



- (51) **International Patent Classification:**
C12N 1/13 (2006.01) *C12P 7/64* (2006.01)
C12N 15/63 (2006.01)
- (21) **International Application Number:**
PCT/US2012/047815
- (22) **International Filing Date:**
23 July 2012 (23.07.2012)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
61/510,641 22 July 2011 (22.07.2011) US
- (71) **Applicant (for all designated States except US):** DON-
ALD DANFORTH PLANT SCIENCE CENTER
[US/US]; 975 N. Warson Road, St. Louis, MO 63132
(US).
- (72) **Inventors; and**
- (75) **Inventors/Applicants (for US only):** SAYRE, Richard
[US/US]; 975 N. Warson Road, St. Louis, MO 63132
(US). PERRINE, Zoe [US/US]; 975 N. Warson Road, St.
Louis, MO 63132 (US). KUMAR, Anil [US/US]; 975 N.
Warson Road, St. Louis, MO 63132 (US).
- (74) **Agent:** BENNETT, Dennis, A.; Global Patent Group,
LLC, 1005 N Warson Road, Suite 201, St. Louis, MO
63132 (US).

- (81) **Designated States (unless otherwise indicated, for every
kind of national protection available):** AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,
HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD,
SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR,
TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) **Designated States (unless otherwise indicated, for every
kind of regional protection available):** ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the
claims and to be republished in the event of receipt of
amendments (Rule 48.2(h))

- (88) **Date of publication of the international search report:**
25 April 2013

(54) **Title:** PLANTS AND ALGAE CAPABLE OF MODULATING ANTENNA SIZE BASED ON LIGHT INTENSITY

(57) **Abstract:** Methods, and compositions for modulating the PSII peripheral antenna size of photosynthetic organisms by negat-
ively regulating the expression of chlorophyll a oxygenase (CAO) to high light intensity. Transgenic photosynthetic organisms that
are capable of modulating their PSII peripheral antenna size as a function of light intensity, and exhibit enhanced photosynthetic
productivity, and methods for their use.



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/047815**A. CLASSIFICATION OF SUBJECT MATTER***C12N 1/13(2006.01)i, C12N 15/63(2006.01)i, C12P 7/64(2006.01)i*

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C12N 1/13; C12P 7/40; C12N 15/63; C12N 15/82; A01H 5/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: Photosystem II, chlorophyll a/b ratio, antenna, light intensity, photosynthetic organism, algae, chlorophyll a oxidase, CAO, cold-shock domain consensus sequence, CSDDCS.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	MUSSGNUM, JAN H. et al., 'NAB1 is an RNA binding protein involved in the light-regulated differential expression of the light-harvesting antenna of <i>Chlamydomonas reinhardtii</i> ', The Plant Cell, December 2005, Vol. 17, No. 12, pp. 3409-3421. See Abstract; pp. 3412-3413; Fig. 4.	1-5, 16-20, 27-30, 39-41
A	MASUDA, TATSURU et al., 'Chlorophyll antenna size adjustments by irradiance in <i>Dunaliella salina</i> involve coordinate regulation of chlorophyll a oxygenase (CAO) and Lhcb gene expression', Plant Molecular Biology, March 2003, Vol. 51, No. 5, pp. 757-771. See Abstract; p. 758, left column.	1-5, 16-20, 27-30, 39-41
A	US20080120749 A1 (MELIS, ANASTASIOS et al.) 22 May 2008 See Abstract; claims 1, 10, 12, 15, and 17.	1-5, 16-20, 27-30, 39-41
A	TERAMOTO, HARUHIKO et al., 'Light-Intensity-Dependent Expression of Lhc Gene Family Encoding Light-Harvesting Chlorophyll-a/b Proteins of Photosystem II in <i>Chlamydomonas reinhardtii</i> ', Plant Physiology, September 2002, Vol. 130, No. 1, pp. 325-333. See Abstract.	1-5, 16-20, 27-30, 39-41

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

25 FEBRUARY 2013 (25.02.2013)

Date of mailing of the international search report

26 FEBRUARY 2013 (26.02.2013)

Name and mailing address of the ISA/KR



Facsimile No. 82-42-472-7140

Authorized officer

HEO, Joo Hyung

Telephone No. 82-42-481-8150



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2012/047815**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 9,11,26,33,36,38
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
Claims 9, 11, 26, 33, 36, and 38 are unclear (PCT Article 6) since they are referring to the multiple dependent claims which do not comply with PCT Rule 6.4(a).
3. ☒ Claims Nos.: 6-8,10,12-15,21-25,31,32,34,35,37,42,43
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2012/047815

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US20100317073 A1 (SAYRE, RICHARD T. et al.) 16 December 2010 See Abstract; paragraphs [0107]–[0108]; claims 1, 14, and 24–26.	1–5, 16–20, 27–30 , 39–41
A	US7642405 B2 (LEE, JAMES WEIFU) 05 January 2010 See Abstract; claims 1–4.	1–5, 16–20, 27–30 , 39–41

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2012/047815

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US20080120749 A1	22.05.2008	US 2010-0221739 A1 US 7745696 B2	02.09.2010 29.06.2010
US20100317073 A1	16.12.2010	AU 2008-333818 A1 AU 2008-333824 A1 CN 101932706 A CN 101932714 A EP 2220225 A2 EP 2220225 A4 EP 2222862 A1 MX 2010006169 A US 2009-0181438 A1 WO 2009-073816 A1 WO 2009-073822 A2 WO 2009-073822 A3	11.06.2009 11.06.2009 29.12.2010 29.12.2010 25.08.2010 22.02.2012 01.09.2010 23.06.2010 16.07.2009 11.06.2009 11.06.2009 05.11.2009
US7642405 B2	05.01.2010	US 2008-0127364 A1 US 2010-0239923 A1 WO 2007-143354 A2 WO 2007-143354 A3	29.05.2008 23.09.2010 13.12.2007 24.12.2008