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DETERMINATION OF WEEDS IN RICE FIELDS OF SOUTH EASTERN ANATOLIA REGION OF TURKEY

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Abstract

This study was conducted in 2012 to determine the most prevalent and challenging weeds in the rice fields of Southeastern Anatolia, Turkey. Rice production in the region differs from the other regions as conservational tillage practices are being opted in the region in contrast to conventional tillage practices in the other regions of the country. As a result of the survey total 70 different weedy species belonging to 22 families were observed. The incidence and frequency of all the weedy species observed was calculated and families were ranked according to incidence and frequency. Poaceae, Asteraceae and Cyperaceae were the most prevalent families having 12, 12 and 8 species while the rest 19 families were represented with 1-4 species. This survey gives the current prevalence of weedy species in the rice fields, and the information being presented in this article will help in devising management options for the troublesome weeds in the region.

Key words: *rice, South Eastern Anatolia Region, weeds, survey.*

INTRODUCTION

Rice (*Oryza sativa* L.) has the largest cultivated acreage after wheat and ranks third regarding total production after wheat and maize in the world. Despite of its low protein content this crop is rich of essential amino acids. For that reason, it is most widely used in human nutrition following wheat (Elçi et al., 1994). Rice cultivation was firstly practiced in South India and spread to China in 3000 BC and to Java in 1000 BC. It was introduced to Europe during the expedition of Alexander the Great into Asia in 300 BC. It is assumed that this crop entered to Turkey from the South about 500 years ago (Kün, 1985). About 91% of world rice production is consumed by Asian countries (Finnasi, 1979). According to statistical data during 2010, rice was cultivated on 99,000 ha with total production of 860,000 tonnes and average yield 8,690 kg ha^{-1}. In south eastern Anatolia the rice acreage was about 5915 ha (4.7% of total), production was 30675 tonnes with average yield of 5190 kg ha^{-1} (Anonim, 2015). Şanlıurfa and Diyarbakır provinces contributed the 98% of total rice production in the region during 2010. Total rice acreage was 3345 and 2438 ha with average production of 1788 and 1235 tonnes in Şanlıurfa and Diyarbakır provinces respectively (Anonim, 2015).

Euphrates and Tigris rivers constitute the main fresh water resources and the Karacadağ elevation zone receives the most of snowfall in the region. Irrigation water is obtained from the snowmelt waters in March and April. This is why irrigation water temperature in rice fields is low and the way of rice cultivation in the region is called as cold water rice cultivation.

As a local rice variety, Karacadağ rice is especially cultivated in Diyarbakır (Karacadağ basin along with Çınar, Hazro, Çermik and Kocaköy districts), Şanlıurfa (Siverek and Viranşehir districts), Mardin (Derik district), Siirt and Adıyaman provinces. Karacadağ rice genotype receives the intensive demand from the local farming community. Rice cultivation is, in general, performed to be pan-style irrigation system in Turkey. However, in Karacadağ elevation zone flood irrigation system is used in crop production. The reason for this is that the land is not suitable for tillage due to the presence of stones in the soil. Karacadağ rice is special for the region and takes its name from the inactive volcanic mountain Karacadağ where it is intensely cultivated. Karacadağ elevation zone has a thin soil layer formed by deposition of volcanic blow outs with a high organic matter content (5%). Sowing is done keeping the seed rate of 160-180 kg ha^{-1}. Seed is broadcasted from mid-

April to late May and flood irrigation method is opted to fulfil the moisture requirements of the crop. Embankments are constructed over regular intervals in the rice fields to allow only the irrigation water to stay in the fields and avoid run off. Commercial fertilizer are rarely used while, the herbicide application has recently been inducted in the rice production system of the region. In the past, the crop was manually harvested, sundried for several weeks and then threshed but nowadays mechanical harvesting with combine harvester is being practiced in plain areas (Anonim, 2014). Due to the difference in cultivation and tillage practices, prevalent and troublesome weeds show great variation throughout the region. Without optimum weed control, achieving optimum yield is virtually impossible in rice. Rice yield ad quality is linearly affected by weeds. Due to the highlighted reasons, an effective weed control is inevitable to eliminate the yield and quality losses posed by weeds. To develop the effective weed control, determination of the prevalent and troublesome weeds is the core step. Rice is the only cereal germinating in submerged/waterlogged conditions and it grows using the dissolved oxygen in irrigation water. Since the competitive ability of the weeds is fairly high, rice crop cannot compete with weeds and they under develop with a dwarf and low tillering, low and poor quality yield.

This study was conducted to determine the prevalence and frequency of troublesome weed species in the rice fields of south eastern Anatolia.

MATERIALS AND METHODS

Survey studies were conducted in 2012 to determine the problematic weed species in rice production fields of south eastern Anatolia region of Turkey. In total 56 fields were surveyed in Diyarbakır (Karacadağ basin along with Çınar, Hazro, Çermik and Kocaköy districts), Şanlıurfa (Siverek and Viranşehir districts), Mardin (Derik district), Siirt and Adıyaman provinces where rice crop is widely cultivated. In field surveys, a 0.25 m^2 quadrate (50 cm × 50 cm) was used. To avoid the biasness in the survey data, 5 quadrates were randomly thrown in different parts of the field under survey in diagonal fashion. In order to avoid border effects quadrates sampling was started at least 15 m inside from the border of the fields alongside an imaginary diagonal line. Individual weeds in the quadrates were counted according to their genus & species in order to calculate arithmetic means, and their incidence and frequency rates m^{-2} (Odum, 1971). Additionally, individuals outside the quadrates were recorded (Uluğ et al., 1993). Unknown species in the fields were collected according to technical requirements, numbered, pressed and taken to laboratory for identification. Species identification of the weeds determined in the region was mainly accomplished according to Davis (1965-1988). Specie identifications were approved by Prof. Dr. A. Selçuk Ertekin Department of Biology, Faculty of Science Dicle University, Diyarbakır Turkey. The formulas used in the calculations were given below.

Intensity (plant m^{-2}) = Y / n

Incidence (%) = (M / n) × 100

Y = Number of individuals of a species within the quadrate.

M = Number of quadrates a plant species occurred.

n = Total number of quadrates thrown.

RESULTS AND DISCUSSIONS

As a result of survey, 70 different species of 22 families were determined, of which one was fern (pteridophyta), 20 were monocotyledonous and 49 were dicotyledonous. The most common families in the surveyed rice fields were *Poaceae* (12 species), *Asteraceae* (12 species) and *Cyperaceae* (8 species). The rest 19 families were represented by 1-4 numbers of species (Table 1).

Incidence (%) and frequency of the weeds (weed m^{-2}) determined in the Karacadağ rice fields exhibited huge variations (Table 2). It is obvious from Table 2 that 15, 14, 9, 8 and 13 weeds in Diyarbakır, Şanlıurfa, Mardin, Adıyama and Siirt provinces respectively were present in more than 50% of rice fields (frequency more than 50%) surveyed. The numbers of weed species of with frequency more than 1% are 4 in Diyarbakır and Şanlıurfa, 3 in Siirt, 2 in Adıyaman and 1 in Mardin. The number of weeds determined in more than 50% of the rice fields over the whole region was 12 and four weed species with frequency more than 1%.

Table 1. Family and species for the weeds determined in the surveyed fields of local Karacadağ rice genotype

FAMILY	No. of species	FAMILY	No. of species
PTERIDOPHYTA			
Equisetaceae	1	*Euphorbiaceae*	1
MONOCOTYLEDONEAE		*Fabaceae*	4
Cyperaceae	8	*Guttiferae*	1
Poaceae	12	*Lamiaceae*	3
DICOTYLEDONEAE		*Lythraceae*	1
Alismataceae	1	*Malvaceae*	3
Amaranthaceae	2	*Onagraceae*	2
Apiaceae	2	*Plantaginaceae*	2
Asteraceae (Compositae)	12	*Polygonaceae*	4
Boraginaceae	1	*Portulacaceae*	1
Chenopodiaceae	1	*Scrophulariaceae*	3
Convolvulaceae	2	*Solanaceae*	3
Total	**42**		**28**
General Total			**70**

Weed species with more than 50% frequency of the total surveyed area in Diyarbakır were *Amaranthus retroflexus*, *Lactuca serriole, Xanthium strumarium*, *Cyperus glomeratus*, *C. longus*, *Lythrum hyssopifolia*, *Cynodon dactylon*, *Echinochloa crus-galli*, *Eragrostis collina*, *Poa nemoralis*, *Sorghum halepense*, *Polygonum persicaria*, *Veronica anagallis-aquatica* subsp. *lysimachioides*, *Physalis angulata* ve *Physalis philadelphica.* Weeds species with frequency more than 1% were *A. retroflexus*, *X. strumarium*, *L. hyssopifolia* and *E. crus-galli*

Weed species found in more than 50% of the total surveyed area in Şanlıurfa were *A. retroflexus*, *L. serriole*, *X. strumarium*, *C. glomeratus*, *C. longus*, *Scirpoides holoschoenus*, *Mentha longifolia*, *L. hyssopifolia*, *C. dactylon*, *E. crus-galli*, *P. nemoralis*, *P. persicaria*, *P. angulata* ve *P. philadelphica.* Weeds species having weeds more than one per unit area in Şanlıurfa were *A. retroflexus*, *X. strumarium*, *L. hyssopifolia* and *E. crus-galli.*

Weed species found in more than 50% of the total surveyed area in Mardin were *X. strumarium*, *Cyperus fuscus*, *C. glomeratus*, *C. longus*, *L. hyssopifolia*, *E. crus-galli*, *S. halepense*, *P. angulata* and *P. philadelphica*. Weeds species having more than one individual per unit area in Mardin was only *E. crus-galli*.

Weed species found in more than 50% of the total surveyed area in Adıyaman were *X. strumarium*, *C. glomeratus*, *L. hyssopifolia*, *E. crus-galli*, *Echinochloa oryzicola*, *S. halepense*, *Polygonum lapathifolium* ve *P. philadelphica*. Weeds species having more than one individual per unit area in Adıyaman were *X. strumarium* and *L. hyssopifolia*.

Weed species found in more than 50% of the total surveyed area in Siirt were *Alisma plantago-aquatica*, *X. strumarium*, *Cyperus difformis*, *C. glomeratus*, *C. longus*, *M. longifolia*, *L. hyssopifolia*, *Epilobium parviflorum*, *E. crus-galli*, *E. oryzicola*, *Phragmites austrialis*, *S. halepense*, *P. lapathifolium* and *P. persicaria*. Weeds species having more than one individual per unit area in Siirt were *Bidens cernua*, *L. hyssopifolia* and *E. crus-galli*.

Weed species found in more than 50% of the total surveyed area in south eastern Anatolia were *A. retroflexus*, *X. strumarium*, *C. glomeratus*, *C. longus*, *M. longifolia*, *L. hyssopifolia, C. dactylon*, *E. crus-galli*, *S. halepense*, *P. persicaria*, *Physalis angulata* ve *Physalis philadelphica*. Weeds species representing more than one individual per unit area in South Eastern Anatolia were *A. retroflexus*, *X. strumarium*, *L. hyssopifolia* and *E. crus-galli*.

Table 2. Incidence and frequency of the weeds present in growing areas of local Karacadağ rice genotype district wise and the region as whole (%, weed m^{-2})

WEED SPECIES	Survey Area in South Eastern Anatolia Region											
	Diyarbakır		Şanlıurfa		Mardin		Adıyaman		Siirt		Total	
	%	Plant m^{-2}	%	Plant m^{-2}	%	Plant m^{-2}	%	Plant m^{-2}	%	Plant m^{-2}	%	Plant m^{-2}
Fam: *ALISMATACEAE*												
Alisma plantago-aquatica L.	-	-	-	-	-	-	-	-	45	0.5	9	0.1
Fam: *AMARANTHACEAE*												
Amaranthus retroflexus L.	85	1.6	92	1.8	25	0.5	29	0.8	35	0.9	53.2	1.12
Amaranthus albus L.	36	0.4	29	0.2	38	0.4	12	0.1	-	-	23	0.22
Fam: *APIACEAE*												
Eryngium campestre L.	24	0.3	43	0.6	26	0.2	16	0.1	15	0.1	24.8	0.26
Eryngium creticum Lam.	13	0.1	20	0.3	-	-	-	-	-	-		
Fam: *ASTERACEAE* (*Compositae*)												
Anthemis sp.	36	0.2	42	0.3	42	0.2	22	0.1	25	0.1	33.4	0.18
Artemisia vulgaris L.	25	0.1	-	-	-	-	36	0.1	23	0.1	16.8	0.06
Bidens cernua L.	22	0.4	27	0.3	-	-	36	0.8	88	1.5	34.6	0.6
Cichorium intybus L.	23	0.1	33	0.1	16	0.1	-	-	-	-	14.4	0.06
Conyza canadensis (L.) Cron.	36	0.2	44	0.4	-	-	18	0.1	14	0.1	22.4	0.1
Lactuca aculeata Boiss.	34	0.1	-	-	-	-	-	-	12	0.1	9.2	0.04
Lactuca saligna L.	22	0.1	26	0.2	18	0.1	-	-	-	-	13.2	0.08
Lactuca serriole L.	66	0.4	55	0.5	30	0.1	24	0.2	33	0.2	41.6	0.28
Notabasis syriaca (L.) Cass.	10	0.1	14	0.1	-	-	-	-	-	-	4.8	0.04
Sonchus sp. (eşek marulu)	19	0.1	36	0.1	22	0.1	15	0.1	-	-	18.4	0.08
Xanthium spinosum L.	-	-	29	0.1	-	-	-	-	-	-	5.8	0.02
Xanthium strumarium L.	70	1.4	76	1.2	73	0.8	66	1.1	48	0.6	66.6	1.02
Fam: *BORAGINACEAE*												
Heliotropeum europaeum L.	-	-	32	0.1	-	-	-	-	-	-	6.4	0.02
Fam: *CHENOPODIACEAE*												
Chenopodium album L.	-	-	-	-	-	-	18	0.1	14	0.1	6.4	0.04
Fam: *CONVOLVULACEAE*												
Convolvulus arvensis L.	23	0.3	33	0.1	19	0.1	30	0.2	43	0.4	29.6	0.22
Convolvulus galaticus Roston. Ex Choisy	36	0.1	43	0.2	-	-	-	-	-	-	15.8	0.06
Fam: *CYPERACEAE*												
Carex sp.	25	0.2	38	0.3	-	-	-	-	-	-	12.6	0.1
Cyperus difformis L.	38	0.3	46	0.4	42	0.3	47	0.4	50	0.4	44.6	0.36
Cyperus fuscus L.	29	0.2	34	0.3	50	0.2	36	0.2	46	0.3	39	0.24
Cyperus glomeratus L.	68	0.6	72	0.8	65	0.5	56	0.4	61	0.5	64.4	0.56
Cyperus longus L.	55	0.5	63	0.7	50	0.2	48	0.3	36	0.2	50.4	0.38
Cyperus rotundus L.	27	0.1	29	0.1	-	-	-	-	-	-	11.2	0.04
Cyperus serotinus Rottb.	23	0.2	36	0.3	23	0.1	33	0.2	36	0.2	30.2	0.2
Scirpoides holoschoenus (L.) Sojak.	42	0.1	55	0.1	39	0.1	28	0.1	33	0.1	39.4	0.1
Fam: *EQUISETACEAE*												
Equisetum sp.	18	0.1	26	0.1	-	-	-	-	23	0.2	13.4	0.08
Fam: *EUPHORBIACEAE*												
Chrozophora tinctoria (L.) Rafin.	27	0.2	28	0.3	27	0.1	22	0.3	-	-	20.8	0.18
Fam: *FABACEAE*												
Trifolium arvense L.	24	0.1	29	0.1	30	0.1	14	0.1	12	0.1	21.8	0.1
Trifolium haussknechtii var. *haussknechtii* Boiss.	26	0.1	31	0.1	-	-	12	0.1	14	0.1	16.6	0.08
Trifolium resupinatum L.	22	0.1	24	0.1	-	-	-	-	-	-	9.2	0.04
Vicia sativa L.	36	0.1	32	0.2	46	0.2	42	0.3	26	0.2	36.4	0.2
Fam: *GUTTIFERAE*												
Hypericum triquetrifolium Turra.	-	-	21	0.1	32	0.1	32	0.2	28	0.1	22.6	0.1
Fam: *LAMIACEAE*												
Mentha longifolia (L.) Hudson	46	0.3	66	0.5	44	0.2	42	0.2	55	0.3	50.6	0.3
Mentha spicata L.	33	0.2	36	0.2	-	-	-	-	-	-		
Marrubium sp.	-	-	-	-	-	-	16	0.1	24	0.1	8	0.04
Fam: *LYTHRACEAE*												
Lythrum hyssopifolia L.	85	1.4	92	1.6	75	0.9	85	1.2	88	1.8	85	1.38
Fam: MALVACEAE												
Alcea setosa (Boiss.) Alef.	26	0.1	36	0.1	-	-	-	-	-	-	12.4	0.04
Hibuscus trionum L.	35	0.1	25	0.1	34	0.1	35	0.1	25	0.1	30.8	0.1
Malva sp.	38	0.1	24	0.1	26	0.1	22	0.1	18	0.1	25.6	0.1
Fam: *ONAGRACEAE*												
Epilobium parviflorum Schreber	-	-	-	-	-	-	43	0.6	56	0.4	19.8	0.2
Epilobium hirsutum L.	42	0.2	38	0.2	-	-	-	-	-	-	16	0.08
Fam: *PLANTAGINACEAE*												
Plantago lanceolata L.	34	0.1	19	0.1	33	0.1	18	0.1	38	0.2	28.4	0.12
Plantago major L.	49	0.2	18	0.1	28	0.1	33	0.2	45	0.2	34.6	0.4
Fam: *POACEAE*												
Agrostis capillaris L.	36	0.1	33	0.1	22	0.1	36	0.1	29	0.1	31.2	0.1
Cynodon dactylon (L.) Pers.	76	0.6	68	0.3	45	0.4	42	0.2	25	0.7	51.2	0.44
Digitaria sanguinalis (L.) Scop.	46	0.2	35	0.2	21	0.1	16	0.1	27	0.2	29	0.16
Echinochloa colonum (L.) Link.	36	0.1	26	0.1	-	-	-	-	-	-	12.4	0.04
Echinochloa crus-galli (L.) P.B.	95	1.4	96	1.6	82	1.1	73	0.8	85	1.2	86.2	1.22
Echinochloa oryzicola Vasing	49	0.1	28	0.1	32	0.1	66	0.4	73	0.7	49.6	0.28
Eragrostis collina Trin.	64	0.3	42	0.2	26	0.1	22	0.2	33	0.1	37.4	0.18
Phragmites austrialis (Cav.) Trin. ex Steudel	-	-	-	-	-	-	-	-	76	0.3	15.2	0.06
Poa nemoralis L.	72	0.1	54	0.1	36	0.1	25	0.1	42	0.1	45.8	0.1
Polypogon monspeliensis (L.) Desf.	-	-	-	-	46	0.1	-	-	39	0.1	17	0.04
Setaria viridis (L.) P. Beauv.	-	-	36	0.1	-	-	-	-	28	0.1	7.2	0.04
Sorghum halepense (L.) Pers.	69	0.5	67	0.6	51	0.4	62	0.6	73	0.8	64.4	0.58
Fam: *POLYGONACEAE*												
Polygonum aviculare L.	36	0.2	19	0.1	28	0.1	25	0.2	17	0.1	25	0.14
Polygonum lapathifolium L.	29	0.1	44	0.3	36	0.1	56	0.3	75	0.8	48	0.32
Polygonum persicaria L.	71	0.3	72	0.4	44	0.2	49	0.4	62	0.5	59.6	0.36
Rumex crispus L.	42	0.1	41	0.1	26	0.1	-	-	-	-	21.8	0.06
Fam: *PORTULACACEAE*												
Portulaca oleracea L.	29	0.1	17	0.1	22	0.1	17	0.1	26	0.1	22.2	0.1
Fam: *SCROPHULARIACEAE*												
Veronica anagallis-aquatica subsp. *lysimachioides* (Guss) Sch.	56	0.3	46	0.4	24	0.1	23	0.1	-	-	29.8	0.18
Veronica anagallis-aquatica subsp. *oxycarpa* (Boiss) Elenevskyi	32	0.1	17	0.1	24	0.1	-	-	-	-	14.6	0.06
Veronica lysimachioides (Boiss.) M.A.	29	0.1	36	0.2	-	-	-	-	-	-	13	0.06
Fam: *SOLANACEAE*												
Physalis angulata L.	68	0.6	76	0.7	65	0.4	45	0.2	32	0.2	57.2	0.42
Physalis philadelphica Lam.	75	0.9	82	0.9	76	0.5	66	0.3	46	0.3	69	0.58
Solanum nigrum L.	36	0.2	23	0.1	18	0.1	24	0.1	23	0.1	24.8	0.12

CONCLUSIONS

According to the results weed species found in more than 50% of the total Karacadağ rice growing area and the species having plants more than one per unit area in South Eastern Anatolia were *Alisma plantago-aquatica*, *Amaranthus retroflexus*, *Bidens cernua, Cynodon dactylon*, *Cyperus difformis*, *Cyperus fuscus*, *Cyperus glomeratus*, *Cyperus longus*, *Echinochloa crus-galli*, *Echinochloa oryzicola*, *Epilobium parviflorum*, *Eragrostis collina*, *Lactuca serriole*, *Lythrum hyssopifolia*, *Mentha longifolia*, *Phragmites austrialis*, *Physalis angulata*, *Physalis philadelphica*, *Poa nemoralis*, *Polygonum lapathifolium*, *Polygonum persicaria*, *Sorghum halepense*, *Veronica anagallis-aquatica* subsp. *lysimachioides* and *Xanthium strumarium*. In a study conducted in Uzunköprü district of Edirne province *Diplachne fusca*, *Echinochloa crus-galli*, *Cyperus rotundus, Echinochloa oryzoides*, *Paspalum paspalodes*, *Ammania baccifera*, *Lindernia dubia* and *Scirpus maritimus* were reported to be the most frequent weed species (Uzun and Demirkan, 2013). Also, in another study conducted in the rice fields of Marmara region *Cyperus* spp., *Scirpus* spp. and *Alisma plantago-aquatica* were determined to be the dominant weed species (Özdemir, 1992). Moreover, in a study conducted in south eastern Anatolia 32 years ago 14 weed species were determined and reported that *E. crus-galli*, *E. oryzicola*, *E. macrocarpa*, *E. colonum*, *Cyperus difformis* and *Cyperus fuscus* were the most important weeds of the rice fields in the region (Uzun, 1983). In other studies these weeds were also reported to be important weeds (Işık et al., 2000; Damar, 2006; Chang, 1970). In addition, it was claimed that yield loss in rice varied between 40-66% due to to the incidence of *E. crus-galli* in rice (Smith et al., 1977). The small numbers of weeds determined in this survey were similar to the already determined weeds in rice fields during different studies. However, there were number of weeds observed during the survey which were different to the previously observed weeds. Obviously there are a number of reasons for that but probably the most important reason is the differences in soil and climate of the regions, farming systems and amount of herbicides applied. It can be inferred from the results that *A. retroflexus*, *X. strumarium*, *L. hyssopifolia*, *E. crus-galli* come first regarding the frequency rates as *E. crus-galli*, *L. hyssopifolia*, *A. retroflexus* and *X. strumarium* come first in line in terms of incidence. In addition to the other weeds these four species must be taken under control because of their intensive seed production potential, longer viability in the soil seed bank and serious yield losses in cultivated crops.

In addition to the weed competition with crop plans, presence of weed seeds in the rice at the time of harvest decrease its commercial value. Moreover, the use of this seeds contaminated with weed seeds for raising next crop creates the weed problem even in the fields which were weed free earlier. Due to the reason, prevention of the infestations is of pivotal importance in rice farming. Moreover, harvesting and threshing cost for the infested rice fields increase as the weed infestation becomes intense in the rice fields. Total global rice production is approximately 680 million tonnes, with around 90% grown in Asia (FAO, 2009). Rice production is challenged by multiple pests, with weeds reducing global rice production by around 10% (Oerke, 2006). Knowing the rice weed species and density in order to take control of weed species is important. Due to the continuously changing climate, rapid changes are being observed in weedy plants' distribution and abundance. The dramatic changes in temperature and CO_2 are predicted to heavily infect the density of weedy plants. In order to keep the weeds under control in changing climat scenario, knowing their density and prevalence is of key importance. The changing climate can equally affect the weed communities in rice fields.

As a result of the ever increasing world population, demand for food and quality is rising. Therefore, to maintain the quality of the rice; weeds problem must be sorted out on priority basis. The weed scientists must determine the important weeds for different crops particularly rice in the above addressed region and devise effective management strategies.

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