % of the total DNA (Smýkal et al., 2012; Yurkevich et al., 2028).

MATERIALS AND METHODS

Seeds from 3 genotypes (noted as G1 (genotype 1), G2 and G3) of spring pea were surface-sterilized by immersion in 95% ethanol for 5 min, rinsed in distilled water and then left for soak in distilled water for another 3 hours. After this time, the seeds were transferred on wet germination paper in plastic Petri dishes and incubated at room temperature.

After 72 h, roots reached a length of about 25 mm, at which point they were harvested and processed for microscopic study. Harvesting and processing of meristematic rootlets was performed at two different times: 8 am and 2 pm. For processing it was used the squash technique, in 3 replicates for each genotype. All slides were examined using Optika B-290TB microscope.

The mitotic index (MI%) was calculated according to the formula proposed by Fiskesjö, (1985):

M.I.= DC/TC *100

where:

DC=Dividing Cells;

TC=Total No. of Cells.

The frequency of cells in prophase/metaphase/anaphase/telophase is calculated by dividing the number of cells observed in in each of these phases by the total number of cells observed in mitosis, and then multiplying by 100 to get a percentage.

The mitotic index can be used to identify the optimal time for cell division, which is crucial for growth and reproduction. By calculating the ratio of cells in mitosis to the total number of cells in a sample, it can determine when the highest rate of cell division is occurring. This knowledge can help optimize methods like vegetative reproduction for higher success rates, and can be used to evaluate the impact of environmental stressors on pea growth.

RESULTS AND DISCUSSIONS

According to Hawes and Lin (1990), during germination, when roots of pea first emerge, border cells can be collected by the time the root is 5 mm in length. Cell number then increases linearly with increasing root length, as would be expected if meristematic activity were continuous.

In peas, as with other plant cells, prophase of mitosis is a preparatory stage where the cell gets ready to divide its duplicated chromosomes. Before prophase, during a stage called preprophase, a dense ring of microtubules and actin filaments, known as the preprophase band, forms just inside the plasma membrane. This band encircles the nucleus and predicts the future plane of cell division and the location where the cell plate will form during telophase.

The mitotic index can be used to assess the growth potential of different genotypes. Thus, a higher mitotic index may indicate higher growth potential and a lower index under stress conditions may indicate inhibited growth.

The decrease in the mitotic index is primarily caused by cell cycle arrest. The reduced mitotic activity leads to a shorter meristematic zone, the area at the root tip where cell division occurs. The meristem shrinks as cell division is suppressed, and cells differentiate into other tissues closer to the root apex.

The mitotic index of pea root meristems was variable, and indicate values ranging from 4.6% to 8.9%, depending on the genotype (Figure 1). Under non-irrigated conditions, these values can be considerably lower and would decrease with increasing stress.

The mitotic index can fluctuate throughout the day, often showing peaks at certain times due to daily rhythms in cell division activity. Thus, the most intense mitotic activity was recorded around 8 am, while the lowest value was recorded at 2 pm (Figure 1).

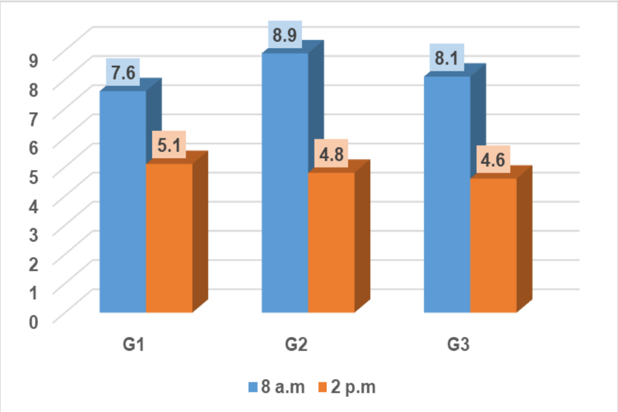

Figure 1. Variability of MI (%) in peas, depending on genotype and time.

The frequency of cells in prophase (FCP%) was about 1.4-3.6% (Figure 2).

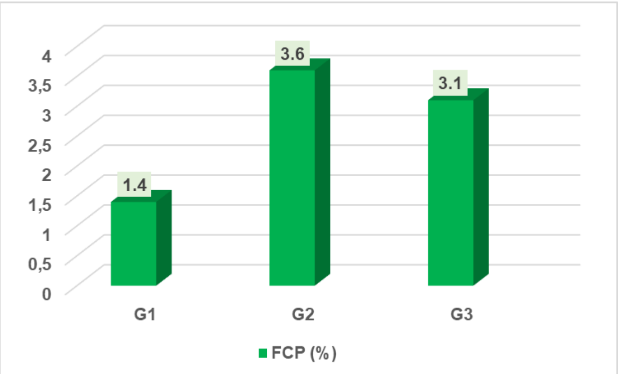

Figure 2. The frequency of cells in prophase (FCP%) in some pea genotypes.

The frequency of cells in metaphase (FCM%) was about 1.6-5.1% (Figure 3).

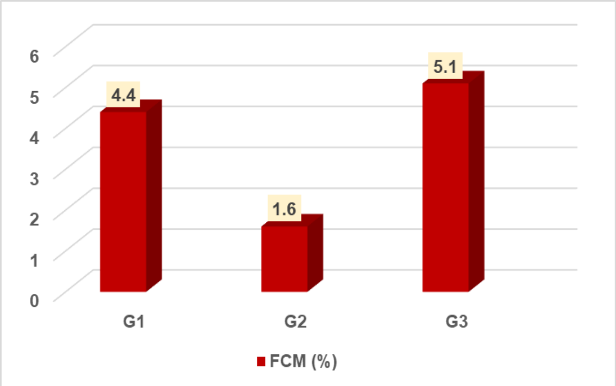

Figure 3. The frequency of cells in metaphase (FCM%) in some pea genotypes.

The frequency of cells in anaphase (FCA%) was about 0.2-0.6% (Figure 4), while the frequency of cells in telophase (FCT%) was about 0.1-0.4% (Figure 5). Because telophase is short-lived, the probability of observing a cell in this specific stage is low.

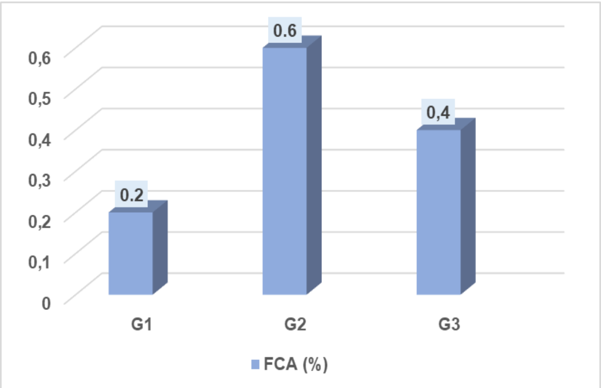

Figure 4. The frequency of cells in anaphase (FCA%) in some pea genotypes.

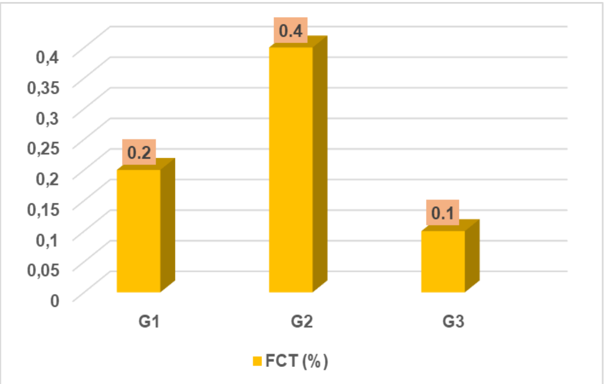

Figure 5. The frequency of cells in telophase (FCT%) in some pea genotypes.

The pea MI (%) can be an early indicator of plant's potential for overall growth and development, as the activity in the root meristem directly impacts root elongation and nutrient uptake ability.

CONCLUSIONS

The mitotic activity of some pea genotypes cultivated on chernozem soil to SCDA Caracal was variable, depending on the genotype but it can fluctuate throughout the day, often showing peaks at certain times due to daily rhythms in cell division activity.

The mitotic index can be used to assess the growth potential of different genotypes. Different pea genotypes have inherent differences in their growth potential and resilience. Measuring the MI allows for a quantitative comparison of how well each genotype adapts and grows in a given soil environment. Therefore, the mitotic index can serve as a quantitative cytological tool to evaluate the physiological and genotoxic effects of varying soil conditions on pea growth potential across different genetic backgrounds.

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