

Geographical Distribution and Importance of Crabgrass (*Digitaria* spp.) in the United States

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미국내 바랭이의 지역적 분포와 잡초로써의 중요성

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ABSTRACT

A survey was conducted to document the geographical distribution and importance of crabgrass species among cropping systems in the continental United States. The total sample size was 117, and 72 surveys were returned - a response rate of 62%. Five crabgrass species, large, smooth, southern, India, and blanket crabgrass, were reported to be distributed and weedy in agricultural and horticultural lands of the United States; and large, smooth and southern crabgrass were commonly being dominant. Over 50% of all respondents considered large crabgrass to be more important species than the others, and smooth and southern crabgrass were reported with 30% and 12%, respectively. Geographically, smooth and large crabgrass were considered as important species in most latitudinal range, while southern crabgrass to be important only in southern region. Crabgrass was considered to be more problematic in turf areas than in the other cropping systems. In turf systems, large crabgrass was reported to be the most important species in southeastern areas with an importance value 4.2 on a 5 point scale, followed by southern and smooth crabgrass. In the northeastern region, smooth crabgrass was reported to be more predominant than large crabgrass, and vice versa in the north-central region. Few respondents observed intraspecific variation in smooth and large crabgrass, but intraspecific variation was reported to exist in southern and blanket crabgrass.

Key words: cropping system, intraspecific variation

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INTRODUCTION

Crabgrass, genus *Digitaria* of the grass family (*Gramineae: Poaceae: Paniceae*), is a seed-propagated summer annual (6, 16, 17). Native to Europe, it is widely distributed and adapted throughout most tropical and temperate regions extending from latitude 50 N to 40 S, and ranked one of the three most serious weeds in agricultural and horticultural lands of those regions (7, 14). Among 60 crabgrass species, 13 weedy species infest the United States, and the most common being smooth or small crabgrass [*D. ischaemum* (Schreb.) Muhl., # DIGIS] and large or hairy crabgrass [*D. sanguinalis* (L.) Scop., # DIGSA] (11).

Crabgrass is morphologically characterized by having membranous ligule and showing prostrate growth habit. Large crabgrass has pubescent leaves in both seedling and adult stage, while smooth crabgrass shows the leaf hairiness in seedling stage (15). Large crabgrass shows more robust and upright growth habit than smooth crabgrass, and southern crabgrass has intermediate morphological characters in leaf hairiness and growth habit (6, 15). It has been reported that large crabgrass was found in the entire latitude of the United States, whereas smooth crabgrass was principally found more in northern areas (12). However, detailed information on the geographical distribution and the relative importance of crabgrass species in each cropping system in the United States is not available.

Physiologically, crabgrass is a C4 pathway plant. It tolerates hot and dry conditions, indicating crabgrass is very competitive during summer when C3 plants, such as cool-season turfgrasses, come under stress (3). Additionally, it was reported that a single smooth crabgrass plant may annually produce up to 188,000 seeds, and a large crabgrass up to 154,000 seeds (12). As a result of this physiological and ecological competitiveness, crabgrass threatens nearly all-cropping systems, especially in turf areas in the United States (3, 5, 10).

Many studies have demonstrated effective crabgrass control with herbicide applications in most agricultural and horticultural lands (1, 2, 4, 8, 9). Despite the availability of these herbicides, however, crabgrass continues to be troublesome in those lands. In order to develop crabgrass management programs based on ecological and biological principles, it is necessary to understand the ecological aspects which contribute to crabgrass distribution and infestation.

This survey was conducted to compile basic information on ecological aspects of crabgrass species. The objectives of this study were to: 1) document geographical distribution and importance of crabgrass among cropping systems and in the United States, and 2) ask if intraspecific variation of crabgrass exists. The survey results could be of importance in further understanding of crabgrass biology and ecology.

MATERIALS AND METHODS

The Survey. In 1995, a two-page survey entitled "Survey on Adaptation and Distribution of Crabgrass" was conducted, and 2 main questions were asked. In question 1, the respondents were asked to rank the importance of smooth, large, southern, and other crabgrass species in each cropping system in their regions. Rating values were on a scale from 1 to 5: 1 = very important, 2 = somewhat important, 3 = occasionally important, 4 = rarely important, 5 = not important. The cropping systems consisted of golf courses, other turfs, cultivated row crops, no till/reduced tillage crops, forage crops, non-crop lands, orchards or vineyards, and the other crops.

In question 2, information was solicited on possible intraspecific variations of each crabgrass species in morphological and phenotypic traits, such as different growth habits, flowering time, and timing of seedling emergence. Additionally, respondents were asked in their opinion to record the other observations that could contribute to the crabgrass infestation and distribution. Accompanying each survey document was a short letter to explain the purpose of the survey; and a postage-paid and self-addressed return envelope was included.

Survey Distribution. In May 1995, 117 surveys were sent to weed science specialists throughout the continental United States. These specialists were selected based on a professional interest in weed science research and extension in turf or other cropping systems (18). Surveys were sent to 2 or 3 individuals in each state, and all responses returned by September 1 1995 were tabulated.

Survey Analysis. Seventy-two surveys were returned with the response rate of 62% (Table 1). The answered importance values for question 1 were inversely transformed to indicate the larger numbers representing the more considered to be important (e.g., 5 = very important and 1 not important). Data were expressed by either importance values or percentage of respondents, and the importance values of each crabgrass species were averaged for each cropping system. A one-way analysis of variance (ANOVA) was used to determine significant differences among the means of the importance value at $P = 0.05$, and mean values were separated by Fisher's least significant difference test at $P = 0.05$

Table 1. Summary of research interests of the survey respondents and percentage of returned

Area of interest ^a	Total Numbers sent	Numbers returned	Percentage returned
Turfgrass(golf courses/others)	56	35	62.5
Other cropping systems ^b	61	37	60.7

^aAll respondents have a professional interest in weed research.

^bInclude row crops, forage crops, orchards or vineyards, etc.

or 0.01 level. Orthogonal contrast was performed to compare the importance means between turf and the other cropping systems. Two-way ANOVA was conducted using general linear model (GLM) of SAS (13) procedure to evaluate regional importance of each crabgrass species in turf management system.

RESULTS AND DISCUSSION

Important Species. Five crabgrass species were reported to be important in agricultural and horticultural lands in the United States. These species consisted of large (*D. sanguinalis*), smooth (*D. ischaemum*), southern (*D. ciliaris*), India (*D. longiflora*), and blanket crabgrass (*D. serotina*). Among these species, most respondents considered large, smooth crabgrass to be more prevalent than the other species. Over 50% of all respondents considered large crabgrass to be more important, and 30 and 12% of respondents answered smooth and southern crabgrass to be occasionally important (Fig. 1). Less than 5% of the respondents ranked other species including India and blanket crabgrass as problematic species.

Distribution and Importance. *Geographical regions;* Geographical distribution of each crabgrass species in the United States is illustrated in appendix Fig. 2. It demonstrated that both smooth and large crabgrass are distributed throughout the most latitudinal range in the continental US, except Maine and Florida. In Maine, the far northeastern area, smooth crabgrass was reported to be the only important species; and in Florida, the far southern area, India and blanket crabgrass were considered to be important

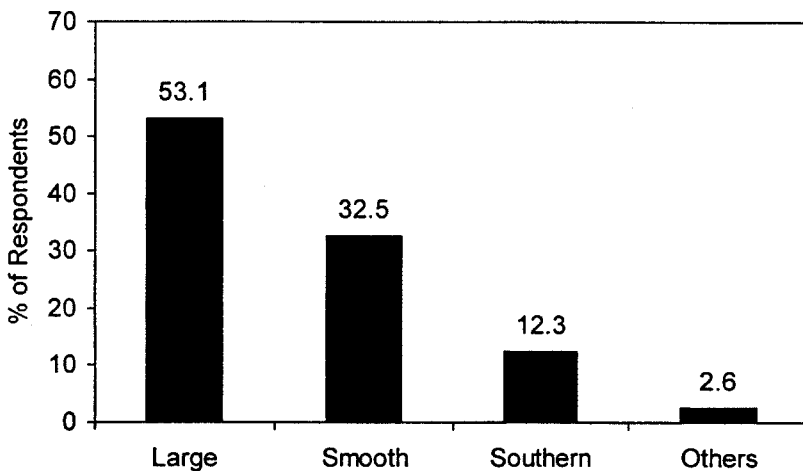


Fig. 1. Percentage of respondents giving rating of 3 (occasionally important), 4 (somewhat important) or 5 (very important) for each crabgrass species in the United States. Other species including India and blanket crabgrass were reported in Florida.

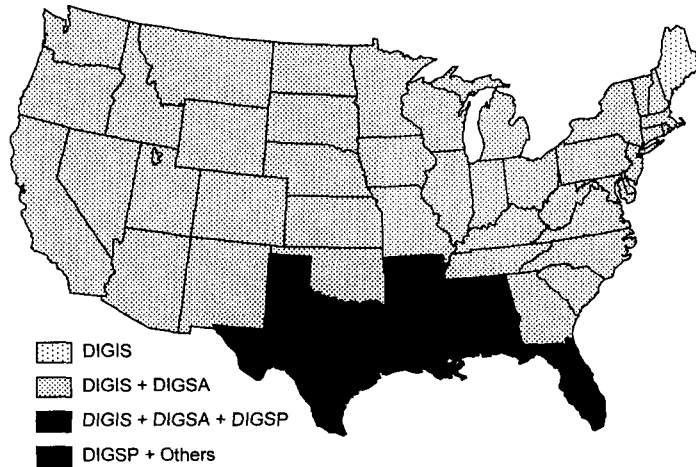


Fig. 2. Weedy crabgrass distribution in the United States. DIGIS, DIGSA, DIGSP are the 5-letter Bayer codes for smooth, large and southern crabgrass, respectively. Other species include India (*D. longiflora*) and blanket crabgrass (*D. serotina*), which were only reported in Florida.

along with southern crabgrass. As shown in Fig. 1, southern crabgrass was found in Mississippi, Texas, Florida and Georgia, while India, and blanket crabgrass were exclusively reported in Florida. These results indicate that southern, India, and blanket crabgrass could be the southern (warmer-climate) adapted, that smooth crabgrass is the northern (cooler-climate) adapted, and that large crabgrass could be the intermediate species in geographical distribution.

Cropping systems. Large and smooth crabgrass were reported to be predominant in nearly all-cropping systems in the United States. Most respondents answered that large crabgrass was more abundant species than smooth crabgrass with importance value 2.8 and 2.2, respectively. The importance value of large and smooth crabgrass among cropping systems showed significant differences, while the other species not to be significant (Table 2). Comparing in cropping systems, most respondents considered both large and smooth crabgrass to be more significantly problematic in turf areas than in the other crop lands (Table 3). The importance values of large and smooth crabgrass in turf significantly differed in geographical range (Table 4). In the northeast, smooth crabgrass was considered to be more abundant than large crabgrass; whereas large crabgrass was predominant in the north central regions. In the southern turf areas, large crabgrass was considered to be the most important species (importance rating 4.2), followed closely by southern(3.3) and smooth crabgrass(2.9) (Table 2 and 4). These survey results clearly indicate that large and smooth crabgrass are considered to be

Table 2. Importance of crabgrass species in various cropping systems in the US

Cropping system	DIGSA ^a		DIGIS		DIGSP		Others ^b	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Golf course (Fairway/green)	3.6a	4.5	3.1a	3.0	1.7	1.0	1.4	1.0
Other turf	3.8a	3.0	3.3a	4.0	1.8	1.0	1.2	1.0
Cultivated row crops	2.9b	3.0	2.1b	2.0	1.6	1.0	1.0	1.0
No till/reduced tillage	2.6b	3.0	2.0bc	2.0	1.6	1.0	1.0	1.0
Forage crops	2.5b	2.0	1.8b	2.0	1.7	1.0	1.0	1.0
Non-cropping lands	2.2bc	2.0	1.7b	1.0	1.3	1.0	1.0	1.0
Orchards and vineyards	2.6b	3.0	1.8b	2.0	1.6	1.0	1.0	1.0
Other crops	2.5b	2.0	1.8b	1.0	1.7	1.0	1.1	1.0
F-statistics ^c	**		**		NS		NS	

^aDIGSA, DIGIS, DIGSP are the 5-letter Bayer codes for large, smooth and southern crabgrass, respectively.

^bOther crabgrass species including India and blanket crabgrass reported in the southeastern regions.

^c**, Significance from one-way ANOVA at P=0.01.

The means in each column are separated by Fisher's Protected LSD at P=0.01 level.

Table 3. Importance ratings of crabgrass species in turf versus other cropping systems

Cropping system	Crabgrass species			
	DIGA ^a	DIGIS	DIGSP	Others ^b
Turf	3.7	3.2	1.8	1.4
Other crops	2.6	1.9	1.6	1.1
Contrast F-test	*	**	NS	NS

^aDIGSA, DIGIS, DIGSP are the 5-letter Bayer codes for large, smooth and southern crabgrass, respectively.

^bOther include India and blanket crabgrass.

NS, *, **, Nonsignificant at P=0.05, significant at P=0.05 and 0.01, respectively.

important in every cropping area, and especially in turf management system of most geographical range.

Intraspecific variation. Few respondents considered intraspecific variation to exist in smooth and large crabgrass, while such variation was considered to exist in southern and blanket crabgrass (data not shown). This result suggests that morphological and phenotypic traits in smooth and large crabgrass, such as timing of seedling emergence and initial growth and development, could be independent of biotypes and geographical region. Additionally, it further implies that a crabgrass management strategy developed

Table 4. Importance ratings of crabgrass species in turf system by geographical regions

Species/Regions	Northeast	North Central	Southeast
DIGSA ^a	3.7(1.1) ^b	3.6(0.9)	4.2(0.8)
DIGIS	4.1(1.2)	2.8(1.3)	2.9(0.9)
DIGSP	1.0(-)	1.0(-)	3.3(1.4)
ANOVA ^c			
Source	df	F	Pr>F
Species	2	29.2	***
Region	2	9.4	**
Species *Region	4	10.4	***

^aDIGSA, DIGIS, DIGSP are the 5-letter Bayer codes for large, smooth and southern crabgrass, respectively.

^bThe value in parenthesis represents standard deviation(SD).

^cTwo-way ANOVA was performed by GLM procedure of SAS.

, *, significant at P=0.01 and 0.001, respectively.

in a certain region could be valid to use in the other geographical range. However, intraspecific variation of smooth and large crabgrass was previously reported, observing smaller growth habit and flowered earlier in the northern than in the southern biotypes (16). Therefore, this inconsistency between this survey result and previous finding indicates a need to further evaluate intraspecific variation of crabgrass species.

요 약

미국내에서 바랭이의 지역적 분포와 각 재배작물에서 잡초로서의 중요성을 자료화하기 위하여 설문조사를 실시하였다. 총 117개의 배포된 설문지중 72개의 설문지가 회수되어 62%의 응답률을 보였다. 미국내의 농, 원예작물 재배지역에는 5종의 바랭이가 분포하는 것으로 보고되었고, 이들은 large, smooth, southern, india 그리고 blanket crabgrass 등이었다. 이들 중 약 50% 이상의 응답자가 large crabgrass를 가장 문제잡초로 인식하고 있었다. 지역적으로 smooth와 large crabgrass는 모든 위도에서 그 우점도가 인정된 반면, southern crabgrass는 우점도가 남부지역에 제한되는 것으로 보고되었다. 바랭이는 다른 작물의 재배지역보다 잔디밭에서 그 문제가 보다 심각한 것으로 보고되었다. 남부지역의 잔디밭에서는 large, southern 그리고 smooth crabgrass의 순서로, 북부지역에서는 smooth crabgrass가 large crabgrass보다 잡초로서의 문제성이 큰 것으로 보고되었다. 대부분의 응답자들은 종내변이성이 smooth와 large crabgrass에는 존재하지 않는 것으로 응답하였으나, southern crabgrass내에는 존재하는 것으로 보고되었다.

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