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The weed species in corn fields in Antalya province of Türkiye

Antalya (Türkiye) ili mısır tarlalarındaki yabancı ot türleri

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ABSTRACT

Objective: The objective of this study was to identify weeds in corn fields and to determine their prevalence and density in Antalya, which is one of the major provinces in Türkiye with regard to corn production.

Material and Methods: Observations were carried out in a total of 47 corn fields in 2020. The number of fields to be surveyed in each district was determined according to the corn cultivation areas. Similarly, the number of quadrats thrown in each field was determined according to the field size. Care was taken to ensure that the fields to be observed were not close to each other. Densities and coverage areas of weeds on the basis of species were recorded in each field.

Results: According to survey results; 26 weed species belonging to 14 families were determined. Among these, it was found that the prominent species were found to be *Cyperus rotundus* L., *Echinochloa crus-galli* (L.) P. Beauv., *Sorghum halepense* (L.) Pers., *Portulaca oleraceae* L. and *Ipomoea triloba* L. The average coverage area of weeds in corn fields was determined to be as 18.7% while the average density was determined to be 21.5 plant m^{-2}.

Conclusion: It was concluded that the density of weeds in the corn cultivation areas of Antalya province is high and it is necessary to control weeds more effectively.

ÖZ

Amaç: Başarılı bir yabancı ot kontrolü, öncelikle türlerin doğru teşhis edilmesine bağlıdır. Bu çalışmada, mısır üretimi bakımından Türkiye'deki önemli illerden biri olan Antalya'da mısır tarlalarında bulunan yabancı otların tespiti, yaygınlık ve yoğunluklarının belirlenmesi amaçlanmıştır.

Materyal ve Yöntem: 2020 yılında toplam 47 mısır tarlasında gözlem yapılmıştır. Her ilçede sürvey yapılacak tarla sayısı ekiliş alanlarına göre belirlenmiştir. Benzer şekilde her tarlada atılan çerçeve sayısı tarla büyüklüğüne göre belirlenmiştir. Sürvey yapılacak tarlaların birbirlerine yakın bulunmamasına özen gösterilmiştir. Her tarlada yabancı otların tür bazında yoğunlukları ve kaplama alanları kaydedilmiştir.

Araştırma Bulguları: Yapılan surveyler neticesinde 14 familyaya ait 26 yabancı ot türü tespit edilmiştir. Bunlar içerisinde *Cyperus rotundus* L., *Echinochloa crus-galli* (L.) P. Beauv., *Sorghum halepense* (L.) Pers., *Portulaca oleraceae* L. ve *Ipomoea triloba* L. öne çıkan türlerdir. Mısır tarlalarında yabancı otların ortalama kaplanma alanı %18,7, ortalama yoğunluk ise 21,5 bitki/m^2 olarak belirlenmiştir.

Sonuç: Antalya ili mısır tarlalarında yabancı ot yoğunluğunun yüksek olduğu ve yabancı ot mücadelesinin daha etkili bir şekilde yapılması gerektiği anlaşılmıştır.

INTRODUCTION

Corn (*Zea mays* L.) is one of the most widely cultivated crops in the world. Since it is used for human nutrition and animal feed, it is also one of the important raw materials for the oil and starch industry. In the last 10 years, the production of grain corn in the world has increased by about 28% to approximately 1.15 billion tons. More than half of this production is made in America (52%), 29% in Asia, 11% in Europe, and 7% in Africa (Anonymous, 2021a). In Türkiye, according to 2020 data, grain corn production was carried out on an area of 692 thousand hectares and with a production of 6.5 million tons (Anonymous, 2021b). The provinces in Türkiye where corn cultivation is most intensive are Adana, Konya, Mardin, Şanlıurfa, Karaman, Sakarya, and Osmaniye. However, corn, which is grown in almost every province of Türkiye, is the cultivated plant with the largest planted area after wheat and barley among cereals (Anonymous, 2020). Naturally, as this intensive production increases, the problems to be solved also ascend and change. In particular, the drought problem, which has increased in recent years and Is expected to increase further in the coming years, as well as sudden changes in the global warming and precipitation regime, may lead to the emergence of new species that will adversely affect corn production, especially weeds. When the observations made in the corn planted areas in Türkiye are taken into consideration, it can be said that more than 100 weed species are seen. However, not all of these have the potential to be a problem. As corn is a plant of hot climate, the weeds that are problematic in corn areas are mostly summer species (Kitiş, 2021). These weed species, like in other cultivated plants, directly compete with corn for factors such as space, water, nutrients, and light, and indirectly cause harm by carrying diseases and harmful insects on them and by secreting toxic chemical substances (allelopathic chemicals) (Zimdahl, 2004; Soltani et al., 2016). The control of weed species, which cause direct and indirect harm to corn, is a major problem for corn producers. The most important and effective method for controlling weeds is the usage of herbicides. However, herbicides should be used in combination with other weed control methods in an integrated and sustainable manner in order to reduce the negative impacts on the environment and human health, and to obtain a more effective and long-lasting control (Doğan et al., 2004; Kitiş, 2021). In this study, it is aimed to define the weed species and their population structure elements in corn fields in Antalya province, which is one of the major provinces with regard to corn production in Türkiye.

MATERIALS and METHODS

The main material of the study consisted of weed species in the corn fields of Antalya province. Apart from this, a one square meter quadrat to determine the weed density and necessary materials for identification of unrecognizable specimens in the fields were used.

Survey studies were carried out in Serik, Aksu and Manavgat districts where most of the corn production took place in Antalya in 2020 (Figure 1). The plain continues to the east by narrowing towards the town of Manavgat and ends in the town of Alanya. It is bordered by the city center to the west. The surface area of the plain is about 27000 ha and its altitude vary between 0-70 m (Anonymous, 2022).

The number of surveys to be carried out in each district was determined according to the weighted average method, taking into account the corn cultivation areas (Bora & Karaca, 1970). Accordingly, survey studies were carried out in 47 fields in total in three districts (Table 1). Surveys were made in the corn fields in July-August, the period when weeds are most intense after irrigation. A special care was taken to ensure that the fields to be surveyed were not close to each other and that there was at least two kilometers between them if possible. Observations in the field were started at least 15-20 m inside of the field in order not to be affected by the edge effect. Four one square meter quadrats in fields up to 0.5 hectare, six for 0.5-1.0 ha fields, eight for 1.0-1.5 ha fields, and ten for the fields with a size of more than 1.5 ha were used and the density of weed species included in these quadrats was recorded. (Modified from Zengin & Güncan, 1993). The quadrats were randomly placed to represent the field, moving along the diagonal of the fields, and not too close to one another.

Figure 1. Antalya province map and districts where surveys were carried out.

Şekil 1. *Antalya il haritası ve surveylerin yapıldığı ilçeler.*

Table 1. Corn cultivation areas and number of surveys by districts

Çizelge 1*. İlçelerdeki mısır ekim alanları ve gerçekleştirilen survey sayıları*

Districts	Area planted (ha)*	Number of surveys
Aksu	3572	31
Manavgat	1200	10
Serik	767	6
Total	5539	47

* Anonymous, 2019.

After the determination of density, other parts of the field were investigated and other weed species not included in quadrats were recorded, and the coverage values (%) of weeds were recorded. Known common weed species were written into survey forms, but the samples that were difficult to recognize were taken in accordance with the herbarium technique, dried and then scientifically identified. Flora of Turkey and the Eastern Islands (Davis, 1965-1985; Davis et al., 1988; Güner et al., 2000) was used to identify plant species. Photographs of all known and unidentified weed samples were taken in the fields.

The frequency and coverage areas of weed species determined as a result of the surveys were calculated using the following formulas belonging to Odum (1971). Evaluation was made on the basis of arithmetic percentage in determining the frequency of incidence.

$$F.I.\ (\%) = n\ /\ m \times 100 \quad (1)$$

$$O.C.A.\ (\%) = C.A.\ /\ m \quad (2)$$

$$S.C.A.\ (\%) = C.A.\ /\ n \quad (3)$$

Where; *F.I* is frequency of incidence (%), *O.C.A* is overall coverage area (%), *S.C.A.* is special coverage area (%), *C.A.* is the total value of coverage area (%) of a species across the surveyed fields, *m* is the total number of sampled fields, *n* is the number of fields in which the species was found.

Evaluation was made on the basis of arithmetic mean in determining the density of weeds with the following formula;

$$O.D.\ (\text{plant m}^{-2}) = T.D.\ /\ m \quad (4)$$

$$S.D.\ (\text{plant m}^{-2}) = T.D.\ /\ n \quad (5)$$

Where; *O.D*. is overall density, *T.D.* is total density, *S.D.* is special density, *m* is the total number of sampled fields, *n* is the number of fields in which the species was found. For the determination of density, the value obtained as a result of the counts for each weed species in a field was divided by the total area counted in that field and the specific weed density (plant.m^{-2}) was calculated. The overall weed density was calculated by dividing the total density of a species in the region (plant.m^{-2}) to the number of surveys.

RESULTS and DISCUSSION

As a result of the surveys carried out in 47 corn fields in Aksu, Serik and Manavgat Districts; 26 weed species are belonging to 14 plant families were found. The list of 26 species in question is given in Table 2.

Table 2. Weed species determined in corn fields in Antalya province

Çizelge 2. *Antalya ili mısır tarlalarında belirlenen yabancı ot türleri*

Plant Family	Weed Species	OCA* %	SCA %	Overall Density	Special Density	Frequency
Amaranthaceae	*Amaranthus retroflexus* L.	0.01	0.08	0.07	0.54	13.00
	Chenopodium album L.	0.29	1.13	0.22	0.85	26.09
Apocynaceae	*Cynanchum acutum* L.	0.33	15.00	0.11	5.25	2.17
Asteraceae	*Sonchus oleraceus* L.	0.08	0.72	0.14	1.33	10.87
	Xantium strumarium L.	0.70	2.29	0.33	1.10	30.43
Boraginaceae	*Heliotropium europaeum* L.	0.18	2.13	0.07	0.86	8.70
Convolvulaceae	*Convolvulus arvensis* L.	0.32	1.47	0.24	1.08	21.74
	Ipomoea triloba L.	1.42	4.66	1.58	5.18	30.43
Cucurbitaceae	*Cucumis melo* var. *agrestis* Naudin	0.09	1.03	0.05	0.58	8.70
Cyperaceae	*Cyperus rotundus* L.	3.58	4.22	4.38	5.16	84.80
Euphorbiaceae	*Chrozophora tinctoria* (L.) Rafin.	0.91	1.90	0.77	1.61	47.83
	Ricinus communis L.	0.02	0.50	0.01	0.25	4.35
Fabaceae	*Arachis hypogaea* L.	0.09	2.00	0.03	0.60	4.35
Malvaceae	*Abutilon theophrasti* Medik.	0.23	2.63	0.43	4.98	8.70
	Corchorus olitorius L.	0.22	10.00	0.76	34.83	2.17
	Hibiscus trionum L.	0.03	0.50	0.01	0.08	6.52
Poaceae	*Cynodon dactylon* (L.) Pers.	0.11	5.00	0.09	4.25	2.17
	Digitaria sanguinalis (L.) Scop.	0.41	6.33	0.36	5.44	6.52
	Echinochloa crus-galli (L.) P. Beauv.	3.50	4.60	6.88	9.04	76.09
	Echinochola colonum (L.) Link	0.61	2.15	0.45	1.59	28.26
	Elymus repens (L.) Gould	0.30	3.40	0.25	2.85	8.70
	Seteria verticillata (L.) P. Beauv.	0.76	5.00	0.93	6.11	15.22
	Sorghum halepense (L.) Pers.	2.70	3.88	1.40	2.02	69.57
Portulacaceae	*Portulaca oleracea* L.	1.54	2.14	1.74	2.43	71.74
Solanaceae	*Physalis angulata* L.	0.26	1.18	0.18	0.81	21.74
Zygophyllaceae	*Tribulus terrestris* L.	0.01	0.50	0.00	0.13	2.17

Abbreviations: OCA: Overall Coverage Area, SCA: Special Coverage Area.

Considering the family distribution of the identified species; Poaceae 7, Malvaceae 3 Euphorbiaceae, Amaranthaceae, Asteraceae and Convolvulaceae 2, and eight other families were represented by one species (Figure 2). Among the species detected in the corn fields, the most common species was purple nutsedge (*Cyperus rotundus*), which was seen in 84.8% of the fields. Barnyard grass (*Echinochloa crus-galli*) with 76.1%, purslane (*Portulaca oleracea*) with 71.7%, and Johnsongrass (*Sorghum halepense*) with 69.6% followed that, respectively (Figure 3). Similarly, Hançerli & Uygur (2017), was reported that purple nutsedge (*C. rotundus*) is the most widespread weed species in the corn cultivation areas of the Çukurova Region, which has very similar climate characteristics with Antalya province. Purple nutsedge has emerged as one of the most important weed species in Antalya as a weed that can grow very well in tropical and subtropical regions, likes water and has adapted to the vegetation of corn.

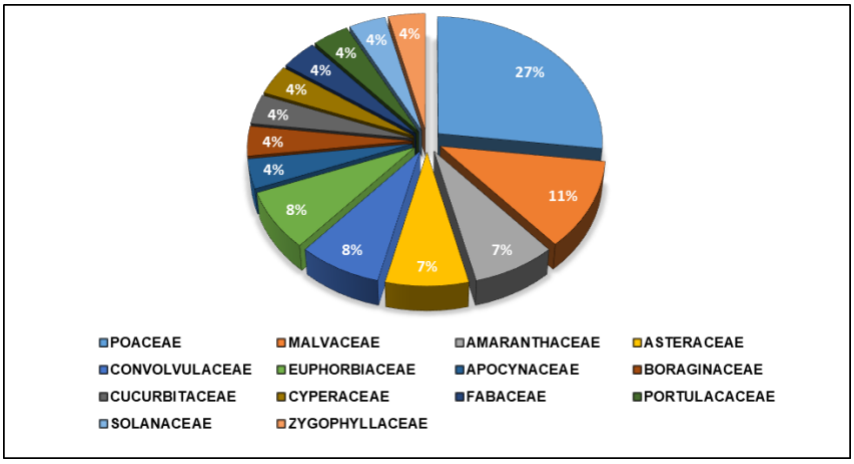

Figure 2. Proportional distribution of identified weed species to families.
Şekil 2. *Belirlenen tür sayılarının familyalara göre oransal dağılımı.*

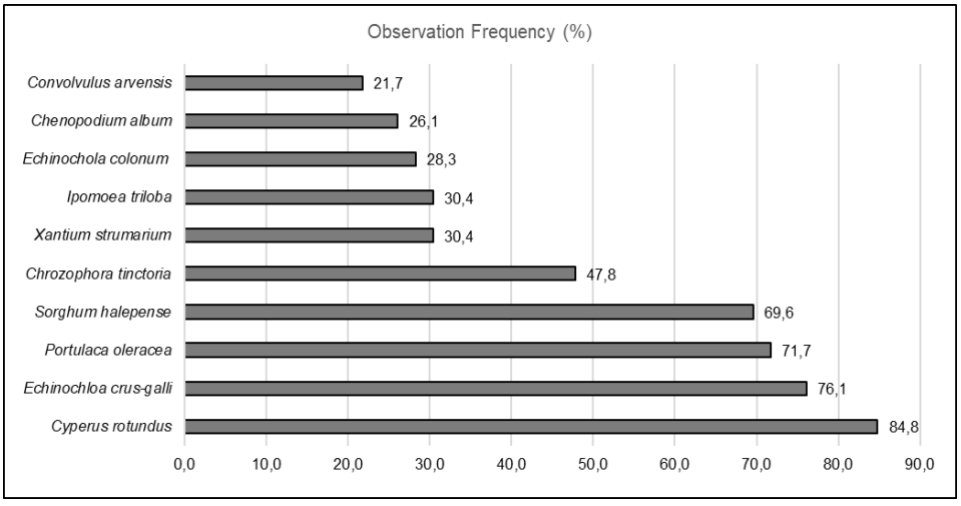

Figure 3. The frequency of the top 10 species encountered in the corn fields of Antalya province.
Şekil 3. *Antalya ili mısır tarlalarında en çok karşılaşılan ilk 10 türün rastlama sıklığı.*

According to the coverage values of weeds seen in the corn fields of Antalya province; It was observed that the species with the highest coverage area was *C. rotundus* with 3.6%, followed by *E. crus-galli* with 3.5%. Johnsongrass (*S. halepense*) came in third place with 2.7% (Figure 4). It has been determined that the weeds seen in the corn fields of the Antalya Plain (Aksu-Serik-Manavgat) cover an average of 18.7% of the fields.

In terms of density, *E. crus-galli* took the first place with an average of 6.9 plants m^{-2}, while *C. rotundus* ranked second with 4.4 plant m^{-2}. *P. oleracea* (1.7 plant m^{-2}) and *I. triloba* (1.6 plant m^{-2}) took the third and fourth rows, respectively. (Table 2). It was determined that the general average weed density in the corn fields of Antalya province was as high as 21.5 plants per square meter. When considering both the frequency of occurrence and the values of coverage area and density in Antalya province, it was observed that the top five most important weed species causing problems in corn fields are *C. rotundus, E. crus-galli, S. halepense, P. oleracea,* and *I. triloba*. The species *Chrozophora tinctoria* and *Setaria verticillata* followed these species. With the exception of the *I. triloba* species, the weed species mentioned above have been identified as important species in many studies conducted in corn cultivation areas in Türkiye (Kaçan et al., 1997; Mennan & Işık, 2003; Güngör, 2005; Hançerli & Uygur, 2017; Arslan, 2018; Turan, 2019; Alptekin et al., 2023; Tepe, 2023).

In Türkiye, a species *Ipomoea triloba*, known as pink ivy by the farmers in Antalya, which is referred to as the morning glory and laughing flowers, has been causing problems in summer crops (particularly cotton) grown in fields of the Antalya province (Özkil et al., 2019; Arslan & Kitiş, 2021). This ivy species which is invasive character was officially recorded for the first time by Yazlık et al. in 2014. The species, which has increased its prevalence and density in the last 10 years, has taken its place among the top five most important weed species in the corn fields in Antalya province today.

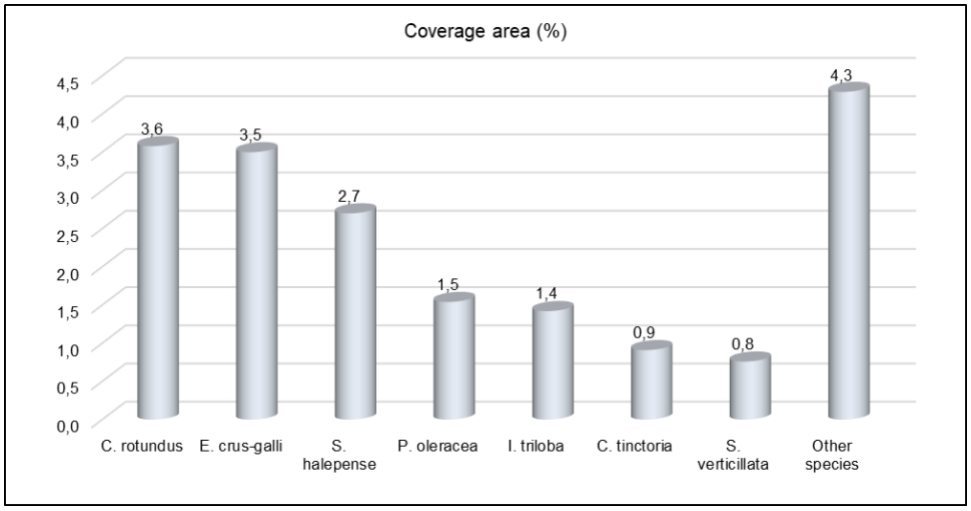

Figure 4. General coverage of weed species identified in corn fields in Antalya province.

Şekil 4. *Antalya ili mısır tarlalarında saptanan yabancı ot türlerinin genel kaplama alanı.*

The species, which has a very fast and aggressive growth feature, clings to the crops in a very short time if it is not controlled in time (Figure 5).

Figure 5. Infestation status of *I. triloba* in corn field in Antalya province (Aksu district-2020).

Şekil 5. *Antalya ilinde mısır tarlasında I. triloba'nın istila durumu (Aksu ilçesi-2020).*

For this reason, mechanical control can also be quite difficult. Three-lobe morning glory is a species that reproduces by seed and can make more than once emergence during a vegetation period, especially depending on irrigation. Due to this feature of the species, *I.triloba* make new emergence despite the herbicides applied in certain periods (Arslan, 2022). This situation also affects corn producers significantly. On the other hand, it is known that the mentioned species continues to spread and threatens other crops. As a matter of fact, in the study conducted by Özkil & Üremiş (2020), it was reported that three-lobe morning glory is also seen in peanut, soybean, eggplant, pomegranate and citrus orchards in the Mediterranean Region, in addition to cotton and corn.

CONCLUSION

As a result, it is seen that the general coverage area (18.7%) and density (21.5 plants m^{-2}) of weeds in the corn cultivation areas of Antalya province are quite high, and it is understood that weed control cannot be done sufficiently and/or effectively. It is thought that the increasing input (plant protection products and fuel oil) costs in recent years also have an effect on this. On the other hand, changing climatic conditions, especially increasing temperatures and variable precipitation regimes cause new and difficult-to-control species such as *I. triloba* to dominate the environment in subtropical regions. This reveals that the currently applied mechanical and chemical methods should be reviewed, new active substances should be registered, or other alternative control methods should be investigated. As an example, flaming could be considered among these alternative methods. This technique is easily applicable, particularly in monocot crops like corn, where the growth point is protected by a sheath. Flame-based weed control can be effectively employed, especially during the early stages of weed emergence and for species that resurface after each irrigation, such as *I. triloba*. I''s worth noting that the number of studies on flame-based weed control in Turkey is relatively limited. However, flaming stands out as one of the most important alternative methods that can be used post-emergence against weed species lacking registered or effective herbicides. Research in this area holds significant importance.

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