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Comparison of Weed Problems in Main and Second Crop Maize (*Zea mays* L.) Growing Areas in Turkey

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Abstract: Survey studies were carried out in 2003 and 2004 growing seasons in Aydin province of Turkey to compare the weed problems in main and second crop maize growing areas and to evaluate the influence of sowing period on the frequency and density of weeds. In total 150 fields sown as main crop at three different periods (fields sown between 15-30 April; 01-07 May and 10-15 May) and 98 fields sown as second crop at three different sowing periods after wheat harvest (fields sown between 17-20 June; 24-27 June and 01-07 July) were monitored to assess the frequency and density (number of individuals per m^{-2}) of weed species in both years. As the result of the studies in total 25 weed species were found in maize growing areas, of which 12 had a frequency of >25%. Although similar species were observed in both main and second crop maize fields in the region, frequency and density of some weeds, as well as the density of total weeds, were markedly lower in second crop maize growing areas. Results also showed that late sowing periods in main crop maize generally resulted in lower weed density, whereas no influence of sowing period on the frequency and density of weeds was observed in second crop maize fields.

Key words: Weeds, maize (*Zea mays* L.), sowing period, main crop, second crop

INTRODUCTION

Maize is an important crop in Turkey grown on 575.000 ha area with total production of 2.800.000 tons in 2003[1]. Although maize is grown in Turkey generally as main crop, it is also grown as second crop after harvesting winter wheat. At both kind of production, weeds are important factors affecting the maize grain yield adversely. According to Oerke and Steiner[2] weeds cause worldwide average yield losses of 12.8 % despite weed control applications and 29.2% in the case of no weed control in maize. Previous studies in Turkey showed that whole season weed interference caused about 35-40% yield losses in maize sown as main crop[3] and by 25% in second crop maize[4]. Also the studies conducted in Aydin Province of Turkey in 2003 showed that weeds caused yield losses by 65 and 49% in main and second crop maize fields, respectively[3].

Although weed control in maize is carried out effectively by means of mechanical or chemical methods after crop emergence, intensive use of these measurements is related with some side effects. Increased soil erosion by intensive tillage, short efficacy period and inadequate efficiency against perennial weeds are the main factors limiting the efficacy of mechanical weed control, while intensive chemical weed control is closely related with some environmental problems including pollution of soil and water sources[5,6] and with the evolution of herbicide resistance in the field[7]. In addition to these side effects intensive weed control is also associated with higher production costs.

As the consequence of these concerns, recent studies focused on the integrated weed management strategies, in which the preventive weed control methods gained in importance. Reducing possible weed problems prior to sowing by applying preventive control methods is the first step of integrated weed management strategy[8]. Crop rotation is an important cultural method affecting the weed situation in any cropping systems. Some previous studies showed that weed problems in maize could be reduced by crop rotation including the rotation with cereals[9,10]. Because of the allelopathical potential of some cereals, it is generally expected that weed populations could be reduced in the following crop grown after cereals. In addition to that cereals reduce the light exposure under plant canopy that cause to prevent the germination of weed seeds[11]. Therefore, it is expected that weed problems in second crop maize could be less significant than in main crop. Another important cultural practice is the adjustment of maize sowing date to maximum weed emergence time. It is generally accepted that pre-sowing soil tillage during the maximum weed emergence time could result with important reductions in weed populations during growing season[11-13].

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Although both of these cultural control aspects are important in developing an efficient preventive weed control strategy in maize, the influence of crop rotation on the frequency and density of weeds, as well as the maximum weed emergence time could be variable depending on weed species. Therefore, knowledge about the weed problems in main and second crop maize production is the key factor to develop an appropriate preventive weed control strategy. Equally important is the definition of the relationships between sowing period and population levels of some important weed species. Therefore, it was aimed with here presented studies to determine and compare the weed species occurring in main and second crop maize growing areas in Aydin province of Turkey and to evaluate the relationships between sowing period and weed problems in main and second crop maize fields.

MATERIALS AND METHODS

Aydin province locates in Western part of Turkey in Aegean region. According to the data supplied by Agricultural Administration of the Province, maize was grown on about 17700 ha area in average of 2003 and 2004 (10370 ha main and 7329 ha second crop).

Survey studies were carried out in 2003 and 2004 maize growing seasons. In total 150 fields (67 and 83 fields in 2003 and 2004, respectively, approximately on 500 ha total growing areas) sown as main crop maize were observed in both years. Observations in second crop maize were done on 98 fields in both years (51 and 47 fields in 2003 and 2004, respectively, approximately on 325 ha total growing areas). Depending on growing areas different number of fields were visited (Table 1) in the north, west, south and east parts of each county. Special attention has been paid to leave 3 km distances between surveyed fields. To assess weed species and their density, observations were done, when maize plants were at 3 to 8 leaf stage on the fields depending on sowing date, which was determined previously as the critical period for weed interference in maize in Aydin province[3]. Particular emphasis has been given to fields, on which no weed control practices had been applied recently. Observations in main crop maize were carried out between 15 and 30 May and in second crop maize between 15 and 25 July in both years. Weeds were determined and counted by using 1 X 1 m (1 m^{-2}) frame thrown four times per 0.5 ha area. In the case of monocotyledonous weeds, each tiller was counted as a separate plant. During surveys sowing date of each field was recorded to assess the influence of sowing period on the frequency and density of weeds. Different sowing periods and the number of surveyed fields are shown in Table 2.

Table 1: Distribution of maize growing areas in Aydin province[1] and number of surveyed fields per county

	Main crop maize		Second crop maize	
County	Growing areas (ha)[2]	Number of surveyed fields[3]	Growing areas (ha)[2]	Number of surveyed fields[3]
Çine	2560	36	940	13
Merkez	2291	33	1093	15
Koçarli	1000	14	450	6
Karpuzlu	1000	14	450	6
Köşk	659	10	300	4
Nazilli	630	9	1150	15
Germencik	630	9	580	8
Bozdoğan	490	8	110	2
Yenipazar	350	5	400	5
Incirliova	350	5	370	5
Kuyucak	300	4	590	8
Söke	20	3	830	11
Total	10370	150	7329	98

[1]Data was supplied by the Agricultural Administration of Aydin province; [2]Growing areas in average of 2003 and 2004; [3]Total number of surveyed areas in 2003 and 2004

Table 2: Number of surveyed fields depending on sowing period

	Main crop maize			Second crop maize		
Sowing period	15-30 April	01-07 May	10-15 May	17-20 June	24-27 June	01-07 July
	Number of surveyed fields					
2003	20	24	23	11	18	22
2004	30	26	27	20	14	13
Total	50	50	50	31	32	35

Frequency of weeds was determined in percent by relating the number of fields infested with a weed with total number of surveyed area[14]. Weed density was determined as average plant number per m^{-2} for each field. To determine the differences in weed populations between main and second crop maize fields, mean densities of 12 weed species having over 25% frequency were compared for significance via t-test. Influence of sowing period on weed populations was analyzed by ANOVA.

RESULTS AND DISCUSSION

Comparison of weed problems in main and second crop maize growing areas: Total 25 weed species were observed during survey studies. Observed weeds were typical for Aydin province occurring also in other important summer crops (Table 3). Similar weed composition was determined for cotton growing areas of Aydin province with the survey studies of Boz[15]. In addition to the similarity of weed species, there are also similarities in the importance ranking of weeds based on frequency in both studies.

In both main and second crop maize growing areas *C. rotundus* was the most frequent weed, followed by *A. retroflexus* and *P. oleracea*. The ranking in the frequency of other weeds were variable in main and

Table 3: Weed species and their frequency in maize growing areas in Aydin province of Turkey

Weed species	Frequency (%)*	
	Main crop maize	Second crop maize
Cyperus rotundus L.	93.0	98.0
Amaranthus retroflexus L.	73.7	57.3
Portulaca oleracea L .	63.0	48.3
Solanum nigrum L.	54.3	28.7
Chenopodium album L.	54.0	6.3
Echniochloa cruss-galli (L.) P.B.	48.0	18.7
Echinochloa colonum (L.) Link	42.7	25.7
Digitaria sanguinalis (L.) Scop.	41.0	34.3
Sorghum halepense (L.) Pers.	38.3	36.7
Xanthium strumarium L.	37.3	44.7
Cynodon dactylon (L.) Pers.	36.0	33.7
Datura stramonium L.	28.7	31.0
Paspalum paspalodes (Michx.) Schrib	15.0	10.0
Heliotropium spp.	14.7	15.3
Convolvulus arvensis L.	10.7	15.0
Amaranthus blitoides L.	8.7	5.0
Phragmites australis (Cv) Trin.ex.Steudel	6.0	7.7
Tribulus terrestris L.	6.0	8.0
Chenopodium murale L.	4.9	0.0
Chrozophora tinctoria (L.) Rafin	1.7	9.0
Alhagi pseudalhagi (Bieb.) Desv.	1.7	0.0
Sonchus spp.	1.7	0.0
Amaranthus viridis L.	0.0	3.0
Seteria verticillata (L.) P.B.	0.0	5.0
Abutilon theoprasti L.	0.0	1.3

*Data from 2003 and 2004 were combined

Table 4: Density of weeds in main and second crop maize growing areas in Aydin province of Turkey

Weed species	Density (plant m^{-2})***		
	Main crop maize	Second crop maize	Relative reduction (%)
*C. rotundus**	43.3±6.0	27.2±3.1	37
*E. cruss-galli***	21.4±7.7	0.8±0.3	96
*A. retroflexus**	18.3±7.0	1.9±0.5	90
S. nigrum ^{NS}	17.2±6.9	3.8±2.3	78
D. sanguinalis*	15.4±4.8	2.0±0.7	87
*P. oleracea**	10.3±2.5	3.3±1.6	68
S. halepense ^{NS}	9.2±4.3	3.0±1.1	67
E. colonum ^{NS}	7.1±3.3	2.5±0.5	65
*C. dactylon**	4.5±1.3	1.7±0.6	62
*C. album**	2.1±0.9	0.1±0.1	52
D. stramonium ^{NS}	0.9±0.3	1.3±0.6	-
X. strumarium ^{NS}	0.6±0.1	0.9±0.3	-
Total weeds**	150.3±19.9	48.5±4.3	67

* Significant at p=0.05; ** significant at p=0.01; NS: Non-significant;
*** Data from 2003 and 2004 were combined

second crop maize fields. In total 12 and 11 weed species had a frequency over 25% in main and second crop maize, respectively. Therefore, particular emphasis will be given on these 12 weed species throughout the results.

There were differences between the frequencies of some weeds in main and second crop maize fields, so that the frequencies of most annual weeds were lower in the second crop production. These reductions in the frequencies were pronounced with *A. retroflexus, P. oleracea, S. nigrum*, *Echinochola* spp., but especially with *C. album*. While *C. album* was the fifth most frequent weed species in main crop maize fields with 54.0% frequency, this weed took the 17th rank in second crop maize fields with a frequency of only 6.3%. Unlike annual weeds, frequencies of perennial weeds (*C. rotundus, C. dactylon, S. halepense* and *D. sanguinalis*) were similar in both main and second crop maize production.

The densities of weed species having over 25% frequency in main or second crop maize fields are shown in Table 4. *C. rotundus* had the highest density in both main and second crop growing areas showing that this weed is the most important species in the region as also Boz[15] found for cotton. As compared to main crop growing areas, total weed density was significantly lower (67% lower) in second crop growing areas. The reductions in the densities of weeds were between 37 and 96% depending on weed species. According to t-test, the reductions in the populations of *C. rotundus, E. cruss-galli, A. retroflexus, D. sanguinalis, P. oleracea, C. dactylon* and C. *album* were significant, whereas the reductions with *S. nigrum, S. halepense, E. colonum, X. strumarium* and *D. stramonium* were not statistically significant.

These results indicate clearly that weed problems in second crop maize are significantly lower than in main crop, as expected. This fact can be explained by two reasons, which should be considered jointly. An explanation for lower weed frequency and density in second crop maize could be that second crop maize is sown generally after harvesting winter grown cereal crops, especially after wheat. It is well known that cereals are sown on narrow row spacing and close the soil surface quickly. Therefore, the light exposure to the soil surface under cereal canopy is quite limited, especially at the later periods in the growing season (between April to June) when summer weeds start to emerge. Thus, it can be thought that the germination of most weed seeds or the growth of most emerged weed seedlings could be prevented or suppressed under wheat canopy due to light shortage at these periods. Teasdale[16] reported that growing some cover crops in crop rotation, such as wheat, is an important component of integrated weed management strategies serving to reduce the weed density for the following crop. In addition to light shortage, the allelopathical effects of some cereals (including wheat) on weeds are well defined in the literature[17,18]. According to Belz and Hurle[19] some root exudates of different wheat (*Triticum aestivum*) cultivars include hydroxamid acids (determined by HPLC-UV analysis) that are toxic to some annual weed species. Boz[20] investigated the allelopathic effects of wheat and rye straw on some

Table 5: Influence of sowing period on the density of weeds (number m^{-2}) in main and second crop maize

	Sowing period					
	15-30 April	01-07 May	10-15 May	17-20 June	24-27 June	01-07 July
	Main crop maize			Second crop maize		
Weed species	Density (number of plants per m^2)**					
C. rotundus NS	59.5±12.0	44.6±13.0	27.6±4.8	25.9±5.0	27.0±4.3	28.5±7.2
E. cruss-galli	13.3±9.0*	48.9±21.9*	5.0±2.5*	0.8±0.5	1.1±0.7	0.6±0.4
A. retroflexus NS	22.4±9.7	29.5±19.5	5.0±1.6	3.0±1.1	1.3±0.6	1.4±0.6
S. nigrum NS	29.7±19.0	16.9±8.5	6.3±3.6	9.0±7.5	5.1±4.8	0.2±0.0
D. sanguinalis NS	41.4±23.1	23.6±9.1	12.9±10.0	3.9±1.5	2.5±0.2	2.2±0.4
P. oleracea NS	10.4±3.9	14.7±5.0	6.3±3.9	3.2±1.1	5.2±4.7	2.0±0.9
S. halepense NS	6.6±2.7	17.0±13	4.8±1.9	2.0±0.8	4.6±2.9	2.6±1.6
E. colonum NS	2.9±1.5	14.5±10.1	4.5±1.6	4.9±2.0	0.9±0.8	0.0±0.0
C. dactylon NS	7.3±3.6	2.9±1.5	3.5±1.1	1.9±0.9	1.0±0.7	2.4±1.5
C. album NS	4.1±2.7	1.5±0.5	0.8±0.3	0.1±0.1	0.1±0.1	0.1±0.1
D. stramonium NS	1.4±0.8	1.0±0.4	0.4±0.2	1.6±0.5	1.2±0.9	3.6±2.2
X. strumarium NS	0.7±0.2	0.7±0.3	0.4±0.1	0.6±0.4	1.7±0.8	0.9±0.1
Total Weeds	199.7±121.5*	215.8±141.1*	77.5±55.7*	56.9±5.5	51.7±8.3	44.5±10.9

* Significant at p=0.05, NS: Non-significant; ** Data from 2003 and 2004 were combined

important weed species occurring in summer crops in Aydin province under controlled and field conditions as well as in the laboratory. As the result he found that the straw treatments reduced the emergence of *P. oleracea, A. retroflexus* and *E. colonum* significantly. These results clearly show that the allelochemicals released by wheat wastes could be considered as one of the most important factors responsible for lower frequency and density of some important annual weeds in second crop maize growing areas. However, Boz[20] found no effects of straw treatments on *C. rotundus*. Another reason for lower weed frequency and density in second crop maize could be related with the relative late sowing period of second crop maize.

Influence of sowing period on weed density in main and second crop maize: As shown in Table 5, the densities of most weeds were not affected by sowing period significantly. Significant differences were observed only with *E. cruss-galli* and with total weeds in main crop growing areas. The highest density of *E. cruss-galli* was found on fields sown within the period between 01 and 07th May. The number of this weed per m^2 was significantly lower in the earlier or later sowing periods. In the case of total weeds lowest weed number was observed on fields sown at the latest period (between 10-15 May). Although the lowest density of most weed species was observed at the latest sowing period, differences were not statistically significant, which can be attributed to the variations in weed densities among observed fields. In second crop total weed number per m^2 was similar for all sowing periods.

These results suggest that delaying sowing period until mid May would result in less weed problems in main crop maize growing areas. This was especially the case with the most frequent weed species of the growing areas in Aydin province, such as *C. rotundus*, *A. retroflexus, S. nigrum, E. cruss-galli* and *C. album*, although the reductions in the populations were not significant. The main reason for that could be the relative early emergence time of these weeds in the region. All these weeds have been observed as initial weeds emerging just before, at the same time or shortly after maize emergence and cause considerable yield losses in previous studies[3]. Therefore, late preliminary soil tillage could destroy most of the non-dormant seeds of these early emerging weeds allowing a maize production with less weed problems during growing season. Similar reductions in the populations of C. *album* and *A. retroflexus* were reported also by Buhler *et al.*[13], so that the population of these weeds in soybean was reduced significantly (by 80 and 25%, respectively) by delaying the sowing period from mid-May until early-June.

Results of these studies suggest that adjusting the soil tillage, as well as the sowing date to initial flushes of important weeds is an important approach in reducing the weed problems in main crop maize production. Such an approach could serve to reduce the intensity of post emergence weed control applications and to save from production costs, as also stated by Barberi[20]. However, more precise information is needed about maximum emergence timings of each important weed species to make more site specific weed control recommendations, because the dominating weed species is variable among fields based on soil and climatic conditions as well as the cropping system[13]. Thus, the aim of further studies should be to study the maximum emergence periods and population dynamics of some important weeds.

Maize and cotton are the main summer crops in Aydin province and weeds are one of the most important yield limiting factors in both crops. Since both crops are grown at the same period, have similar weed composition

and also similar weed control practices are applied in both crops, populations of some weeds intends to increase in such kind of production systems. Therefore, it is not possible to reduce the weed problems in both crops by maize-cotton rotation. However, second crop maize production after winter grown cereals provides opportunity to reduce the number of some problem weeds. Based on the results of here presented studies it can be recommended to grow second crop maize after winter cereals to reduce the populations of some important weeds. Repeating this rotation several times could serve to reduce the weed populations to an acceptable level that could be more efficiently controlled with current weed control measurements. Main crop maize or cotton could be then grown with less weed problems providing that the sowing period should be adjusted to the maximum weed flushes.

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REFERENCES

1. Faostatt, 2004. FAO, Agricultural Statistics, Updated February 2004. www.fao.org
2. Oerke, E.C. and U. Steiner, 1996. Abschätzung der Ertragsverluste im Maisanbau. In: Ertragsverluste und Pflanzenschutz-Die Anbausituation für die wirtschaftlich wichtigsten Kulturpflanzen. German Phytomedical Society Series, Eugen Ulmer Verlag, Stuttgart, Band, 6: 63-79.
3. Doğan, M.N., A. Ünay, Ö. Boz and F. Albay, 2004. Determination of optimum weed control timing in maize (*Zea mays* L.). Turkish J. Agric. For., 28: 349-354.
4. Üremis, I., A.C. Ülger, O. Gönen, B. Çakir, I. Kadioğlu and A. Uludağ, 1997. Determination of critical period for weed control in second crop maize in Cukurova region of Turkey. Proceedings of Second Turkish Congress of Weed Science, 1997, Ayvalik-Izmir, pp: 427-432 (In Turkish with English Abstract).
5. Torstenson, L., 1996. Herbicides in the environment. In: Proceedings of the Second International Weed Control Congress, Copenhagen, pp: 267-273.
6. Perkins, J.H. and B.R. Patterson, 1997. Pests, Pesticides and Environment. A Historical Perspective of Prospects for Pesticide Reduction. In: Techniques for Reducing Pesticide Use. Economic and Environmental Benefits, John Willey and Sons, England, Ch. 2, pp: 13-35.
7. Rubin, B., 1996. Herbicide-resistant weeds-the inevitable phenomenon: Mechanisms, distribution and significance. Zeitschrift für Pflanzenkrankheiten und Pflanzenschutz, Sonderheft XV, pp: 17-32.
8. Kudsk, P. and J.C. Streibig, 2003. Herbicides- a two edged sword. Weed Research, 43: 90-102.
9. Singer, J.W., W.J. Cox, R.R. Hahn and E.J. Shields. 2000. Cropping systems effects on weed emergence and densities in corn. Agron. J., 92: 754-760.
10. Tawainga, W.K. and W.J. Cox, 2000. Tillage X rotation X management interactions in corn. Agron. J., 92: 493-500.
11. Barberi, P., 2003. Preventive and Cultural Methods for Weed Management. In: Weed Management for Developing Countries. FAO Plant Production and Protection Paper, (Ed. Labrada, R.), Add. 1., pp: 179-193.
12. Cousens, R. and M. Mortimer, 1995. Extrinsic Factors Affecting Population Density. In: Dynamics of Weed Populations, Cambridge University Press, Ch. 6, pp: 169-216.
13. Buhler, D.D., R.G. Hartzler, F. Forcella and J.L. Gunsorus, 1997. Relative emergence sequence for weeds of corn and soybeans. Iowa State University, Cooperative Extension Service, pp: 4.
14. Odum, E.P., 1971. Fundamentals of Ecology. W.B. Saunders Company, Philadelphia, London, Toronto, pp: 574.
15. Boz, Ö., 2000. Determination of weed flora, distribution and density of weed species occurring in cotton growing areas in Aydin. J. Turkish Weed Sci., 3: 10-16.
16. Tesdale, J.R., 2003. Principles and Practices of Using Cover Crops in Weed Management Systems. In: Weed Management for Developing Countries. FAO Plant Production and Protection Paper, (Ed. Labrada, R.), Add. 1., pp: 169-178.
17. Kilung, K., P. Kwangho, K. Ku and K.H. Park, 1997. Weed management using a potential allelopathic crop. Korean J. Weed Sci., 17: 80-93.
18. Wu, H., J. Pratley, D. Lemerle and T. Haig, 1999. Crop Cultivars with allelopathic capability. Weed Res., 39: 171-180.
19. Belz, R. and K. Hurle, 2001. Tracing the source-do allelochemicals in root exudates of wheat correlate with cultivar-specific weed-suppressing ability. Brighton Crop Protection Conference-Weeds, pp: 317-320.
20. Boz, Ö., 2003. Allelopathic effects of wheat and rye straw on some weeds and crops. Asian J. Plant Sci., 2: 772-778.