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Occurrence and distribution of weed species on horticulture fields in Chungnam province of Korea

Ki Seon Hwang[1], Min Yong Eom[1], Su Hyuk Park[1], Ok Jae Won[1], In Yong Lee[2], Kee Woong Park[1,*]

[1]Department of Crop Science, Chungnam National University, Daejeon 305-764, Korea.
[2]Department of Agro-Food Safety & Crop Protection, National Academy of Agricultural Science, RDA, Jeollabuk-do 565-851, Korea.

Abstract
A survey of weed occurrence was conducted to identify problematic weed species in a horticultural crop field to get basic information for effective weed control. Surveys of weed species occurring in horticultural crop fields (garlic, onion, red pepper and Chinese cabbage) were conducted in Chungnam province of Korea from April to October in 2014. A total of 516 sites of the 17 regions were identified as having 114 weed species belonging to 32 families. The most dominant weed species in the horticultural crop fields were *Chenopodium album* var. *centrorubrum* (8.83%), followed by *Digitaria ciliaris* (5.71%), *Conyza canadensis* (5.46%) and *Capsella bursa-pastoris* (4.67%). Specifically, as a result of this study, the occurrence of 35 species of exotic weeds, such as *Chenopodium album* and *Taraxacum officinale,* were confirmed. Almost 68% of the investigation sites was determined under dominance value 1 (range of cover < 10; numerous individuals) by Braun-Branquet cover-abundance scale, indicating a proper weed control in horticultural crop field. As a result of scientific and technological advances, an improved cultivation method is changing the weed occurrence in agricultural land. Additional research needs to be undertaken for the development of weed control methods through such periodic monitoring of occurrence of weeds.

Key words: Chungnam province, exotic weed, horticultural crop field, weed control, weed occurrence

INTRODUCTION

Due to an increase in income from rapid growth of the economy, there have been enormous changes in the consumption pattern of agricultural products. Consumption of food has been steadily changing from starchy food, especially grains, to foods that are high in protein and vitamin contents (Jeong 2000). With the increasing awareness in the quality of life, there has been an upsurge in the demand for safe food, leading to changes in agricultural practices towards more environment friendly farming, which is safer for humans and animals. Particularly, there has been much focus on the safety and environmental hazards of herbicides used to manage weeds that grow during the cultivation of crops.

In agriculture, weeds may play some roles, providing diversity, ecosystem functions and supporting many other species such as insects and birds (Marshall et al. 2003). It is ecologically meaningful data to understand the weed species diversity of agricultural land because the same weeds can occur in different growing conditions such as upland, orchard and pasture.

The occurrence of weeds in a crop field means an increase in the density of plants in a limited area. Conse-

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***Corresponding Author**
E-mail: parkkw@cnu.ac.kr
Tel: +82-42-821-5726

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quently, the presence of weeds in a field, with a planting density designed to yield the maximum amount of crops, would inevitably decrease the average crop yield (Won et al. 2011). The decrease in crop yield could range from 30 to 100 percent, depending on weed management. Along with a decrease in their quantity, the weeds also bring a decline in the crop quality. Depending on the type of crop, a variety of preventative measures, including the use of herbicides, are applied to manage weed occurrence in agricultural land. Along with herbicide use, vinyl mulching, rice and barley straw, and hand weeding are also used to manage weed occurrence (Lee et al. 2001). Before weed growth begins, pesticides are applied for soil treatment, while mulching, nonselective herbicides in furrows, and hand weeding are usually employed during the cultivation period.

In the Chungnam province, there is an increase in garlic and onion fields, but a decrease in number of red pepper and Chinese cabbage fields. Red pepper is the number one crop in Korea in terms of cultivation area and yield production. However, in 2013, in the Chungnam region, the cultivated area decreased by 29.9%, from 6,572 ha in 2005 to 1,968 ha (KOSTAT 2013). The reason for this decrease could be the requirement of a substantial amount of labor, and the difficulty to mechanize transplanting and harvesting processes. Therefore, it is necessary to use herbicides due to the fact that agricultural population is declining and rapidly aging.

Weed development is influenced by the region's landform, soil property, and types of industry. Weed vegetation in agricultural land has changed depending on cropping patterns and weed control methods. Improved crop management techniques, including herbicides, have resulted in good control of weeds and have facilitated different cropping patterns and steadily increasing crop yields (Marshall et al. 2003). The change in herbicide is the main cause of changes in the diversity, amount of weed development, and dominant weed species within an agricultural ecosystem (Kim and Shin 2007). A successive application of the same herbicide has the most direct influence on the change in the community of weeds that develop in crop fields (Kim et al. 2012).

To effectively manage weeds that grow in crop fields and to prepare measures against the changes in weed community, it is important to understand the weed species and their distribution. Botanically, weeds are divided into pteridophytes and spermatophytes. Spermatophytes are further divided into dicotyledones and monocotyledons, with further divisions into different families. Weeds are also classified as grassy weeds, broadleaf weeds, and sedge weeds. Based on their life cycles, they could be either annual weeds or perennial weeds. This practical classification is meaningful in the selection of herbicides, since each group has a similar response to herbicides (Rural Development Administration 2000).

In Korea, since dry field crops are usually cultivated in small areas, there have been fewer studies on controlling weeds growing in dry fields, as compared to studies for weeds in rice fields. Systematic studies on weeds growing in dry fields only started after 1980 (Im et al. 2008). In a five year period starting from 2000, Lee et al. (2007) studied the distribution of weeds growing on cultivated land, and reported that there are 302 species of weeds in dry fields, including 30 major weed species in Korea.

The ultimate goal of managing weeds is effective weed control, and therefore it is essential to understand the occurrence and the distribution of weeds that grow in crop fields. Studying the distribution of weeds would enable a systematic construction of weed management system by continuously providing the current state of weed growth. If problematic weeds and foreign weeds are identified, suitable preventative measures can be applied, and we could hope for an improvement in both quality and quantity of crops, as well as saving of labor.

This study, conducted every ten years by the rural development administration (RDA) as a part of the nationwide-detailed distribution analysis of weed development in cultivated lands, was undertaken to retain basic data that would enable the development of effective labor-saving weed control technology by understanding the distribution patterns of weeds and the extent of damage they have on major horticultural crops grown in the Chungnam province.

MATERIALS AND METHODS

This study was conducted from April to October of 2014 (garlic and onion: April-May, red pepper: July-August, and Chinese cabbage: October), to confirm the development patterns and the changes in distribution of weeds that grow on crop fields of major horticultural crops in 17 cities and guns (districts) of Chungnam region, including Daejeon and Sejong.

Selecting survey sites

The target crop fields were horticultural crop fields with little to no preventive measures against weeds; they were randomly selected from eup or myeon belonging to each city and gun, that were divided according to administrative districts. The frequency and distribution of weed growth were investigated in each survey site. To understand the changes in the weed community in same crop fields, we used Hi Drive ver. 2.0 (a smartphone application) to record GPS (ICE CPS 100c) information and address. The area of each crop field was roughly measured by counting how many steps it takes a researcher to get from one end to the other. The weed development and the area surrounding the fields were photographed (Canon 100D). Weed species were identified with visual assessment, and the covering ratio was studied based on the 7-level system (5, 4, 3, 2, 1, + and r) of Braun-Blanquet (1964). The cover-abundance index used by Braun-Blanquet is as follows: 5, covering more than 75% of the whole target fields; 4, any number of individuals covering 50-75% of the area; 3, any number of individuals covering 25-50% of the area; 2, very numerous or covering at least 5% of the area; 1, plentiful but of small cover value; +, sparsely present, cover small; r, very sparsely present, cover very small (Poore 1955).

Analysis of results

To figure out the dominant species based on the results, we analyzed the importance value (Curtis and McIntosh 1950). Frequency, defined as the percentage of samples where certain species appear among all the crop fields under observation, was calculated by dividing the number of crop fields with a certain species, by the number of all the crop fields. Relative frequency (RF) was calculated by dividing frequency by the sum of frequencies of all the species multiplied by 100. Relative cover (RC) was calculated by dividing the cover degree (a value found by dividing the area that a certain species occupies by the area of the enumeration district) by sum of the cover degree of all the species multiplied by 100. Importance value (IV) was calculated by adding the relative frequency and the relative cover degree and dividing the results in half.

The results from the weed survey were compiled into lists, in accordance with the Synonymic List of Vascular Plant of Korea (Korea National Arboretum 2007). Exotic weeds were recorded using "Colored Illustrations of Naturalized Plants of Korea (Park 2009) as a reference. For the confirmed species of weeds, we classified them into annual, biennial and perennial weeds, based on life cycles presented by Raunkiaer (1934), and then calculated the distribution proportion of each family of weeds.

RESULTS AND DISCUSSION

The species and the distribution patterns of weeds in the 516 crop fields (82 for red pepper, 285 for garlic, 86 for onion, and 63 for Chinese cabbage) of Chungnam province were analyzed (Table 1), there were a total of 32 weed families, comprised of 114 species. There were 69 species of annual weeds, 25 species of biennial weeds, and 22 species of perennial weeds, which comprised 61%, 22%, and 18% of the total, respectively (Table 2). The most dominant weed in the Chungnam region was *Chenopodium album* var. *centrorubrum* (8.83%), with *Digitaria ciliaris* (5.71%), *Conyza canadensis* (5.46%), *Capsella bursa-pastoris* (4.67%), and *Plantago asiatica* (3.27%) being the next dominant species. The top ten weed species comprised 39.28% of the total, indicating that these are the problematic species of the horticultural lands in the Chungnam region. Also, we found 35 species of exotic weeds growing in this region, including *Acalypha australis*, *Chenopodium album*, and *Taraxacum officinale*. In a five year period starting from 2000, Lee et al. (2007) studied the distribution of weeds growing on upland land in Korea, reported that 112 weed species of 33 families were identified and Compositae was most dominant family comprised 18.0%. Choi et al. (2009) had previously reported that there are 28 species belonging to 15 families of exotic weeds in dry fields in Chungnam province. In this survey, some species such as *Ambrosia artemisiifolia*, *Ammannia coccinea* and *Lactuca scariola* were identified, that were unconfirmed in the last survey conducted

Table 1. The number of survey sites at each location of Chungnam province in Korea

Location	Garlic	Onion	Red pepper	Chinese cabbage
Gyeryong	4	1	0	2
Gongju	18	2	8	0
Geumsan	16	0	0	7
Nonsan	18	0	6	9
Dangjin	20	17	5	9
Daejeon	1	14	1	1
Boryeong	12	3	1	3
Buyeo	18	14	6	12
Seosan	36	6	0	4
Seocheon	11	4	0	10
Sejong	12	1	1	0
Asan	13	5	7	0
Yesan	18	6	7	5
Cheonan	16	1	0	0
Cheongyang	23	2	9	5
Taean	29	5	0	4
Hongseong	20	5	12	11
Total	285	86	63	82

Table 2. Occurrence of weed species on horticulture fields in Chungnam province

Rank	Scientific name	Family	Life cycle	I.V.[†]
1	*Chenopodium album* var. *centrorubrum*	Chenopodiaceae	Annual	8.83
2	*Digitaria ciliaris*	Poaceae	Annual	5.71
3	*Conyza canadensis*	Compositae	Biennial	5.46
4	*Capsella bursa-pastoris*	Cruciferae	Biennial	4.67
5	*Plantago asiatica*	Plantaginaceae	Perennial	3.27
6	*Rorippa palustris*	Cruciferae	Biennial	3.00
7	*Cyperus amuricus*	Cyperaceae	Annual	3.00
8	*Portulaca oleracea*	Portulacaceae	Annual	2.87
9	*Poa annua*	Poaceae	Biennial	2.48
10	*Equisetum arvense*	Equisetaceae	Perennial	2.05
11	*Stellaria media*	Caryophyllaceae	Biennial	1.99
12	*Lamium amplexicaule*	Labiatae	Annual	1.55
13	*Cerastium glomeratum*	Caryophyllaceae	Annual	1.51
14	*Acalypha australis*	Euphorbiaceae	Annual	1.49
15	*Arenaria serpyllifolia*	Caryophyllaceae	Annual	1.35
16	*Humulus japonicus*	Cannabaceae	Annual	1.35
17	*Centipeda minima*	Compositae	Annual	1.33
18	*Stellaria alsine* var. *undulate*	Caryophyllaceae	Annual	1.16
19	*Draba nemorosa*	Cruciferae	Annual	0.99
20	*Mazus pumilus*	Scrophulariaceae	Annual	0.97
21	*Vicia hirsute*	Leguminosae	Annual	0.97
22	*Artemisia princeps*	Compositae	Perennial	0.95
23	*Echinochloa crus-galli*	Poaceae	Annual	0.91
24	*Solanum nigrum*	Solanaceae	Annual	0.81
25	*Taraxacum platycarpum*	Compositae	Perennial	0.76
26	*Alopecurus aequalis*	Poaceae	Annual	0.73
27	*Lindernia procumbens*	Scrophulariaceae	Annual	0.73
28	*Chenopodium album*	Chenopodiaceae	Annual	0.72
29	*Eclipta prostrate*	Compositae	Annual	0.70
30	*Galium spurium* var. *echinospermon*	Rubiaceae	Annual	0.67
31	*Taraxacum officinale*	Compositae	Perennial	0.55
32	*Veronica didyma* var. *lilacina*	Scrophulariaceae	Annual	0.54
33	*Amaranthus lividus*	Amaranthaceae	Annual	0.50
34	*Oxalis corniculata*	Oxalidaceae	Perennial	0.49
35	*Hemistepta lyrata*	Compositae	Biennial	0.48
36	*Trifolium repens*	Leguminosae	Perennial	0.46
37	*Lactuca indica*	Compositae	Biennial	0.40
38	*Eclipta alba*	Compositae	Annual	0.40
39	*Erigeron annuus*	Compositae	Biennial	0.37
40	*Rorippa indica*	Cruciferae	Perennial	0.37
41	*Bothriospermum tenellum*	Boraginaceae	Annual	0.35
42	*Euphorbia supine*	Euphorbiaceae	Annual	0.32
43	*Mollugo pentaphylla*	Molluginaceae	Annual	0.31
44	*Eragrostis multicaulis*	Poaceae	Annual	0.31
45	*Commelina ommunis*	Commelinaceae	Annual	0.30
46	*Persicaria hydropiper*	Polygonaceae	Annual	0.30
47	*Senecio vulgaris*	Compositae	Biennial	0.30
48	*Cyperus iria*	Cyperaceae	Annual	0.28
49	*Sigesbeckia pubescens*	Compositae	Annual	0.25
50	*Eleusine indica*	Poaceae	Annual	0.22
51	*Youngia japonica*	Compositae	Biennial	0.20
52	*Lindernia dubia*	Scrophulariaceae	Annual	0.19
53	*Rumex crispus*	Polygonaceae	Perennial	0.18
54	*Crepidiastrum sonchifolium*	Compositae	Biennial	0.17
55	*Ixeridium dentatum*	Compositae	Perennial	0.16
56	*Cyperus nipponicus*	Cyperaceae	Annual	0.16
57	*Cyperus microiria*	Cyperaceae	Annual	0.14

Table 2. continued

Rank	Scientific name	Family	Life cycle	I.V.†
58	*Trigonotis peduncularis*	Boraginaceae	Biennial	0.14
59	*Leonurus japonicus*	Labiatae	Biennial	0.14
60	*Viola mandshurica*	Violaceae	Perennial	0.13
61	*Chenopodium ficifolium*	Chenopodiaceae	Annual	0.13
62	*Sonchus asper*	Compositae	Biennial	0.11
63	*Ludwigia prostrata*	Onagraceae	Annual	0.11
64	*Bidens tripartite*	Compositae	Annual	0.10
65	*Cardamine fallax*	Cruciferae	Biennial	0.10
66	*Amaranthus retroflexus*	Amaranthaceae	Annual	0.10
67	*Calystegia sepium*	Convolvulaceae	Perennial	0.10
68	*Amaranthus patulus*	Amaranthaceae	Annual	0.09
69	*Pinellia ternata*	Araceae	Perennial	0.09
70	*Persicaria vulgaris*	Polygonaceae	Annual	0.09
71	*Calystegia sepium* var. *japonicum*	Convolvulaceae	Perennial	0.08
72	*Eragrostis japonica*	Poaceae	Annual	0.08
73	*Echinochloa utilis*	Poaceae	Annual	0.08
74	*Galinsoga ciliate*	Compositae	Annual	0.08
75	*Brassica juncea*	Cruciferae	Biennial	0.07
76	*Persicaria thunbergii*	Polygonaceae	Annual	0.06
77	*Physalis angulate*	Solanaceae	Annual	0.06
78	*Salvia plebeia*	Labiatae	Biennial	0.06
79	*Astragalus sinicus*	Leguminosae	Biennial	0.06
80	*Aeschynomene indica*	Leguminosae	Annual	0.06
81	*Bidens frondosa*	Compositae	Annual	0.06
82	*Fimbristylis miliacea*	Cyperaceae	Annual	0.06
83	*Sonchus oleraceus*	Compositae	Biennial	0.06
84	*Persicaria nepalensis*	Polygonaceae	Annual	0.06
85	*Cyperus difformis*	Cyperaceae	Annual	0.06
86	*Lactuca scariola*	Compositae	Biennial	0.05
87	*Bidens bipinnata*	Compositae	Annual	0.05
88	*Amaranthus mangostanus*	Amaranthaceae	Annual	0.05
89	*Sigesbeckia glabrescens*	Compositae	Annual	0.05
90	*Cardamine flexuosa*	Cruciferae	Biennial	0.05
91	*Persicaria longiseta*	Polygonaceae	Annual	0.04
92	*Malva neglecta*	Malvaceae	Biennial	0.04
93	*Rotala indica* var. *uliginosa*	Lythraceae	Annual	0.04
94	*Polygonum aviculare*	Polygonaceae	Annual	0.04
95	*Ammannia coccinea*	Lythraceae	Annual	0.04
96	*Stellaria aquatica*	Caryophyllaceae	Perennial	0.04
97	*Ixeris strigosa*	Compositae	Perennial	0.03
98	*Setaria viridis*	Poaceae	Annual	0.03
99	*Ambrosia artemisiifolia*	Compositae	Annual	0.03
100	*Oenothera biennis*	Onagraceae	Biennial	0.03
101	*Euphorbia humifusa*	Euphorbiaceae	Annual	0.03
102	*Metaplexis japonica*	Asclepiadaceae	Perennial	0.03
103	*Chelidonium majus* var. *asiaticum*	Papaveraceae	Biennial	0.03
104	*Achyranthes fauriei*	Amaranthaceae	Perennial	0.03
105	*Kyllinga brevifolius*	Cyperaceae	Perennial	0.03
106	*Lepidium apetalum*	Cruciferae	Biennial	0.02
107	*Pilea mongolica*	Urticaceae	Annual	0.02
108	*Abutilon theophrasti*	Malvaceae	Annual	0.02
109	*Phyllanthus ussuriensis*	Euphorbiaceae	Annual	0.02
110	*Boehmeria pannosa*	Urticaceae	Perennial	0.02
111	*Justicia procumbens*	Acanthaceae	Annual	0.02
112	*Amaranthus viridis*	Amaranthaceae	Annual	0.02
113	*Aster subulatus* var. *sandwicensis*	Compositae	Annual	0.02
114	*Mollugo verticillata*	Molluginaceae	Annual	0.02

†I.V., importance values.

by Choi et al (2009). With the domestic economic growth and the increase in the import of livestock feed, the possibilities of exotic weeds inflow into Korea has increased (Oh et al. 2004). The accidental or intentional introduction of non-native weeds continues to threaten natural and agricultural ecosystems worldwide (Mack et al. 2000, Pimentel 2002). These exotic weeds could alter the ecosystems of the distribution areas and areas surrounding them. Therefore, there is a need to constantly monitor and develop preventive technologies, to prevent both the spread of exotic weeds that are already growing, and the inflow of additional exotic weeds.

The analysis of importance values in each cultivated crop showed differences in number of weed species and their dominant weed species. However, similar weed species and number of weeds were identified on the crop fields around the same survey time. In the winter crop fields, *Chenopodium album* var. *centrorubrum*, belonging to Chenopodiaceae, was the most dominant species. In onion fields, after *Chenopodium album* var. *centrorubrum*, the other prevalent species in the order of occurrence were *Capsella bursa-pastoris*, *Digitaria ciliaris*, and *Conyza Canadensis*. In garlic fields, the order of prevalence was *Conyza Canadensis*, *Digitaria ciliaris*, and *Capsella bursa-pastoris* (Table 3). In red pepper fields, *Portulaca oleracea* showed the most occurrence, and *Cyperus*

Table 3. Importance values of top 10 weed species on garlic, onion, red pepper and Chinese cabbage fields

Rank	Garlic		Onion		Red pepper		Chinese Cabbage	
	Scientific name	I.V.[†]	Scientific name	I.V.	Scientific name	I.V.	Scientific name	I.V.
1	*Chenopodium album*	17.72	*Chenopodium album*	16.69	*Portulaca oleracea*	8.87	*Portulaca oleracea*	8.07
2	*Conyza canadensis*	12.29	*Capsella bursa-pastoris*	10.44	*Cyperus amuricus*	7.24	*Digitaria ciliaris*	7.54
3	*Digitaria ciliaris*	9.12	*Digitaria ciliaris*	8.23	*Acalypha australis*	5.71	*Rorippa palustris*	6.44
4	*Capsella bursa-pastoris*	8.06	*Conyza canadensis*	8.08	*Digitaria ciliaris*	5.48	*Chenopodium album*	5.73
5	*Plantago asiatica*	6.61	*Plantago asiatica*	6.26	*Centipeda minima*	5.31	*Echinochloa crus-galli*	5.02
6	*Rorippa palustris*	4.38	*Stellaria media*	4.65	*Rorippa palustris*	3.88	*Cyperus amuricus*	3.95
7	*Equisetum arvense*	3.76	*Arenaria serpyllifolia*	3.97	*Echinochloa crus-galli*	3.57	*Stellaria aquatica*	3.82
8	*Poa annua*	3.37	*Rorippa palustris*	3.74	*Poa annua*	3.01	*Poa annua*	3.66
9	*Lamium amplexicaule*	3.17	*Cerastium glomeratum*	3.58	*Chenopodium album*	2.90	*Cerastium glomeratum*	3.45
10	*Stellaria media*	2.98	*Poa annua*	3.54	*Mazus pumilus*	2.82	*Chenopodium album*	3.20

[†]I. V., importance values

Table 4. Dominant index of weed species occurred in garlic, onion, red pepper and Chinese cabbage fields classified by families

Garlic		Onion		Red pepper		Chinese Cabbage	
Family	D. I.[†]	Family	D. I.	Family	D. I.	Family	D. I.
Compositae	13.89	Compositae	13.33	Compositae	24.75	Compositae	28.17
Poaceae	13.89	Caryophyllaceae	13.33	Polygonaceae	6.93	Poaceae	11.27
Caryophyllaceae	11.11	Cruciferae	10.00	Cyperaceae	6.93	Cruciferae	8.45
Cruciferae	11.11	Scrophulariaceae	10.00	Cruciferae	6.93	Polygonaceae	7.04
Convolvulaceae	5.56	Poaceae	10.00	Poaceae	6.93	Chenopodiaceae	4.23
Leguminosae	5.56	Leguminosae	6.67	Amaranthaceae	5.94	Cyperaceae	4.23
Scrophulariaceae	5.56	Solanaceae	3.33	Euphorbiaceae	3.96	Caryophyllaceae	4.23
Solanaceae	2.78	Rubiaceae	3.33	Labiatae	2.97	Scrophulariaceae	4.23
Rubiaceae	2.78	Labiatae	3.33	Leguminosae	2.97	Leguminosae	4.23
Labiatae	2.78	Polygonaceae	3.33	Chenopodiaceae	2.97	Solanaceae	2.82
Euphorbiaceae	2.78	Chenopodiaceae	3.33	Scrophulariaceae	2.97	Oxalidaceae	1.41
Polygonaceae	2.78	Cyperaceae	3.33	Solanaceae	1.98	Labiatae	1.41
Chenopodiaceae	2.78	Cannabaceae	3.33	Onagraceae	1.98	Commelinaceae	1.41
Cyperaceae	2.78	Equisetaceae	3.33	Lythraceae	1.98	Euphorbiaceae	1.41
Cannabaceae	2.78	Portulacaceae	3.33	Molluginaceae	1.98	Convolvulaceae	1.41
Others	11.11	Others	6.70	Others	17.82	Others	14.08
Total (%)	100		100		100		100

[†]D. I., dominant index.

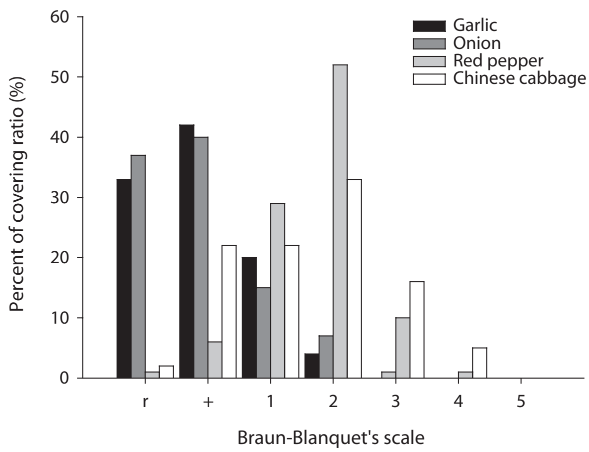

Fig. 1. Percent of covering ratio (%) by Braun-Blanquet's cover-abundance scale (from r to 5) at total survey sites of each cultivation fields (82 for red pepper, 285 for garlic, 86 for onion, and 63 for Chinese cabbage).

amuricus, *Acalypha australis*, and *Digitaria ciliaris* were the other prominent weeds. In Chinese cabbage fields, *Portulaca oleracea* was the most dominant, followed by *Digitaria ciliaris*, *Rorippa palustris*, and *Chenopodium album*. When the weed species for each cultivated crop were divided by family, Compositae were the most prevalent (Table 4). This was similar to the survey results in 2003 (Choi et al. 2009) that showed that the 25 species in Compositae family comprised 20% of all the weed species occurring in the Chungnam region. Weed species diversity in upland is more limited than other agricultural fields by continuous plowing. That is the reason this study was similar to previous research. However, as per the results of the present study, *Bidens frondosa*, *Eclipta prostrata*, *Commelina ommunis*, *Cyperus amuricus*, *Cyperus iria*, *Aeschynomene indica*, *Ludwigia prostrata*, *Digitaria ciliaris*, *Persicaria hydropiper*, *Persicaria longiseta*, *Persicaria vulgaris* and *Lindernia procumbens* were identified on horticulture fields in arable lands of the Chungnam province. The control of those weed species need to be aggressively managed on account of the possibility of them becoming problematic.

In terms of types of crop, 71 species belonging to 25 families were found in Chinese cabbage fields, 36 species belonging to 20 families were found in garlic fields, 30 species belonging to 17 families were found in onion fields, and 101 species belonging to 30 families were found in red pepper fields. Generally, weed occurrence surveys show an increasing trend of weed species as the number of fields analyzed are increased. However, in this study, there were more species of weeds identified in red pepper fields and Chinese cabbage fields, but which were lower in numbers than in garlic fields and onion fields. Also, according to the dominance value analysis by Braun-Blanquet, about 43% of garlic fields and 39% of onion fields had dominance value + (weed occurrence is below 5% of the fields surveyed), showing low weed occurrence frequency. About 53% of red pepper fields and about 34% of Chinese cabbage fields had dominance value 2 (weed occurrence is between 5 and 25%), showing a relatively high weed occurrence frequency. This is probably due to the differences in survey periods, which leads to differences in weed types, along with the fact that since garlic and onion are local indigenous products of the Chungnam region, a systematic and continuous weed control is put into place during the growing period of the crops (Fig. 1). Generally, during the cultivation period, weed management is done with nonselective herbicides being treated in the furrows along with hand weeding; any lack of weed management results in the weeds to flourish. Therefore, the fact that we performed this study in summertime when weed growth is vigorous, seems to be the reason that the dominance values of red pepper fields and Chinese cabbage fields are shown to be high.

In addition, *Acalypha australis*, which showed the highest occurrence in red pepper fields, belongs to the Euphorbiaceae family. The effectiveness of herbicides for this type of weed is low and it occurs widely during the growing period of crops; thus, more caution should be exercised in executing preventive measures. Although the importance values were found to be lower, *Lindernia dubia* and *Amaranthus patulus* are found to occur in horticultural crop fields of the Chungnam region. Since these weed species could become problematic due to increase in occurrence, there should be further research to develop a suitable technology for their control. Abnormal temperatures due to global climatic changes are another cause for modifications of the weed communities. Changes in atmosphere, temperature, precipitation and solar radiation causing climatic change, will lead to changes in plant growth and distribution. Additional research is required for the development of weed control methods through periodic monitoring of occurrence of weeds.

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