Research on Element-accumulating Capacity of Plants

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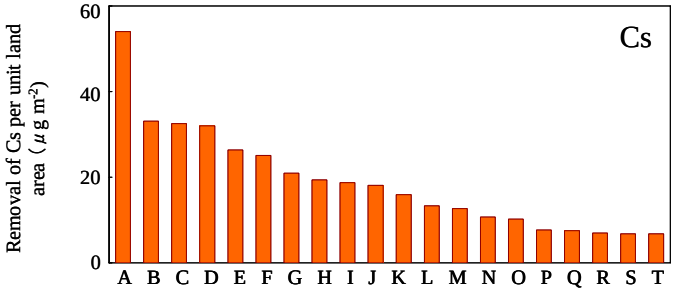
Abstract

Phytoremediation is a possible countermeasure against soil contamination with radionuclides. Identifying and establishing hyperaccumulators is the key to developing practical phytoremediation methods. This study aims to select or develop hyperaccumulators usable for radionuclides that could potentially be released in Aomori Prefecture due to the location of a nuclear fuel reprocessing facility there. For that purpose, we focused on the following two approaches: to search for hyperaccumulators for Cs, Sr and I from crops and wild plants, and to employ a genetic approach to develop transgenic plants using genes controlling Cs resistance in *Arabidopsis* mutants.

Several crops were selected as candidate accumulators of each element according to their ability to remove the element when the plants were cultivated in an experimental field by conventional practice. The selected candidate Cs accumulators were *Portulaca oleracea, Amaranthus hypochondriacus, Helianthus annuus* and *Lactuca sativa var. angustana*. The candidate Sr and I accumulators were *Amaranthus hypochondriacus* and *Helianthus annuus*. Those candidates will be examined further for removal of the elements under different cultivation conditions in the experimental field. The best accumulator for each element will then be selected based on the removal results.

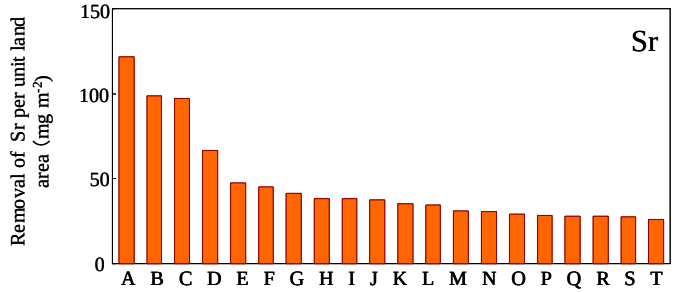
Eight wild plants were selected by analysis results with ICP-MS after screening of 282 species by X-ray fluorescence analysis. Those plants will be cultivated in the experimental field and their removal of the target elements from soil will be checked.

For a genetic approach, thirteen lines of Cs-resistant *Arabidopsis* mutants have already been established. The causative genes of two lines of the mutants were identified. The causative genes of the CsR33 and CsR80 lines were a chloroplast signal recognition particle subunit (*cpSRP54*) gene and glutamyl-tRNA reductase (*HEMA1*) gene, respectively. Since the causative genes are related to chlorophyll synthesis and most of the mutants showed yellowish leaves, Cs-resistance was considered to be linked to chlorophyll metabolism. *Arabidopsis* knockout mutants of chlorophyll synthesizing enzyme genes were examined for Cs resistance, and six knock-out lines were found to have it.



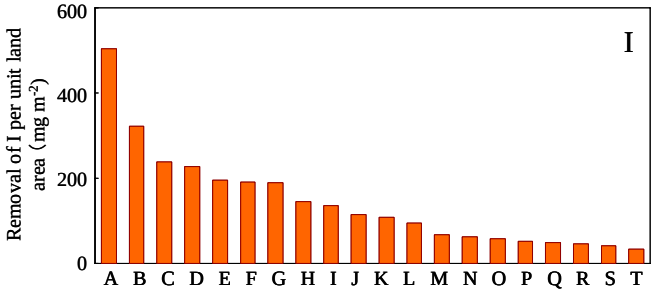
A : ***Portulaca oleracea*** var. ***sativa*** 'Suberihiyu'
B : ***Amaranthus hypochondriacus*** 'Amaransasu. taiwan'
C : ***Helianthus annuus*** 'Himawari'
D : ***Amaranthus hypochondriacus*** 'Amaransasu. nagano'
E : ***Amaranthus hypochondriacus*** 'Amaransasu. ichinohe'
F : ***Amaranthus tricolor*** 'Amaransasu.'
G : ***Lactuca sativa*** var. ***angustana*** 'Kakichisha. red'
H : ***Brassica rapa*** var.***amplexicaulis*** 'Santousai'
I : ***Kochia scoparia*** 'Houkigusa'
J : ***Celosia argentead*** 'Keitou. kurume'
K : ***Lactuca sativa*** var. ***angustana*** 'Kakichisha.green'
L : ***Thymus vulgaris*** 'Taimu'
M : ***Amaranthus hypochondriacus*** 'Amaransasu. summer red'
N : ***Brassica rapa*** 'Kabu. tsugarubeni'
O : ***Brassica rapa*** 'Kabu. atsumi-kabu'
P : ***Celosia argentead*** 'Keitou. candle'
Q : ***Brassica oleracea*** var. ***gongylodes*** 'Kôrurabi. purple bird'
R : ***Perilla frutescens*** var.***crispa*** 'Siso. ao-chirimen'
S : ***Cucubita maxima*** 'Kabocha'
T : ***Brassica napus*** var.***napobrassica*** 'Kabu. rutabaka'

Fig. 1 Removal of Cs per unit land area in an experimental field by 20 crops.



A : ***Helianthus annuus*** 'Himawari'
B : ***Amaranthus tricolor*** 'Amaransasu.'
C : ***Amaranthus hypochondriacus*** 'Amaransasu. taiwan'
D : ***Amaranthus hypochondriacus*** 'Amaransasu. nagano'
E : ***Brassica rapa*** var. ***amplexicaulis*** 'Santousai'
F : ***Brassica napus*** var.***napobrassica*** 'Kabu. rutabaka'
G : ***Brassica oleracea*** var. ***gongylodes*** 'Kôrurabi. purple bird'
H : ***Amaranthus hypochondriacus*** 'Amaransasu. summer red'
I : ***Brassica napus*** 'Kabu. turnip'
J : ***Amaranthus hypochondriacus*** 'Amaransasu. ichinohe'
K : ***Brassica oleracea*** var.***gongylodes*** 'Kôrurabi. gland duke'
L : ***Celosia argentead*** 'Keittou. kurume'
M : ***Perilla frutescens*** var.***crispa*** 'Siso. ao-chirimen'
N : ***Brassica rapa*** 'Kabu. ayameyuki'
O : ***Celosia argentead*** 'Keitou. candle'
P : ***Raphanoth sativus*** 'Daikon. milano-daikon'
Q : ***Brassica rapa*** 'Kabu. tsugarubeni'
R : ***Raphanoth sativus*** 'Daikon. aokubi-daikon'
S : ***Portulaca oleracea*** var. ***sativa*** 'Suberihiyu'
T : ***Hyssopus officinalis*** 'Hisoppu'

Fig. 2 Removal of Sr per unit land area in an experimental field by 20 crops.



A : ***Helianthus annuus*** 'Himawari'
B : ***Amaranthus hypochondriacus*** 'Amaransasu. summer red'
C : ***Amaranthus hypochondriacus*** 'Amaransasu. taiwan'
D : ***Thymus vulgaris*** 'Taimu'
E : ***Amaranthus tricolor*** 'Amaransasu.'
F : ***Agastache urticifolia*** 'Agasutâshe. butterfly blue'
G : ***Amaranthus hypochondriacus*** 'Amaransasu. nagano'
H : ***Echinochloa esculenta*** 'Hie. yariko-hie'
I : ***Amaranthus hypochondriacus*** 'Amaransasu. ichinohe'
J : ***Ocimum basilicum*** 'Suîto bagiru'
K : ***Cucubita maxima*** 'Kabocha'
L : ***Perilla frutescens*** 'Egoma. siro-egoma'
M : ***Portulaca oleracea*** var. ***sativa*** 'Suberihiyu'
N : ***Hyssopus officinalis*** 'Hisoppu'
O : ***Agastache rugosa*** 'Agasutâshe. golden jubilee'
P : ***Brassica rapa*** var. ***amplexicaulis*** 'Santousai'
Q : ***Sorghum bicolor*** 'Morokosi'
R : ***Stipa tenuissima*** 'Sutipa. pony tail'
S : ***Raphanoth sativus*** 'Daikon. milano-daikon'
T : ***Brassica rapa*** 'Kabu. ayameyuki'

Fig. 3 Removal of I per unit land area in an experimental field by 20 crops.