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DETERMINATION OF COMPETITION CAPACITY OF LOCAL KARACADAG AND OSMANCIK-97 RICE VARIETY AGAINST SOME WEEDS

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Abstract

In the first part the effects of aqueous extracts of leaf, straw, hull and seed of 7 different weed species on germination of local Karacadag and Osmancık-97 rice seeds was investigated. In the second part, Karacadag and Osmancık-97 rice seeds were sown together with weed seeds to plots, and it was determined effects of varied weed species on germination, root, seedling, leaves and grain yield of rice varieties in field conditions. As a result of the findings; aqueous extracts of *Echinochloa crus-galli* L. Beauv, *E. oryzoides*(Ard.) Fritsch., *Amaranthus retroflexus* L. and *Physalis peruviana* L. were found to be the weeds which inhibit the germination of both rice seeds the most in both laboratory and field conditions.

Introduction

Weeds are the factor which causes the highest yield loss in rice cultivation. This rate changes in between 30-100% depending on cultivation systems, rice varieties, weed type and intensity (Smith 1988, Hassan *et al*. 1994, Pandey 1996). Moreover, weeds also indirectly increase the production costs, and they decrease the quality of rice.

In Turkey, generally *Echinochloa* and *Alisma* genera - which are monocotyledon- cause significant yield loss in rice fields. *Crus-galli* and *Colonum* subspecies of *Echinochloa* species is the significant problem of rice cultivation areas at many countries as well as in Turkey (Isik *et al*. 2001). Despite the use of annual 3 million tons of herbicides in the whole world, it is known that there is a loss of over 10% in agricultural production due to weeds (Stephenson 2000). In case of implementation of no control methods, it was observed that this rate had changed in between 45 and 90% in various cultivated plants depending on ecologic and climatic conditions (Ampong-Nyarkoand De Data 1991, Moody 1996). In order to decrease herbicide, use in rice cultivation, it is extremely important to increase competition capacity of the current rice varieties. The basic reasons of deficiency and delay in these operations are being unable to completely present the competition mechanism and its components. When the reasons of different responses of rice varieties against competition with weeds are searched, it was observed that there were many differences and that various data are being obtained.

In recent years, the biotechnological developments have made it possible to transfer the desired characteristics to the required species. The database enriched with this kind of information can make it possible to help plant breeders who will develop resistant varieties in competing with weeds. In addition, it is also important to know the allelopathic speciation which is another important factor in competition. Wu *et al*. (2003) had informed that allelopathic potential in rice species -which will be developed genetically, will have an important role in the control of weeds. The determination of allelopathic speciation in rice cultivars either at laboratory or at field studies had revealed that scanning of local rice varieties in this respect is important.

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Other purposes of this study are to determine the quality of weed sub-species frequently encountered at rice fields of Turkey, to examine their effect on growth and yield of rice plant, and to investigate the suitable competition methods.

Materials and Methods

Seven weed species grown in the irrigated areas namely, *Physalis peruviana* L. (*physalis*-bladder), *Amaranthus retroflexus* L. (cockscomb), *Echinochloa crus-galli* L. Beauv (barnyard grass), *Potamogeton pectinatus* L. (pondweed), *Panicum miliaceum* L. (millet), *Cyperus difformis* L. (umbrella plant) and *Echinochloa oryzoides* (Ard.) Fritsch. (early barnyard grass), and local Karacadag and Osmancik-97 rice varieties were used as material in the present investigation.

Karacadag rice is a mid-late local variety, and it is resistant against cold and drought. This local variety is awny with long plant height but weak in resistance against lodging. Its unbroken rice ratio is in between 65 and 70% after processing. It's a local variety having unique taste and flavor which is favoured by the local inhabitants. Osmancik-97 is a variety of Italian origin, and its height is in between 105 and 110 cm. It does not shed grains and it is non-awn. Its grains are yellow and long. The weight of 1000-grain is 38 - 39 g. It's mid early and its maturity period is 125 - 130 days. Its unbroken rice yield is in between 45 and 60% during processing rice.

This study was performed under the field conditions of Dicle University, Faculty of Agriculture during 2012 and 2013, and the germination tests were observed in laboratory conditions. In the first section of the research, the effects of collected weeds on the germination of rice seeds were investigated. In the test, water extract method -developed by Chung *et al*. (1997) and Ahnand Chung (2000) - was used, and the leaves, stems, glumes and seeds of 7 different weed sub-species were dried at drying ovens at room temperature of 24^{o}C. Thereafter, they were grinded and sieved separately material thus obtained was stored at 5^{o}C for further use. From this material 5 g was taken and it was kept for 24 hrs at 24^{o}C within 100 ml distilled water. This solution was then filtered by 4 layers of cheesecloth and centrifuged for 4 hrs. The supernatant part of the centrifuged material was passed through filter paper (Whatman No: 42). For preventing the solution from contamination by any microorganism, it was passed through 0.2 nm Nalgene filter and made ready to be used.

In the germination tests, 100 seeds from each of local Karacadag and Osmancik-97 rice varieties were placed in Petri dishes 9 cm dia. having two layers of filter paper on the base. The 10 ml solution obtained by grinding the leaves, stems, glumes and seeds of each weed was used in Petri dishes. The control contained only same amount of distilled water. The Petri dishes were set to germination cabinets at 24^{0}C temperature as the randomized parcels experimental design with 3 replications. The germination percentages of the rice seeds were counted and calculated at seventh and twelfth days.

In the second part of the research, 2 rice varieties, with the calculation of 50 plants per square meter and weed seeds, with the calculation of 20 plants per square meter with 3 replications were mixed and sowed to plots in the first week of May. The trials were made following randomized blocks design.

The number of plants was counted on the tenth and twentieth days from emergence at 1 square meter area, and the root and seedling lengths of the plants were measured. The plants, removed from the soil by their roots, were cut from the internode over the root, and their surface fresh biomass and root weights were weighed. The dry biomass of rice root and seedlings were weighed in the laboratory after drying at 70^{0}C for 48 hrs and expressed as the dry weights of rice plants (Ottis *et al.* 2005). The lengths and widest parts of the leaves of 20 plants were measured, and were multiplied by the 0.79 coefficient, and thus the leaf area index was calculated. The

panicles of 20 plants taken at the maturity period from each parcel were counted, and after blending, the grains had been weighed and grain yield per panicle was determined.

The parameters such as germination rates in laboratory and field conditions (%), root length (cm), seedling length (cm), weights of fresh and dry seedling (g), weights of fresh and dry roots (g), leaf area index (cm^2) and grain yield per panicle (g) were examined, and their association with competition was searched.

The data was analyzed as per the Duncan Test in TARIST packaged software (Duncan 1955), and two years' means were calculated.

Results and Discussion

Regarding the germination rates of rice seeds within different weed solutions inside special Petri dishes at laboratory environment, it was observed that the mean values was 56.5% for the Karacadag local variety and 34% for the Osmancik-97 variety. The highest germination rate of the Karacadag rice seeds was observed first in control (97.5%) in which pure water was applied, and then in Petri dishes in which *P. miliaceum* (88.8%), *P. pectinatus* (86.65%) and *C. difformis* (80.15%) solutions were used (Table 1). And regarding the Karacadag rice seeds within the petri dishes in which other weed solutions are used, germination was observed but it was determined at a low rate. It was observed that the germination rates of *E. crus-galli* (2%), *E. oryzoides* (13.95%) and *A. retroflexus* (18%) at laboratory environment were very low (Table 1). The low values of this rate can be attributed to the effect of weeds extracts used as irrigation water. And the highest germination rate of Osmancik-97 rice seeds was again obtained from the control dishes where pure water was applied (84%), and it was found to be very low in petri dishes where *C. difformis* (20%), *P. pectinatus* (6%), *P. miliaceum* (5%) solutions was used. In germination environments where *E. crus-galli*, *E. oryzoides*, *A. retroflexus* and *P. peruviana* weed solutions were used, it was observed that Osmancik-97 riceseeds didn't germinate. The irrigation extracts prepared by *E. crus-galli*, *E. oryzoides*, *A. retroflexus* and *P. peruviana* were found to be the weeds which inhibit the germination of both Karacadag and Osmancik-97 rice seeds the most.

Table 1. Means and groups formed between weeds and varieties regarding germination rates in laboratory and field conditions.

Weeds	Germination rate (%) (Lab.)			Germination rate (%) (Field)		
	Karacadag	Osmancık-97	Mean	Karacadag	Osmancık-97	Mean
Physalis peruviana	38.00 b	0.00	38.00 bc	61.50 b	24.00 bc	42.75 cd
Amaranthus retroflexus	18.00 bc	0.00	18.00 cd	80.00 a	30.50 b	55.25 bc
Echinochloa crus-galli	2.00 c	0.00	2.00 d	24.50 c	11.00 c	17.75 e
Potamogeton pectinatus	86.65 a	5.00	45.82 bc	83.00 a	16.50 bc	49.75 bc
Panicum miliaceum	88.80 a	6.00	61.20 ab	85.00 a	19.00 bc	52.00 bc
Cyperus difformis	80.15 a	20.00	60.10 ab	88.50 a	27.50 bc	58.00 b
Echinochloa oryzoides	13.95 bc	0.00	13.95 cd	52.15 b	19.50 bc	35.825 d
Control	97.50 a	84.00	90.75 a	91.00 a	87.50 a	89.25 a
Mean	56.540 a	34.00 b		70.706 a	29.438 b	

The differences between the means shown by the same letter are not significant at the 0.05 level according to LSD test.

Regarding the germination rate of seeds at field conditions, it was observed that the mean values of the varieties are 70.7% for Karacadag local variety and 29.4% for Osmancik-97 variety. The highest germination rates of Karacadag seeds were found in control plots free from weed seeds (91.0%), and in plots with *C. difformis* (88.5%), *P. miliaceum* (85.0%), *P. pectinatus*

(83.0%), *A. retroflexus* (80.0%) weed seeds. Karacadag seeds had showed low rates of germination in the plots sown with *E. crus-galli* (24.5%), *E. oryzoides* (52.15%) and *P. peruviana* (61.5%) weed seeds. And the highest germination rate of Osmancik-97 rice seeds was again obtained from the control parcels free from weed seeds (87.5%), and in the plots sown with other 7 weed seeds, the germination rates were found to be very low as being in between 16.5-30.5% (Table 1).

After emergence, 10 and 20 days later, at each parcel, the root lengths of rice plants were measured after cleaning, and their mean was taken. Regarding the root lengths of rice seedlings, it was observed that the mean values of the varieties were 12.9 cm in Karacadag variety and 12.8 cm in Osmancik-97 variety, and that there was no statistically significant difference in between them. The highest root length of Karacadag seedlings was measured in the control parcels free from weeds (15.1 cm), and in plots with *P. pectinatus*(14.5 cm) and *A. retroflexus*(14.14 cm) weed seeds. And the highest root length of Osmancik-97 seedlings was observed in the control parcels free from weeds (18.6 cm), and then in the plots with *P. peruviana* (17.8 cm) and *A. retroflexus* (17.0 cm) weeds. In parcels where *E. crus-galli* weed was sown, it was observed that the root length of both Karacadag (9.2 cm) and Osmancik-97 (7.3 cm) varieties decreased significantly (Table 2).

Table 2. Means and groups formed between weeds and varieties regarding root length and seedling length.

Weeds	Root length (cm)			Seedling length (cm)		
	Karacadag	Osmancık-97	Mean	Karacadag	Osmancık-97	Mean
Physalisperuviana	12.255 b	17.875 a	15.065 a	10.825 b	10.500 a	10.663 b
Amaranthus retroflexus	14.140 ab	17.000 a	15.570 a	10.360 bc	11.375 a	10.868 b
Echinochloa crus-galli	9.285 c	7.325 c	8.305 c	7.585 de	6.875 b	7.230 cd
Potamogetonpectinatus	14.500 ab	10.810 b	12.655 b	17.695 a	7.475 b	12.585 a
Panicum miliaceum	12.490 ab	10.525 b	11.508 b	8.750 cd	7.385 b	8.068 cd
Cyperus difformis	13.595 ab	10.375 b	11.985 b	9.890 bc	6.405 b	8.148 c
Echinochloa oryzoides	12.210 b	10.330 b	11.270 b	8.730 cd	7.800 b	8.265 c
Control	15.100 a	18.665 a	16.883 a	5.945 e	7.480 b	6.713 d
Mean	12.947 a	12.863 a		9.973 a	8.162 b	

The differences between the means shown by the same letter are not significant at the 0.05 level according to LSD test.

The number of plant was counted in the 10^{th} and 20^{th} days from emergence, and the seedling lengths of the plants were measured. Regarding the seedling lengths of two rice seedlings, it was observed that the mean values of the varieties were 9.9 cm for Karacadag local variety and 8.1 cm for Osmancik-97 variety, and that the statistical difference in between them was significant. The highest seedling length of the Karacadag was measured in plots with *P. pectinatus* (17.6 cm) weed. The seedling lengths of Karacadag rice plants had remained significantly short in control parcels free from weeds (5.9 cm). The highest seedling lengths of Osmancik-97 rice was measured in mixed sown plots with *A. retroflexus* (11.3 cm) and *P. peruviana* (10.5 cm) weeds. No statistical difference was observed in respect of seedling length at control parcels free from weed and at parcels planted with 5 other weeds, and values in between 6.4 -7.8 cm was measured (Table 2).

The plants, removed from the soil by their roots, were cut from the internode over the root, and their surface fresh biomass weights were weighted. Regarding the fresh seedling weights of rice seedlings, it was observed that the mean values of the varieties were 1.976 g in Karacadag

local variety and 2.081 g in Osmancik-97 variety, and that there was no statistically significant difference in between varieties. The highest fresh seedling weights of Karacadag rice plants was measured in control parcels free from weeds (2.810 g), and in mixed planted plots with *P. pectinatus* (2.530 g). In parcels where *E. crus-galli* and *E. oryzoides* weeds were mixed planted, it was observed that the fresh seedling weight of Karacadag local variety remained significantly below the mean. The highest fresh seedling weights of Osmancik-97 rice seedlings was measured in plots planted as mixed with *P. pectinatus* (3.390 g). In parcels where *P. miliaceum* (1.530 g) and *C. difformis* (0.835 g) were planted, the fresh seedling weights of rice plants had remained at very low levels (Table 3).

Table 3. Means and groups formed between weeds and varieties regarding fresh seedling weight and dry seedling weight.

Weeds	Fresh seedling weight (g)			Dry seedling weight (g)		
	Karacadag	Osmancık-97	Mean	Karacadag	Osmancık-97	Mean
Physalis peruviana	1.740 cd	2.320 cd	2.030 bcd	0.395 bc	0.439 bc	0.417 bc
Amaranthus retroflexus	1.820 bc	3.120 ab	2.470 ab	0.520 b	0.473 bc	0.497 b
Echinochloa crus-galli	1.025 e	2.450 bc	1.738 d	0.272 bc	0.293 bc	0.283 bc
Potamogeton pectinatus	2.530 a	3.390 a	2.960 a	0.400 bc	0.565 b	0.482 b
Panicum miliaceum	2.365 abc	1.530 ef	1.948 cd	0.469 bc	0.205 c	0.337 bc
Cyperus difformis	2.470 ab	0.835 f	1.653 de	0.401 bc	0.320 bc	0.360 bc
Echinochloa oryzoides	1.050 de	1.325 cd	1.188 e	0.163 c	0.294 bc	0.228 c
Control	2.810 a	1.680 de	2.245 bc	0.853 a	0.930 a	0.891 a
Mean	1.976 a	2.081 a		0.434 a	0.440 a	

The differences between the means shown by the same letter are not significant at the 0.05 level according to LSD test.

The dry biomass weights of rice seedlings were weighted at laboratory by drying at 70^0C for 48 hours. Regarding the dry seedling weights of rice seedlings at field conditions, it was observed that the mean values of the varieties were 0.434 g in Karacadag and 0.440 g in Osmancik-97, and that there was no statistically significant difference in between them. The highest dry seedling weights of Karacadagrice was measured in control parcels free from weeds (0.853 g). It was observed that in parcels mixed planted with *E. oryzoides* weeds, the dry seedling weights of Karacadaglocal variety remained significantly below the mean. The highest dry seedling weights of Osmancik-97 rice seedlings were measured in control parcels free from weeds (0.930 g). At parcels where *P. miliaceum* (0.205 g) seeds were planted, the dry seedling weights of rice plants had remained at very low levels (Table 3).10 and 20 days after emerge at each parcel, the roots of the plants were cut at laboratory after cleaning and their fresh weights were weighted, and then their dry root weights were weighted by drying at drying oven at 70^0C for 48 hrs (Ottis *et al.* 2005). Regarding the fresh root weights of rice seedlings, it was observed that the mean values of the varieties were 0.870 g in Karacadag and 1.096 g in Osmancik-97, and that there was no statistically significant difference in between them. The highest fresh root weights of Karacadag plants was measured in control parcels free from weed (1.649 g), and in mixed planted plots with *P. miliaceum* (1.245 g) weeds. At parcels where *E. crus-galli* was planted as mixed, it was observed that the fresh root weights of Karacadag remained at low levels. The highest fresh root weights of Osmancik-97 seedlings was measured in plots planted as mixed with *P. pectinatus* (2.283 g) weed. In parcels where *C. difformis* (0.268 g) and *E. crus-galli* (0.368 g) weeds were planted, the fresh root weights of rice plants had remained at very low levels (Table 4).

Regarding the dry root weights of rice seedlings cultivated with weeds, it was observed that the mean values of the varieties were 0.196 g in Karacadag and 0.231 g in Osmancik-97, and that there was no statistically significant difference in between them. The highest dry root weights of Karacadag local variety was measured in control parcels free from weeds (0.282 g), and in parcels planted as mixed with *P. miliaceum* (0.282 g). At parcels where Karacadag rice plants were planted as mixed with *E. oryzoides*(0.093 g) and *E. crus-galli* (0.110 g), it was observed that the dry root weights of Karacadag plants remained significantly low. The highest dry root weights of Osmancik-97 rice plants was measured in plots planted as mixed with *P. pectinatus* (0.403 g) weed. At parcels where *C. difformis* (0.097 g) and *P. miliaceum* (0.115 g) seeds were planted as mixed, the dry root weights of rice plants had remained at very low levels (Table 4).

Table 4. Means and groups formed between weeds and varieties regarding fresh root weight and dry root weight.

Weeds	Fresh root weight (g)			Dry root weight (g)		
	Karacadag	Osmancık-97	Mean	Karacadag	Osmancık-97	Mean
Physalis peruviana	0.475 bc	1.091 cd	0.783 cd	0.217 ab	0.272 ab	0.245 abc
Amaranthus retroflexus	0.573 bc	1.765 ab	1.169 bc	0.174 ab	0.296 ab	0.235 abc
Echinochloa crus-galli	0.281 c	0.368 e	0.324 e	0.110 b	0.200 bc	0.155 c
Potamogeton pectinatus	1.115 ab	2.283 a	1.699 a	0.214 ab	0.403 a	0.309 a
Panicum miliaceum	1.245 a	0.718 de	0.981 cd	0.282 a	0.115 c	0.198 bc
Cyperus difformis	1.109 ab	0.268 e	0.689 de	0.200 ab	0.097 c	0.148 c
Echinochloa oryzoides	0.516 bc	0.725 de	0.620 de	0.093 b	0.195 bc	0.144 c
Control	1.649 a	1.553 bc	1.601 ab	0.282 a	0.269 ab	0.275 ab
Mean	0.870 a	1.096 a		0.196 a	0.231 a	

The differences between the means shown by the same letter are not significant at the 0.05 level according to LSD test.

The lengths and widest parts of the leaves of plants removed at 20th day after emergence-were measured, and were multiplied by the 0.79 coefficient, and thus the leaf area index was calculated. Regarding the leaf area indices of rice seedlings cultivated with weeds, it was observed that the mean values of the varieties were 16.03 cm^2 in Karacadag local variety and 8.60 cm^2 in Osmancik-97 variety, and that there was statistically significant difference in between them. It was observed that the Karacadag rice plants had wider leaf area compared to Osmancik-97 variety, and the widest leaf area among Karacadag local varieties was measured at control parcels free from weed (22.50 cm^2). At plots where Karacadag plants are planted as mixed with *E. oryzoides* (8.65 cm^2), it was observed that the leaf area index of Karacadag plants remained significantly low. The mean values regarding highest leaf area indices of Osmancik-97 plants were found at plots where rice plants are planted as mixed with *P. pectinatus* (13.67 cm^2) and *A. retroflexus* (12.17 cm^2). At plots where rice plants are planted as mixed with *C. difformis* (5.27 cm^2), *P. miliaceum* (5.84 cm^2) and *E. oryzoides* (6.26 cm^2), it was observed that the leaf area indices of Osmancik-97 rice plants remained significantly low (Table 5).

The panicles of 20 plants taken at the maturity period from each parcel were counted, and after blending, the grains had been weighed and grain yield per panicle was determined. Regarding the grain yield per panicle of rice plants cultivated with weeds, it was observed that the mean values of the varieties were 1.876 g in Karacadag local variety and 1.394 g in Osmancik-97 variety, and that there was statistically significant difference in between them. It was observed that

the Karacadag plants had higher grain yield as compared to Osmancik-97 variety. The highest grain yield among Karacadag local variety was found in the control parcel free from weed (2.430 g) and in parcel planted as mixed with *A. retroflexus* (2.040 g). At plots where Karacadag plants were planted as mixed with *E. oryzoides* (1.485 g) and *E. crus-galli* (1.585 g), it was observed that the grain yield per panicle of Karacadag plants remained significantly low. The mean values regarding highest grain yield per panicle of Osmancik-97 plants were found at control parcels free from weeds (1.785 g), and at plots planted as mixed with *P. pectinatus* (1.615 g) weeds. At plots planted as mixed with *E. crus-galli* (1.060 g), *E. oryzoides*(1.125 g) and *P. peruviana* (1.190 g) weeds, it was observed that the grain yield per panicle of Osmancik-97 rice remained significantly low (Table 5).

Table 5. Means and groups formed between weeds and varieties regarding leaf area index andgrain yield per panicle.

Weeds	Leaf area index (cm^2)			Grain yield per panicle (g)		
	Karacadag	Osmancık-97	Mean	Karacadag	Osmancık-97	Mean
Physalis peruviana	16.51 ab	9.69 abc	13.10 ab	1.885 bc	1.190 bc	1.537 bcd
Amaranthus retroflexus	15.84 b	12.17 ab	14.00 ab	2.040 ab	1.345 abc	1.693 bc
Echinochloa crus-galli	12.25 bc	8.38 abc	10.32 bc	1.585 bc	1.060 c	1.323 cd
Potamogeton pectinatus	17.82 ab	13.67 a	15.75 a	1.890 bc	1.615 ab	1.753 ab
Panicum miliaceum	16.14 ab	5.84 bc	10.99 bc	1.900 abc	1.535 abc	1.718 b
Cyperus difformis	18.51 ab	5.27 c	11.89 abc	1.790 bc	1.495 abc	1.643 bcd
Echinochloa oryzoides	8.65 c	6.26 bc	7.45 c	1.485 c	1.125 bc	1.305 d
Control	22.50 a	7.50 abc	15.00 ab	2.430 a	1.785 a	2.108 a
Mean	16.03 a	8.60 b		1.876 a	1.394 b	

The differences between the means shown by the same letter are not significant at the 0.05 level according to LSD test.

Consequently, it had been concluded that the *E. crus-galli* and *E. oryzoides* weeds negatively affect the germination rate, root length, dry seedling weight, tiller number, leaf area index and grain yield per panicle in both rice plants. Moreover, it was observed that these two weeds negatively affect the fresh seedling weight and dry root weight in Karacadag local variety.

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