

GENOME-WIDE IDENTIFICATION AND ANALYSIS ON GENE FAMILIES OF GROWTH-REGULATING FACTOR (GRF) AND GRF-INTERACTING FACTOR IN *ISATIS INDIGOTICA* FORT.

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Growth regulating factor (GRF) binds to the QLQ (Gln, Leu, Gln) domain at the N-terminal of GRF interacting factor (GIF), acting as a transcriptional co-activator and playing important roles in plant growth, development and resistance to stresses. To date, no comprehensive identification and analysis of GRF and GIF gene families have been reported in Isatis indigotica Fort.. In this study, the gene structures, conserved motifs, physicochemical properties, chromosomal localizations, cis-acting elements, evolutionary relationships and expression patterns were systematically analyzed. The results showed that there were 10 LiGRFs distributed on 5 chromosomes, and 4 LiGIFs on 2 chromosomes. LiGRFs and LiGIFs could be divided into 4 and 2 subfamilies, respectively. LiGRFs has two pairs of segmental duplication genes, but no tandem duplication genes. Moreover, LiGRFs (19.14-fold) and LiGIFs (8.0-fold) had the highest expression levels in young leaves and stems, compared with those in roots. The upstream regions of LiGRFs and LiGIFs contained more photo and MeJA hormone responsive elements, responding to shade and hormone stresses. Furthermore, the correlation analysis showed that LiGRF4 and LiGIF2, LiGRF4 and LiGIF4, and LiGRF4 and LiGIF3 were co-expressed with each other, which suggested that these paired genes could function together. The findings provided the more fundamental information on LiGRFs and LiGIFs, and laid good foundations for their further functional research in I. indigotica.

Key words: *Isatis indigotica* Fort., GRF, GIF, gene family, expression pattern.

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ПОВНОГЕНОМНА ІДЕНТИФІКАЦІЯ ТА АНАЛІЗ СІМЕЙСТВ ГЕНІВ ФАКТОРА РЕГУЛЯЦІЇ РОСТУ (GRF) ТА ФАКТОРА ВЗАЄМОДІЇ З GRF В *ISATIS INDIGOTICA* FORT. Фактор регуляції росту (GRF) зв'язується з доменом QLQ (Gln, Leu, Gln) на N-кінці фактора взаємодії з GRF (GIF), діючи як транскрипційний коактиватор та відіграючи важливу роль у рості, розвитку та стійкості рослин до стресів. На сьогоднішній день не було опубліковано жодних даних про комплексну ідентифікацію та аналіз сімейств генів GRF та GIF у *Isatis indigotica* Fort. У цьому дослідженні було систематично проаналізовано структуру генів, консервативні мотиви, фізико-хімічні властивості, хромосомну локалізацію, цис-діючі елементи, еволюційні зв'язки та патерни експресії. Результати показали, що є 10 LiGRF, розподілених на 5 хромосомах, та 4 LiGIF на 2 хромосомах. LiGRF та LiGIF можна розділити відповідно на 4 та 2 підродини. LiGRF мають дві пари генів сегментарної дуплікації, але не мають генів тандемної дуплікації. Більше того, LiGRF (19,14-кратно) та LiGIF (8,0-кратно) мали найвищі рівні експресії в молодих листках і стеблах порівняно з коренями. Висхідні ділянки LiGRF та LiGIF містили більше елементів, що реагують на світло та гормон MeJA у відповідь на тіньовий та гормональний стрес. Крім того, кореляційний аналіз показав, що LiGRF4 та LiGIF2, LiGRF4 та LiGIF4, а також LiGRF4 та LiGIF3 спільно експресувалися одне з одним, що свідчило про те, що ці спарені гени могли функціонувати разом. Отримані результати надали більш фундаментальну інформацію про LiGRF та LiGIF і заклали міцну основу для подальших функціональних досліджень *I. indigotica*.

Ключові слова: *Isatis indigotica* Fort., GRF, GIF, сімейство генів, патерн експресії.

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