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The application of principal component analysis and cluster analysis to research of vetch seed germination in the presence of nickel chloride in the medium

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Abstract

The results of studies on the germination of vetch seeds (*Vicia sativa* L.) under conditions of increasing concentrations of nickel chloride in the medium were analyzed with the principal component analysis (PCA) and cluster analysis. The absence of a positive correlation between seed germination characteristics and amylase activity under experimental conditions was shown. Analysis of the biomass and linear dimensions of the emerging vetch sprouts with these methods revealed the closest relationship between (1) wet weights of shoots and root, (2) dry weights of shoots and root, and (3) shoot and main root length. At the same time, a closer relationship was found between the wet and dry mass than with the linear dimensions of the organs. The inclusion of data on the activity of the enzymes amylase and urease showed a positive correlation of morphological characteristics with the activity of urease, which may indicate a more significant role of this enzyme for the formation of seedlings than amylase activity. The inclusion of data on the content of proline in the analysis led to the fact that it was one of the last to enter into a single cluster, which indicates a weak connection of this indicator with the vetch seedling formation processes. The use of data on low molecular weight components: the content of photosynthesis pigments, proline, ascorbic acid, flavonoids showed a negative correlation with the first main component for flavonoids and a positive correlation for other indicators. In the constructed dendrogram, primary clusters form photosynthesis pigments and proline with flavonoids. These first-order clusters form a single second-order cluster, after which ascorbic acid is included in the overall system. Based on the results obtained, it was concluded that under conditions of increasing concentrations of nickel chloride in the medium (1), nitrogen metabolism, rather than carbohydrate metabolism, is critical for seed germination of vetch; (2) the accumulation of total biomass of shoots and roots is more important in the formation of seedlings than their linear dimensions; (3) closer correlations take place between the content of chlorophyll and carotenoids, proline and flavonoids, while the presence of the detected amount of ascorbic acid is not critical for the formation of vetch sprouts.

References

[1] A.R. Fernie. Editorial overview – computational approaches in aid of advancing understanding in plant physiology. *Frontiers in plant science*. **2011**. Vol.2. P.5-7. – doi: 10.3389/fpls.2011.00078.
[2] E.A. Abramova, V.V. Ivanishchev. Characteristics of vetch seed germination in the presence of nickel ions in the medium. *Izv. Tul'skogo Gos. Univer. Yestesvenniye Nauki*. **2016**. No.2-3. P.70-78. (russian)
[3] V.V. Ivanishchev, and N.N. Zhukov. Manifestations of oxidative stress in sprouts of triticale under condition of short-term exposure of sodium chloride. *Butlerov Communications.* **2017**. Vol.52. No.11. P.123-130. ROI: jbc-02/17-52-11-123
[4] V.V. Ivanishchev, and N.N. Zhukov. On the interrelation of water exchange and photosynthesis in triticale sprouts with short-term action of sodium chloride. *Butlerov Communications.* **2018**. Vol.53. No.3. P.35-42. ROI: jbc-02/18-53-3-35
[5] V.V. Ivanishchev. Investigation of the effect of short-term salt stress with the method of cluster analysis. *Butlerov Communications.* **2018**. Vol.54. No.4. P.134-139. ROI: jbc-02/18-54-4-134
[6] V.V. Ivanishchev. On the application of statistical methods in the study of stress in plants and their selection. *The bulletin of Kharkiv national agrarian university. Series Biology.* **2018**. Iss.3 (45). (russian)

[7] A. Sharma, M. Bakshi. Variability in Growth, Physiological, and Biochemical Characteristics among Various Clones of *Dalbergia sissoo* in a Clonal Seed Orchard. International *Journal of Forestry Research*. **2014**. Article ID 829368. 9p. http://dx.doi.org/10.1155/2014/829368.
[8] Principal component analysis method. http://xn--c1acc6aafa1c.xn--p1ai/?page_id=2252. (russian)
[9] D.A. Shabanov, M.A. Kravchenko. Data statistical analysis in zoology and ecology. **2011**. https://batrachos.com/biostatistica (russian)
[10] N.N. Bureeva. Multidimensional statistical analysis with an application of "STATISTICA" software package. *Nyzhnii Novgorod: NNGU*. **2007**. 112p. (russian)
[11] E.A. Abramova, V.V. Ivanishchev. The study of seedlings morphogenesis during vetch seeds germination in the presence of nickel ions. *Izvestiya Tul'skogo Gos. Univer. Yestesvenniye Nauki*. **2012**. Iss.2. P.246-252. (russian)
[12] E.A. Abramova, V.V. Ivanishchev. The water content in vetch (*Vicia sativa* L.) seedlings and its biomass formation in the presence of nickel ions. *Belgorod State University Scientific Bulletin. Natural sciences*. **2012**. No.15(134). Iss.20. P.42-45. (russian)
[13] E.A. Abramova, V.V. Ivanishchev. The Content of Photosynthetic Pigments and Ascorbic Acid in Vetch Seedlings in the Presence of Nickel Chloride. *Belgorod State University Scientific Bulletin. Natural sciences*. **2012**. No.9(128). Iss.19. P.152-155. (russian)
[14] E.A. Abramova, V.V. Ivanishchev. The accumulation of proline in vetch seedlings in the presence of nickel chloride in the medium. *Vseross. Nauch. Konf. S mezdunarod. uchastiem, posv. 135-litiyu so dnya rozdeniya prof. V.N. Khitrovo "Aktual'nost idei V.N. Khitrovo v issledovanii biorasnoobrasiya Rossii" I Kruglii stol "Produkcionnii process rastenii i ego regulaciya" v chest 110-letiya so dnya rozd. Prof. S.I. Efremova. Sb. Statei. Orel. 18-20 sent. 2014. Pod red. T/I/ Pusinoi. Orel.* **2014**. P.163-166. (russian)
[15] E.A. Abramova, V.V. Ivanishchev. The flavonoids content in vetch seedlings in the presence of nickel ions. *Sovremennoe sostoyanie yestestvennikh i tekhnicheskikh nauk: Materiali VIII Mezhdunarod. Nauchno-prakt. Konf. (14.09.2012). Moscow: Izd-vo "Sputnik+".* **2012**. P.25-28. (russian)