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(*Trigonella foenum-graecum* L.)

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(Matricaria recutita L.)

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(Artemisia sieberi L.)

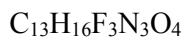
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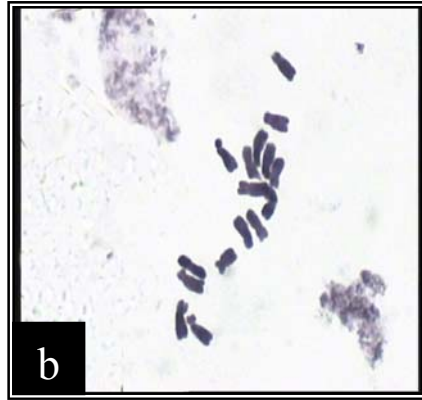
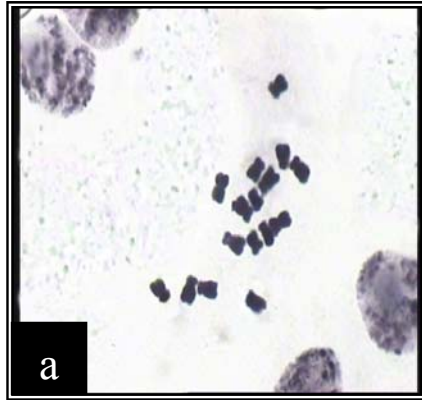
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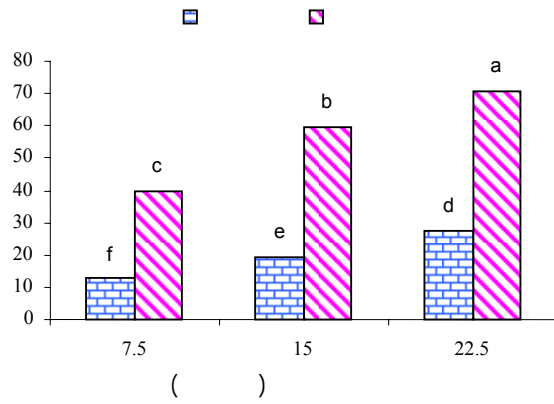
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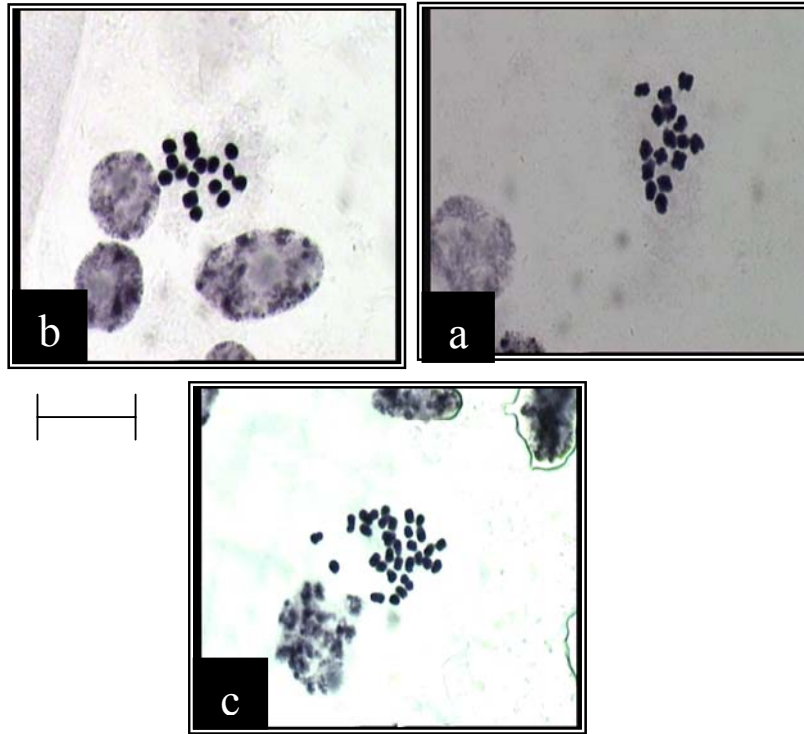
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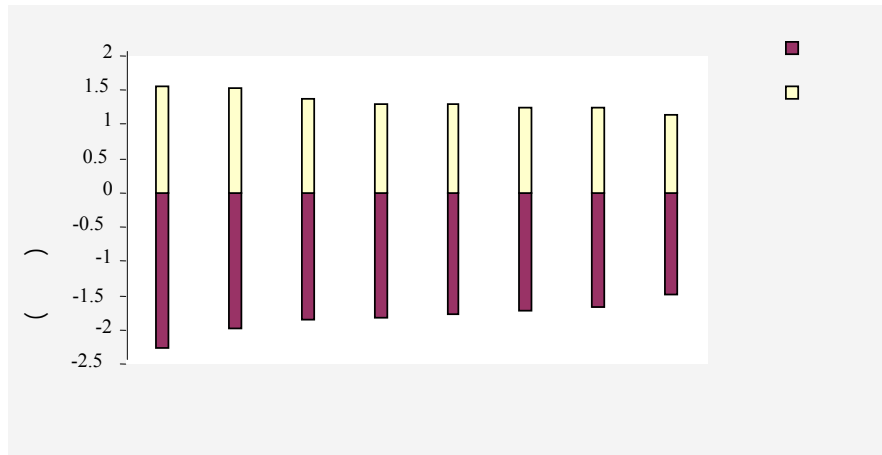
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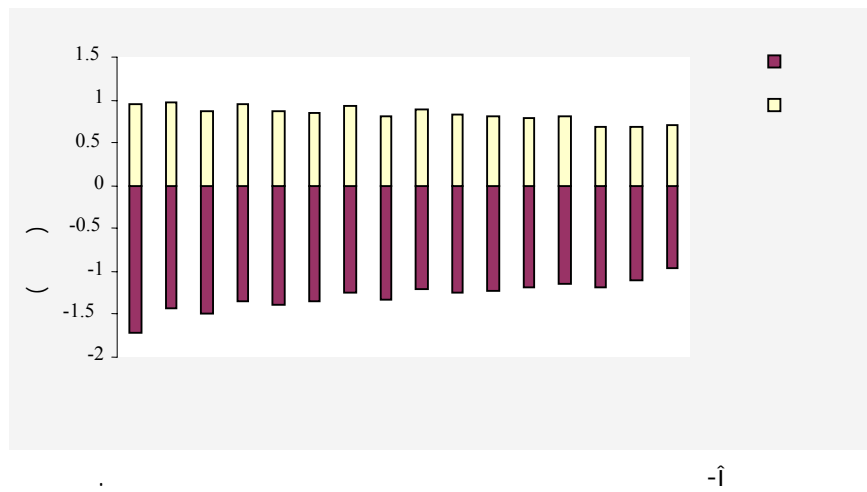
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\hat{i}	$/\hat{e}\hat{e}$	\hat{c}	$\hat{e} \hat{i}$	$/ \hat{e}$	$\hat{c}\hat{e}$	m
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\dot{y}/ \dot{y}^c	$/^a$	$/^a$	$/^a$	$/\dot{y}^a$	$()$
$\dot{y}/^a$	$/^c$	$/^b$	$/^b$	$/^b$	$()$
$\dot{y}/^b$	$/^b$	$\dot{y}/^c$	$/^c$	$/^c$	$()$

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1. Adaniya, S. and D. Shira. 2001. In vitro induction of tetraploid ginger (*Zingiber officinalis* Roscoe) and its pollen fertility and germinability. *Science Horticulture*, 88: 277-287.
2. Ahmad, F., S. Acharya, Z. Mir and P. Mir. 1999. Localization and activity of rRNA genes of fenugreek *in situ* hybridization and silver staining. *Theoretical and Applied Genetics*. 98(2): 179-185.
3. Alishah, O. and M. Bagherieh-Najjar. 2008. Polyploidization effect in two diploid cotton (*Gossypium herbaceum* and *G. arboretum*) species by colchicine treatments. *African Journal of Biotechnology*. 7(2): 102-108.
4. Das, A.B., M. Pattnaik, T. thangaraj and P. Das. 1997. Cytophotometric estimation of nuclear DNA content and karyotype analysis of eight cultivars of *Trigonella foenum-graecum*. *Cytobios*. 91: 171-179.
5. Dhawan, O.P. and U.C. Lavania. 1996. Enhancing the productivity of secondary metabolites via induced polyploidy: A review. *Euphytica*. 87: 81-89.
6. Hansen, A.L., A. Gertz, M. Joersbo and S.B. Andersen. 1998. Antimicrotubule herbicides for *in vitro* chromosome doubling in *Beta vulgaris* L. ovule culture. *Euphytica*. 101: 231-237.
7. Hansen, N.J.P. and S.B. Andersen. 1996. In vitro chromosome doubling potential of colchicine, oryzalin, trifluralin, and APM in *Brassica napus* microspore culture. *Euphytica*. 88(2): 159-164.
8. Hess, D. and D. Bayer. 1974. The effect of trifluralin on the ultrastructure of dividing cells of the root meristem of cotton (*Gossypium hirsutum* L. Acala 4-42). *Journal of cell science*. 15: 429-441.
9. Jesus, L.D. 2003. Effect of artificial polyploidy in transformed roots of *Artemisia annua* L. *Plant Cell Reports*. 21: 809-813.
10. Klima, M., M. Vyvadilova and V. Kucera. 2008. Chromosome doubling effects of selected antimitotic agents in *Brassica napus* microspore culture. *Plant Breed*. 44(1): 30-36.
11. Ladizinsky, G. and C.G. Vosa. 1986. Karyotype and c-banding in *Trigonella foenum-graecum*. *Plant Systematic and Evolution*. 153(1): 1-5.
12. Levan, A.K., K. Fredga and A.A. Sandberg. 1964. Nomenclature for centromeric position on chromosomes. *Hereditas*. 52: 201-220.
13. Mehrafarin, A., A. Qaderi, Sh. Rezazadeh, H. Naghdi Badi, Gh. Noormohammadi and E. Zand. 2010. Bioengineering of Important Secondary Metabolites and Metabolic Pathways in Fenugreek (*Trigonella foenum-graecum* L.). *Journal of Medicinal Plants*. 9(35): 1-18.
14. Najaf Poor, M. 1994. About the medicinal plant of fenugreek. *Research Institute of Forests and Range*. 18 pp.
15. Niknam, V. and A. Kiyani. 2004. Effects of drought and salinity stress on some biochemical parameters of fenugreek *in vitro*. 2nd medicinal plants Conference, Shahed University, Tehran. 186 pp.
16. Raghuvanshi, S.S. and M. Pant. 1980. Studies on the distribution of b chromosome in different plant parts of *Trigonella foenum-graecum*. *Caryologia*. 33(2): 215-225.
17. Rey, H.Y., P.A. Sansberro, M.M. Collavino, J.R. Davina, A.M. Gonzalez and L.A. Mroginski. 2002. Colchicine, trifluralin and oryzalin promoted development of somatic embryos in *Ilex paraguariensis*. *Euphytica*. 123: 49-56.

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18. Riasat, M. 2001. Investigation of cytogenetic of genus fenugreek (*Trigonella*) in Fars province. M.Sc thesis, Faculty of Science Orumieh University. 121 pp.
 19. Rudi, D. 1998. Trifluralin and iron influence on morphological characteristics and iron absorption of soybean varieties in greenhouse. M.Sc thesis, Faculty of Agriculture Shiraz University. 125 pp.

Effect of Trifluralin Herbicide on Polyploidy Induction and Chromosome Changes in Root Meristem Cells of Fenugreek (*Trigonella foenum-graecum*)

E. Afshari¹, G.A. Ranjbar², S.K. Kazemitabar³, M. Riasat⁴ and H. Kazemi Poshtmasari⁵

Abstract

Fenugreek (*Trigonella foenum-graecum*) is an annual herbaceous plant belongs to Papilionaceae family and is important as a pharmaceutical, agronomic and pastoral plant. In order to study the effect of trifluralin on ploidy induction and cytogenetic characteristics of cells in the root meristem of fenugreek some seeds of this species were planted in the incubator and after germination root tips were used for karyotypic studies. For treating the seeds trifluralin liquid 48% were applied at 7.5, 15 and 22.5 μM concentrations for 12 and 24 h. The Video Analysis System was used for karyotype analysis. The basic chromosome number was $X=8$. The results showed that concentration of trifluralin, treatment duration and interaction between them on the ploidy induction were statistically significant. The maximum ploidy induction was happened by immersion seedlings in 22.5 μM trifluralin at 24 h. The result of analysis of variance based on completely randomized design (CRD) showed a significant difference among the karyotypes for all chromosomal traits ($P<0.05$). Trifluralin affected severity on the length of chromosomes and karyotypic formula so that the longest chromosomes belonged to the karyotype control sample and the shortest chromosomes were observed after treating with trifluralin. After applying treatment was reduced the percentage of submetacentric chromosomes and were added to the percentage of metacentric chromosomes.

Keywords: Chromosome, Cytogenetic changes, Ploy Ploidy induction, Trifluralin, Fenugreek

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