Advances in Weed Science
formerly Planta Daninha

Weed species in banana (*Musa* spp.) production systems in Türkiye

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Abstract: Background: Banana (*Musa* spp.) cultivation, has a centaury history in open fields in Mediterranean part of Türkiye has become enlarged for three decades due to benefits of covered production.

Objective: Weed species, their frequencies, distributions and reasons under current techniques and geographical attributes in banana fields and greenhouses were determined to provide data to develop strategies and systems for sustainable weed management and cultivation of banana.

Methods: Weeds and their coverage and densities were determined in banana fields and greenhouses surveying 2% of banana production acreage in 2021–2022.

Results: 68 different species of 25 families were recorded. The most common weed species were *Cardamine occulta*, *Amaranthus retroflexus*, *Portulaca oleracea*, *Conyza canadensis*, and *Oxalis corniculata*. The number of weeds, their coverage and densities in individual fields were not affected significantly by production method (open-field vs greenhouse) or banana cultivars but location. Years and field size affected the number of weed species while homogeneity and cycles affected weed coverage and density. Dominant species in greenhouses were *C. occulta*, *Pilea microphylla*, *O. corniculata*, *Echinochloa crus-galli*, *Setaria verticillata*, and *A. retroflexus* but *Cyperus rotundus*, *S. verticillata*, *O. corniculata*, and *P. oleracea* in open fields. *C. occulta* and *Pilea microphylla* were recorded first time in Türkiye.

Conclusions: The most common species and dominant species in fields are mainly aliens including both neophytes and archeophytes. Greenhouses and production techniques might have effect on weed problem. There are needs for further research on banana weeds including their controls to establish better strategies and control systems in banana management.

Keywords: Mediterranean; Open field; Greenhouse; Alien plants; Banana cycles; *Cardamine occulta* Hornem; *Pilea microphylla* (L.) Liebm

Journal Information:
ISSN - 2675-9462
Website: http://awsjournal.org
Journal of the Brazilian Weed Science Society

How to cite: Torun H, Ozkil M, Üremiş İ, Uyar S, Uludağ A. Weed species in banana (*Musa* spp.) production systems in Türkiye. Adv Weed Sci. 2023;41:e020230004.
https://doi.org/10.51694/AdvWeedSci/2023;41:00016

Approved by:
Editor in Chief: Carol Ann Mallory-Smith
Associate Editor: Carlos Eduardo Schaedler

Conflict of Interest: The authors declare that there is no conflict of interest regarding the publication of this manuscript.

Received: January 27, 2023
Approved: September 11, 2023

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1. Introduction

Bananas (*Musa* spp.), originated from South Asia, are grown by 130 countries, which is led by India (Food and Agriculture Organization of the United Nations, 2023). They are an important produce in agriculture and economy of subtropical and tropical regions of the world. Banana, a cash crop in Türkiye, has produced along the coastal part of the Mediterranean region of Türkiye since the 1930s (Gök, Zaman, 2003). Production, starting on very limited fields has expanded year by year and reached 12,827 ha with 883,455 tons production per year (Turkish Statistical Institute, 2022).

Banana producing area of Türkiye is between 36th and 37th parallels which is the northest point of the banana production of the world. The area has typical Mediterranean climate that is rainy winters and drought summers. Especially temperature difference between day and night and between winter and summer as well as high summer and low winter temperatures is the main challenge in banana cultivation in the region. Open field banana production has almost centaury long history in a line between Mediterranean cost and Taurus mountains, which goes along central district and Anamur district of the Mersin province where foehn winds are common that makes banana growing possible. Banana production in covered environment has over three decades history in the region, which caused expanding banana areas via causing an increase in yield and shortening harvest duration (Gubbuk, Pekmezci, 2004). Covered production was mainly helped avoiding winter frosts that became detrimental from time to time, providing higher temperatures from 14 °C that not happen in late autumn and winter in the region and temperatures banana needs to start growing, and maintaining optimal humidity, 70–80%. On the other hand, under unproper conditions, temperature passes 34 °C that stress in plants start and diseases might be triggered together with higher humidity (Türkay, 2007). Heating is not a common practice; mist systems were used against frost. Drip irrigation and mini sprinklers are common irrigation methods (Sakarkaya, 2022).

Weeds are among the bottlenecks in banana production, which cause yield decrease and affect yield components as well as delay flowering and harvest (Santos et al., 2019). Especially young banana plants more prone to weed competition due to delay at maturity (Isaac et al., 2007). Yield components were negatively affected in weedy plots comparing to plots *Nelsonia canescens* (Lam.) Spreng were used as cover crop where weed density were reduced 60% (Fongod et al., 2010). Furthermore, there were more snails that bother the crop on upper parts of banana in weedy plots (Fongod et al., 2010). *Commelina diffusa* Burm., a weed in banana fields have been used as cover crop to prevent soil erosion; however, it increased nematodes and fungus that cause disease on banana (Isaac et al., 2007).

The studies have showed that many different factors can affect weed flora in banana cultivation from agricultural applications such as weed control and irrigation techniques to geographic, climatic, edafic and agronomic factors (Isaac et al., 2007; Fongod et al., 2010; Moura Filho et al., 2015; Cierjacks et al., 2016; Lanza et al., 2017; Ragas et al., 2019; Quintero-Pertúz et al., 2020; Wang et al., 2023). In order to develop strategies on researches and implementations on weeds in banana cultivation require to find out weed species and their phytosocioligical attributes. So far no a phytosociological study has been conducted in Türkiye except one where in a limited area in western Mediterranean part of Türkiye (Yılmaz et al., 2019).

The aim of current study is to find out weed species in banana cultivation under open field and covered systems in Eastern Mediterranean Region of Türkiye, and discuss possible research and implementation methods for a sustainable banana production.

2. Material and Methods

Weed surveys in open field and greenhouse banana cultivation at 2% of banana acreage in the Mediterranean region of Türkiye were performed in Adana (Ceyhan, Karataş, Sarıçam, Seyhan, Yumurtalık, and Imamoglu districts), Antalya (Alanya, Gazipaşa and Manavgat districts), Hatay (Arsuz and Erzin districts), and Mersin (Akdeniz, Anamur, Aydıncık, Bozyazı, Erdemli, Silifke, and Tarsus districts) in 189 fields from the beginning of April to end of September in 2021 and 2022 (Table 1).

The climate of area is typical Mediterranean climate with hot and dry summers and rainy and warm winters (Figure 1). The average temperature which was 17.3 °C for 1991–2020 period increased 0.6 °C and 0.9 °C in 2021 and 2022, respectively (Turkish State Meteorological Service, 2021; 2022). Many parts of the region have received more precipitation around 10–20% in 2021 and 2022 comparing to long term averages although drought in low levels was seen in some parts (Turkish State Meteorological Service, 2021; 2022).

Banana fields were chosen randomly but proportional acording to district acreages. The area of field, production method (open field/covered), production cycles, and banana cultivar were recorded. In each field, five1m^2 areas were chosen as sampling points which were determined randomly. In each sampling point, plant species were recorded, their coverage (%) estimated, and individuals of each species were counted. The coverage (%) and density (individual in a squaremeter) of a species for a field were calculated as average of data in five sampling points and presented. Homogenity of weediness (%) for

Table 1 - Banana production areas in the Mediterranean region of Türkiye (Turkish Statistical Institute, 2022), and sampled area

Provinces	Banana Cultivation Area in 2020 (ha)	Studied fields	
		Area (ha)	The number of fields
Adana	280.7	89.0	38
Antalya	5,067.6	46.2	29
Hatay	112.1	16.5	20
Mersin	5,637.1	68.2	102
Covered	-	188.2	165
Open field	-	31.7	24
TOTAL	11,097.5	219.9	189

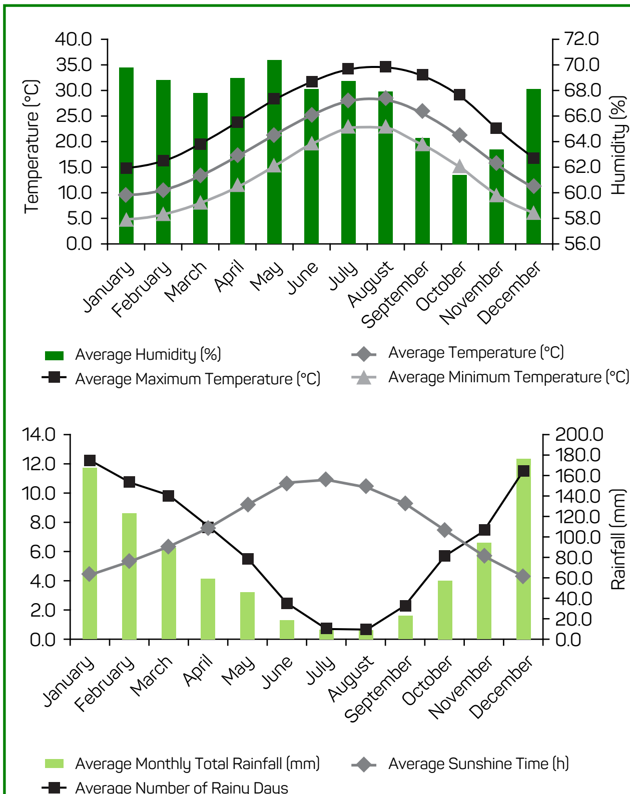

Figure 1 - Climatic features of the survey area (the graphs were drawn using Korkmaz, Fakı, 2009; Duran, Günek, 2010; Aksu, 2016; Işık et al., 2016; Karaca, 2021; Karakuş and Selim, 2022; Turkish State Meteorological Service, 2023)

a field were calculated weed occurred points out of five sampling points. Weed species were determined mainly using Flora of Turkey by Davis (1965-1988) although online resources and newer literature were used as well. In addition, weeds were presented according to their families and cotyledon types.

Using the data, distribution of weed species were calculated for a given area such as total survey area, a district, a production method, or a province etc. and presented as frequency (%), which shows the percentage of fields that a species were determined regarding to given area. For instance:

$$F_g = N_d/N_t*100$$

$$F_f=N_{do}/N_{to}*100$$

$$F_g=N_{dg}/N_{tg}*100$$

Where F_g, F_o or F_g are frequency of an individual species as percentage in given area as all fields, open fields or greenhouses, respectively; N_d, Nd or N_{dg} are the number of all fields, open felds or greenhouses that an individual species was detected; N_t, N_{to} or N_{tg} was the number of surveyed total fields, total open fields or total greenhouses.

The number of plant species, the number of monocot and dicot plants, percent coverages and density of weed species from each sampled field were analyzed using box-plot graphs and correlation among these five parameteres were calculated with R software. Data were analyzed using non-metric multidimensional scaling plot (NMDS) using R software. Five parameters (the number of species, the number of dicots, the number of monocots, weed density, and weed covarage in each field) against factors that are survey year (2021 vs 2022), province (Adana, Antalya, Mersin, Hatay), District (Ceyhan, Karataş, Sarıçam, Seyhan, Yumurtalık, Imamoglu, Alanya, Gazipaşa, Manavgat, Arsuz, Erzin Akdeniz, Anamur, Aydıncık, Bozyazı, Erdemli, Silifke, Tarsus), Cultivars (Alata Azman, Azman, Bodur Azman, Grand Nain, Şimşek, Cavendish), Method (open field vs greenhouse), Size (smaller than 0.5 ha (Small), upto 1 ha (Lower Medium), upto 2 ha (Upper Medium), over 2 ha (Large)), homogenty of weeds in individual field (No, Medium, High), cycles (No, Same, Renewed).

3. Results and Discussion

In the study, 68 weed species from 25 families were determined in banana fields: Poaceae with 13 species followed by Amaranthaceae with 7 species, and Euphorbiaceae with 6 species (Table 2). In Colombia, 204 weed species from 54 families were reported with Poaceae as the most dominant family with 31 species followed by Fabaceae and Asteraceae (Quintero-Pertúz et al., 2020), which were also prominent families following to first three ranked ones in the current study. Maybe larger study area and climatic and geographic conditions in Colombia caused higher number of weed species and families. In other studies, in narrower areas in Brazil, Poaceae and Fabaceae were also dominant families (Sarmento et al., 2015; Moura Filho et al., 2015). In the studies with different crops having similar durations with banana in the same region, 59 to 96 weed species belonging to 26 to 30 families were reported (Üremiş et al., 2013; Soylu et al., 2017; Özkil et al., 2019; Üremiş et al., 2020).

The most common weed species were CAROC (51.32%), AMARE L. (48.68%), POROL (34.92%), ERICA (30.16%), and OXACO (30.16%) in general (Table 2). CAROC (58.79%), AMARE (47.88%), and OXACO (32.12%), ERICA (30.91%), POROL (30.91%) and PILMI (29.09%) had the highest frequency in greenhouses while POROL (62.50%) AMARE (54.17%), SETVE (41.67%), AMASP (33.33%), EPHPT (33.33%) in open fields. Except POROL and SETVE, all other most common species are alien to Mediterranean Basin. Both arceophytes such as AMARE and neophytes such as OXACO and PILMI were among highly distributed species although the number of native species were higher. There were more species in greenhouse production than open field. It is possible greenhouse creates an environment suitable for plant growth and/or visiting more greenhouses than open fields for banana production

The number of species were 39 with the highest or the second highest coverage in greenhouses, which CAROC in 82 greenhouses, PILMI (34), OXACO (30), ECHCG (23), SETVE (20), AMARE (17) were in over 10% of visited greenhouses. In the case of density per squaremeter, 40 different species were with highest or the second highest density in greenhouses. CAROC in 61 greenhouses, PILMI (36), AMARE (29), SETVE (20), OXACO (19), ECHCG (19) were record as the most densely populated in greenhouses. Only rank for species were changed comparing to coverage and density. Most of the remaining species with dominance in a greenhouse as either coverage or density has less than in 5 greenhouses.

Less open field were visited due to the smaller number of fields and 17 species were recorded for coverage and 16 species for density for the highest two ranks. Species were recorded in three or more fields were POROL (8), SETVE (7), CYPRO (5), AMASP (3), DIGSA (3) and ERICA (3) for coverage, and CYPRO (6), SETVE (6), OXACO (4), POROL (4), DIGSA (3) and MEDSS (3) for density. The species, DIGSA and SETVE. with highest density or coverage in greenhouses are mainly neophyta except two grass species. It shows new and advanced technologies have driven invasion by plants in agriculture, which implies establishment of stronger quarantine measures and early warning systems.

Comparing to all fields, the median of the number of weed species in a field was 6 (1–15) but most of the fields had species between 4–7 (Figure 2). Mostly fields had

Table 2 - Weed species in banana fields in the Mediterranean region for Türkiye and their frequencies

Family	Weed species	EPPO Code	Frequency (%)		
			General	Greenhouse	Open field
Amaranthaceae	*Amaranthus albus* L.	AMAAL	4.76	4.24	8.33
	Amaranthus graecizans L.	AMAGR	0.53	0.61	-
	Amaranthus retroflexus L.	AMARE	48.68	47.88	54.17
	Amaranthus spinosus L.	AMASP	5.82	1.82	33.33
	Amaranthus viridis L.	AMAVI	6.88	7.27	4.17
Asteraceae	*Conyza canadensis* (L.) Cronquist	ERICA	30.16	30.91	25.00
	Senecio vernalis Waldst. & Kit.	SENVE	2.12	1.21	8.33
	Sonchus oleraceus L.	SONOL	16.40	23.03	20.83
	Xanthium strumarium L.	XANST	1.59	1.82	-
Boraginaceae	*Buglossoides arvensis* (L.) I.M.Johnst.	LITAR	1.06	1.21	-
	Heliotropium europaeum L.	HEOEU	4.23	1.82	20.83
Brassicaceae	*Capsella bursa-pastoris* (L.) Medik.	CAPBP	1.59	1.82	-
	Cardamine occulta Hornem.	CAROC	51.32	58.79	-
	Sinapis arvensis L.	SINAR	0.53	0.61	-
Caryophyllaceae	*Stellaria media* (L.) Vill.	STEME	5.29	6.06	-
Chenopodiaceae	*Chenopodium album* L.	CHEAL	21.69	23.64	8.33
	Chenopodium vulvaria L.	CHEVU	1.06	1.21	-
Convolvulaceae	*Convolvulus arvensis* L.	CONAR	12.17	12.12	12.50
	Ipomoea triloba L.	IPOTR	2.65	3.03	-
Cucurbitaceae	*Cucumis melo* var. *agrestis* Naudin	CUMMG	2.65	3.03	-
Cyperaceae	*Cyperus rotundus* L.	CYPRO	15.87	13.94	29.17
Equisetaceae	*Equisetum arvense* L.	EQUAR	2.65	2.42	4.17
Euphorbiaceae	*Chrozophora tinctoria* (L.) A.Juss.	CRZTI	1.06	1.21	-
	Euphorbia chamaesyce L.	EPHCH	0.53	0.61	-
	Euphorbia helioscopia L.	EPHHE	2.12	1.82	4.17
	Euphorbia nutans Lag.	EPHNU	6.88	3.03	33.33
	Euphorbia prostrata Aiton	EPHPT	4.23	4.24	4.17
	Mercurialis annua L.	MERAN	8.47	5.45	29.17
Fabaceae	*Medicago* spp.	MEDSS	7.41	6.67	12.50
	Melilotus officinalis (L.) Lam.	MEUOF	5.82	6.67	-
	Trifolium spp.	TRFSS	2.12	2.42	-
	Vicia sativa L.	VICSA	1.06	1.21	-
Geraniaceae	*Geranium dissectum* L.	GERDI	1.06	1.21	-
Lamiaceae	*Lamium amplexicaule* L.	LAMAM	2.65	3.03	-
Malvaceae	*Malva* spp.	MALSS	16.93	18.18	8.33
Oxalidaceae	*Oxalis corniculata* L.	OXACO	30.16	32.12	16.67
Papaveraceae	*Fumaria officinalis* L.	FUMOF	0.53	0.61	-
	Papaver rhoeas L.	PAPRH	0.53	0.61	-
Plantaginaceae	*Kickxia* spp.	KICSS	1.06	1.21	-
	Veronica anagallis-aquatica L.	VERAA	2.12	2.42	-

Continue

Continuation

Family	Weed species	EPPO Code	Frequency (%)		
			General	Greenhouse	Open field
Plantaginaceae	*Veronica arvensis* L.	VERAR	6.88	7.88	-
	Veronica hederifolia L.	VERHE	1.06	1.21	-
	Veronica montana L.	VERMO	1.59	1.82	-
Poaceae	*Cynodon dactylon* (L.) Pers.	CYNDA	1.06	1.21	-
	Dactyloctenium aegyptium (L.) Willd.	DTTAE	1.59	0.61	8.33
	Digitaria sanguinalis (L.) Scop.	DIGSA	13.76	12.73	20.83
	Echinochloa colonum (L.) Link	ECHCO	6.88	7.27	4.17
	Echinochloa crus-galli (L.) P.Beauv.	ECHCG	22.75	24.85	8.33
	Eleusine indica (L.) Gaertner.	ELEIN	3.70	4.24	-
	Paspalum paspalodes (Michx.) Scribn.	PASDS	1.06	1.21	-
	Phalaris spp.	PHASS	0.53	0.61	-
	Poa annua L.	POAAN	3.70	4.24	-
	Poa trivialis L.	POATR	1.06	1.21	-
	Setaria verticillata (L.) P.Beauv.	SETVE	28.57	26.67	41.67
	Setaria viridis (L.) P.Beauv.	SETVI	5.29	6.06	-
	Sorghum halepense (L.) Pers.	SORHA	2.12	1.82	4.17
Polygonaceae	*Polygonum aviculare* L.	POLAV	3.70	3.64	4.17
	Polygonum lapathifolium L.	POLLA	0.53	0.61	-
	Rumex spp.	RUMSS	0.53	0.61	-
Portulacaceae	*Portulaca oleracea* L.	POROL	34.92	30.91	62.50
Primulaceae	*Anagallis arvensis* L.	ANGAR	2.12	2.42	-
Ranunculaceae	*Ranunculus* spp.	RANSS	5.82	6.67	-
Solanaceae	*Physalis angulata* L.	PHYAN	6.35	7.27	-
	Solanum nigrum L.	SOLNI	18.52	18.18	20.83
Urticaceae	*Parietaria judaica* L.	PAIDI	14.81	13.94	20.83
	Pilea microphylla (L.) Liebm.	PILMI	25.40	29.09	-
	Urtica urens L.	URTUR	12.70	13.33	8.33
Zygophyllaceae	*Tribulus terrestris* L.	TRBTE	2.12	2.42	-

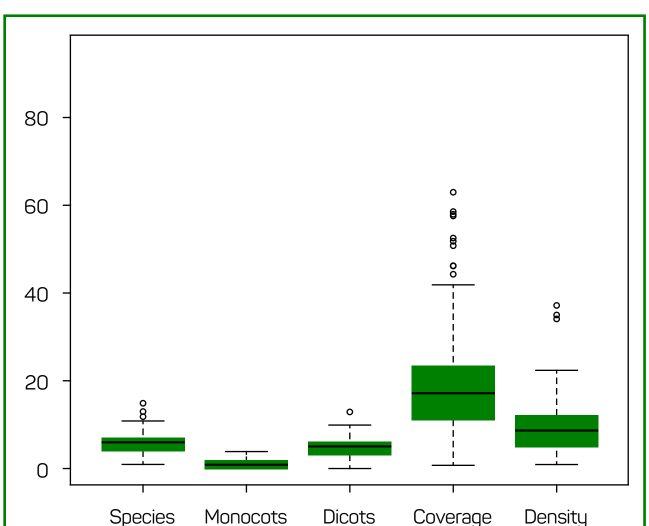

Figure 2 - Distribution of weed parameters

up to 2 monocotyledon species although Poaceaae had the highest number of species in all survey area. Weed density per square meter was 8.80 individulas (median), which has reached to 37.20. The weed coverage mainly changed between 11.00% to 23.60% although there were fields covered with weeds up to 95.00%, means all field were weedy.

The weed parameters measured correlated in varying ways (Figure 3). The number of species correlated strongly with the number of dicotyledon species but less with monocotyledons. Weed coverage correlated with dicotyledons as expected. Weed density and weed coverage had high correlation as well.

The fields have two patterns in NMDS plot, but it was not possible to drove a concrete conclusion. Weed density and coverage had exactly same direction and power while the number of monocotyledon weeds did not show similar

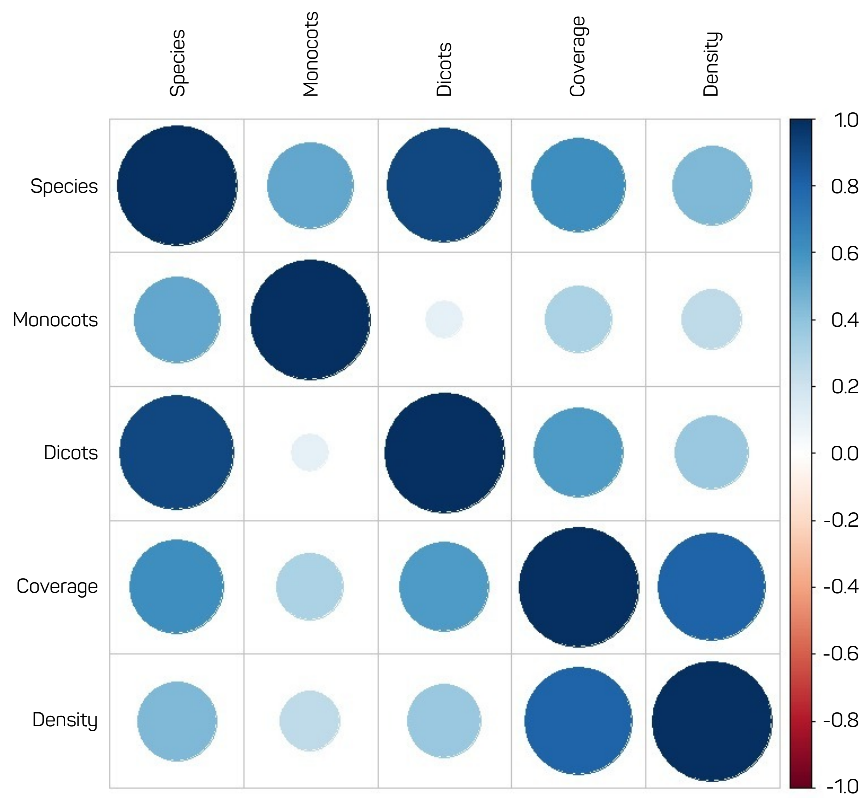

Figure 3 - Correlation among measured weed parameters

distribution with the number of dicotyledons or total weed species (Figure 4).

Growing method for banana (open field vs greenhouse) or banana cultivars did not significantly affect any weed parameters measured but location especially districts level (Table 3; Figure 5). The median density in fields varied between 4.60 (Gazipaşa and Karaisalı districts) and 14.60 (Yumurtalık district). For weed coverage and the number of weed species changes were between 10.20 and 4.50 (Bozyazı) to 41.80 and 13.00 (Manavgat) (Data not presented).

AMARE was the most common species in two provinces, Adana and Hatay, CAROC in Mersin where has oldest banana fields and largest banana production area, and POROL in Antalya where has another largest banana area. The highest frequency of AMARE was recorded in Adana (63.16%) and Hatay (65.00%), CAROC in Mersin (58.82%), and POROL in Antalya (65.52%) (Table 4).

The other four factors have affected some parameters (Table 3). Year and field size significantly affected density and coverage while homogenity of weeds in field and growing cycles affected the number of species mainly (Table 2; Figure 6).

The crop cycles were grouped in three catagories. No-cycle (N) refers annually planted banana which is common in open field and applied in greenhouses as well; same banana root kept and used generally upto five years was denoted "S"; and root were renewed more than one times was showed as "R". Weed density and coverage were higher in greenhouses in R categories (Table 3; Figure 6). Only greenhouses with different crop cycling compared for the number of weed species. There were 62 species no-cycle (N) greenhouses or in the first year of its cycles but the number of species decreased to 37 in greenhouses applying renewed cycles system (R) (Table 5).

4. Conclusions

The weeds in open field are very similar to the other crops grown in the region but new species such as CARCO and PIMID have dominant in greenhouse banana production. There is no clue how these species have reached in the area although PIMID could be an escape from ornamental plant production or from houses. The muddy, warm and humid environment in banana greenhouses might be supporting increase and spread of

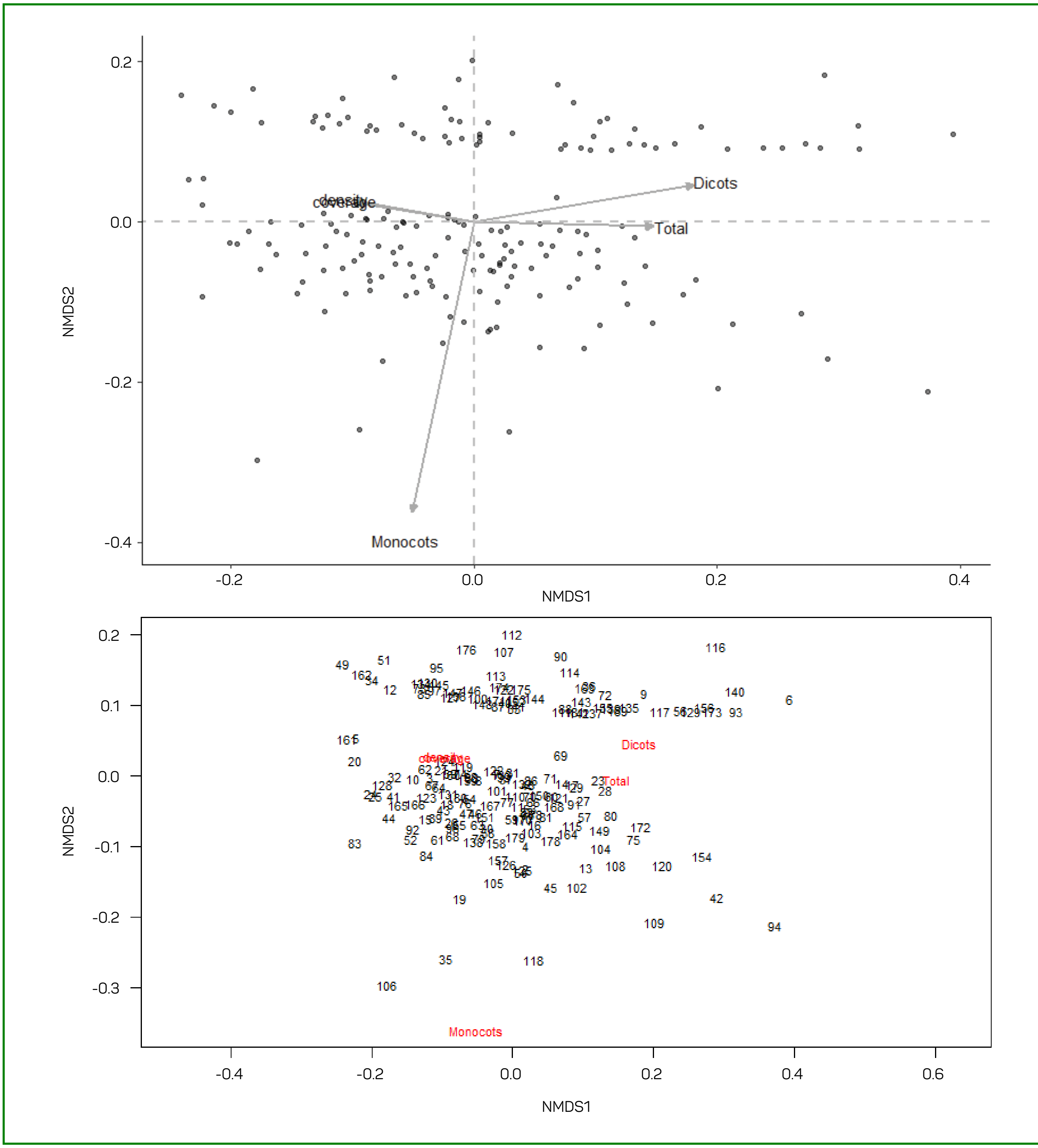

Figure 4 - The distribution for fields and measured weed parameters under the influence of field factors

Table 3 - Effect of field factors on weed parameters in banana areas

Factors	Density	Covarage	Total/ Species	Dicots	Monocots
Year	NS	NS	*	NS	***
Province	NS	***	***	***	**
District	**	***	***	**	*
Method	NS	NS	NS	NS	NS
Cultivars	NS	NS	NS	NS	NS
Size	NS	NS	**	*	**
Homogenity	***	***	NS	**	NS
Cycles	**	NS	NS	NS	NS

Level of significance p<0.05 (*), p<0.01 (**) and p <0.001 (***)

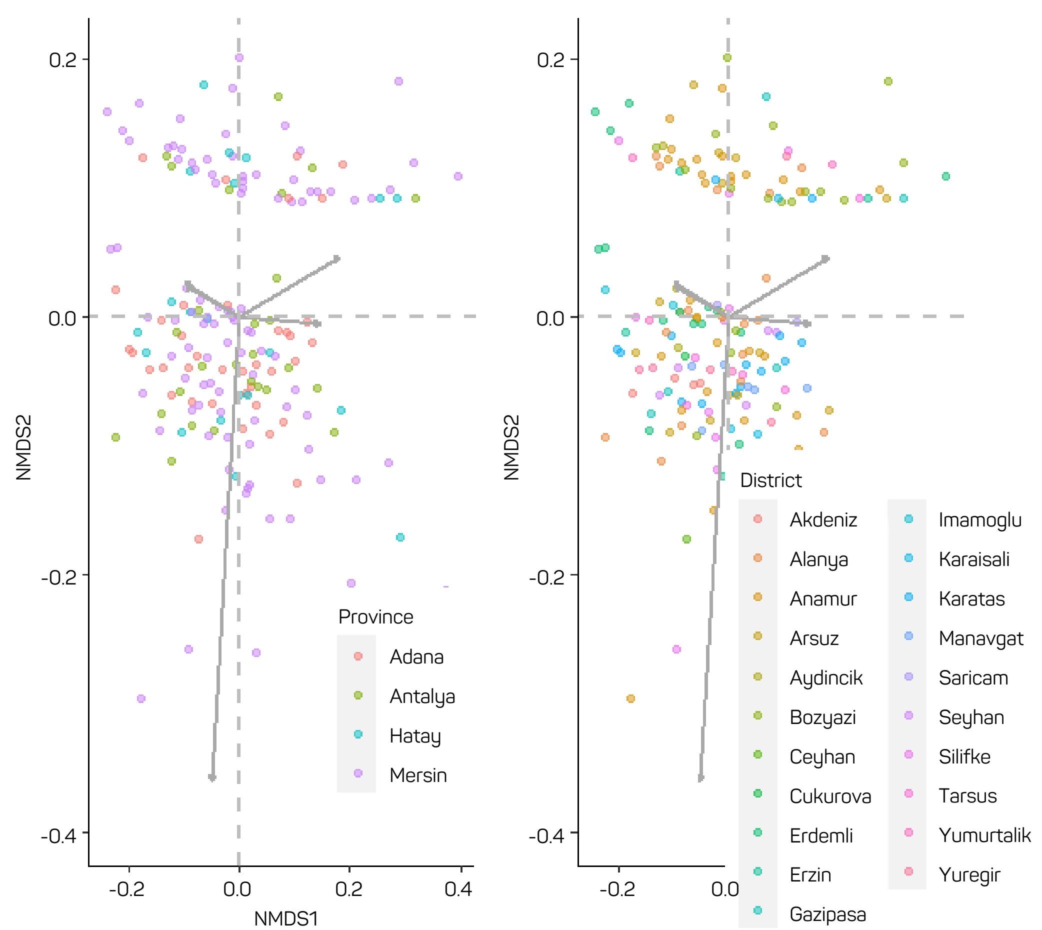

Figure 5 - Effect of location (provinces and districts) on five weed parameters measured

Table 4 - The most frequent speciesaccording to provinces provinces

Provinces	Weed species	Frequency (%)
Adana	AMARE	63.16
	ERICA	60.53
	POROL	52.63
	CAROC	44.74
	CHEAL	42.11
	ECHCG	36.84
Antalya	POROL	65.52
	AMARE	62.07
	CYPRO	37.93
	CAROC	34.48
	AMASP	34.48
	SETVE	31.03
Hatay	AMARE	65.00
	CHEAL	50.00
	CAROC	50.00
	SETVE	35.00
	ECHCG	30.00
	MALSS	30.00
Mersin	CAROC	58.82
	OXACO	41.18
	PILMI	37.25
	AMARE	36.27
	SETVE	25.49
	ERICA	24.51

these species. In addition, open field production evolved annual cycles system to prevent diseases which ended up more tillages and open area for dry warm mountain wind. In greenhouse production banana roots were kept around five years (cycles) and renewed roots after 5 years have kept many years.

This is a second study but more comprehensive than earlier one. Now, weed problems are clearer, which show more research needed to find out solutions. Labor based family farms rely on mechanical and chemical weed control, which should be improved. Manure use a common practice that needs to be applied carefully. These issues make farmer training necessary and find out farmers' profiles and their views on weed control to be able to draw a strategy and find out weed management systems.

5. Author's contributions

HT, MÖ, İÜ, and AU: conceptualization of the manuscript and development of the methodology. HT and MÖ: data collection and curation. HT, MÖ, İÜ, SU and AU: data analysis. HT, MÖ, İÜ, and AU: data interpretation. HT and MÖ: funding acquisition and resources. HT and MÖ: project administration. İÜ and AU: supervision. HT and MÖ: writing the original draft of the manuscript. HT and AU: writing the first revised version. HT, MÖ, İÜ, and AU: writing, review and editing. All authors read and agreed to the published version of the manuscript.

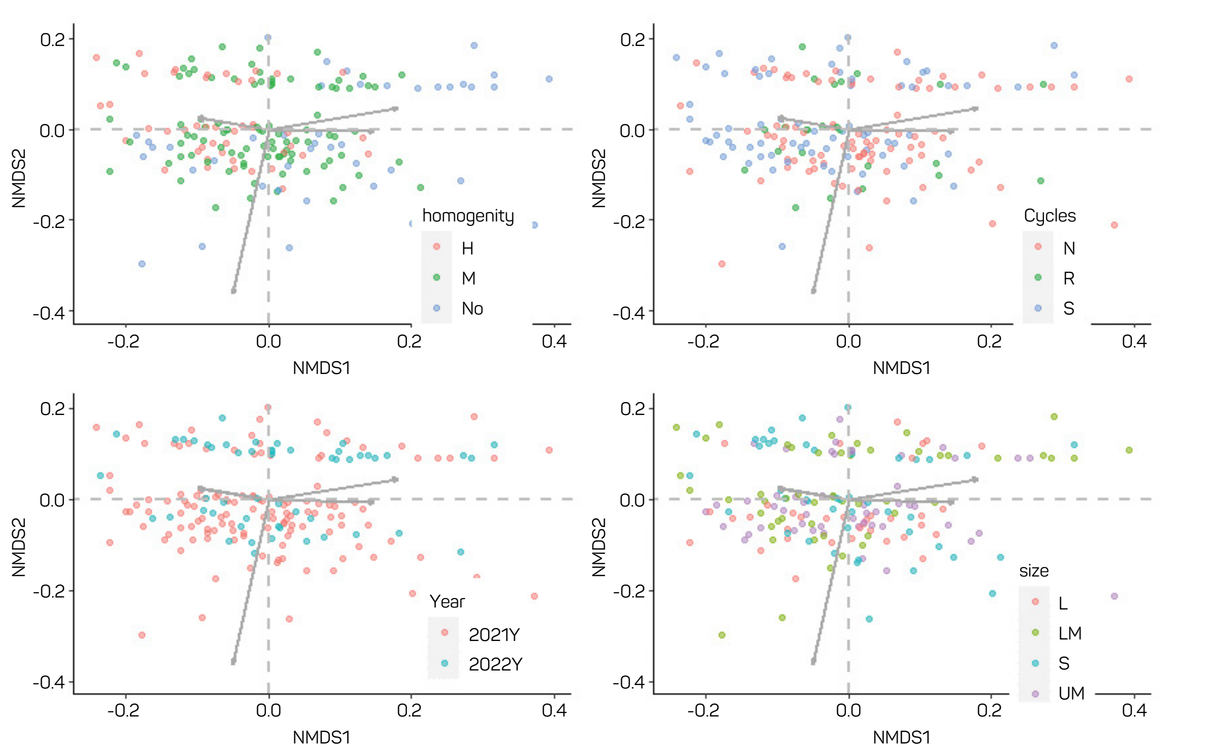

Figure 6 - Effect of different factors on five weed parameters measured

Table 5. The frequency of the weed species in banana greenhouses in the Mediterranean region			
Weed species	Cycles and Frequency (%)		
	N	S	R
AMAAL	8.70	1.89	-
AMAGR	-	-	2.33
AMARE	40.58	49.06	58.14
AMASP	1.45	1.89	2.33
AMAVI	14.49	3.77	-
ANGAR	4.35	-	2.33
LITAR	2.90	-	-
CAPBP	1.45	3.77	-
CAROC	49.28	71.70	58.14
CHEAL	21.74	15.09	37.20
CHEVU	1.45	1.89	-
CRZTI	1.45	1.89	-
CONAR	7.25	20.75	9.30
ERICA	36.23	32.08	20.93
CUMMG	4.35	1.89	2.33
CYNDA	2.90	-	-
CYPRO	18.84	11.32	9.30
DTTAE	1.45	-	-
DIGSA	8.70	11.32	20.93
ECHCO	10.14	5.66	4.65
ECHCG	26.09	22.64	25.58
ELEIN	1.45	7.55	4.65
EQUAR	-	5.66	2.33
EPHCH	-	1.89	-
EPHHE	1.45	1.89	2.33
EPHNU	2.90	1.89	4.65
EPHPT	5.80	5.66	-
FUMOF	1.45	-	-
GERDI	2.90	-	-
HEOEU	4.35	-	-
IPOTR	4.35	3.77	-
KICSS	2.90	-	-
LAMAM	7.25	-	-
MALSS	20.29	20.75	11.63
MEDSS	4.35	5.66	11.63
MEUOF	8.70	5.66	4.65
MERAN	5.80	3.77	6.98
OXACO	26.09	37.74	34.88
PAPRH	1.45	-	-
PAIDI	14.49	16.98	9.30

Continue

Continue

Weed species	Cycles and Frequency (%)		
	N	S	R
PASDS	2.90	-	-
PHASS	1.45	-	-
PHYAN	11.59	5.66	2.33
PILMI	18.84	41.51	30.23
POAAN	5.80	-	6.98
POATR	-	1.89	2.33
POLAV	4.35	5.66	-
POLLA	-	1.89	-
POROL	36.23	26.42	27.91
RANSS	7.25	7.55	4.65
RUMSS	-	1.89	-
SENVE	2.90	-	-
SETVE	21.74	28.30	32.56
SETVI	5.80	5.66	6.98
SINAR	1.45	-	-
SOLNI	15.94	18.87	20.93
SONOL	21.74	11.32	11.63
SORHA	4.35	-	-
STEME	4.35	5.66	9.30
TRBTE	4.35	1.89	-
TRFSS	2.90	1.89	2.33
URTUR	13.04	9.43	18.60
VERAA	5.80	-	-
VERAR	5.80	9.43	9.30
VERHE	2.90	-	-
VERMO	2.90	1.89	-
VICSA	2.90	-	-
XANST	4.35	-	-

6. Acknowledgements

Authors Thank to Professor Necmi Aksoy to identifying some species and Professor Fatih Kahraman for sharing his knowledge on statistics.

7. Funding

This study was financially supported by the Republic of Türkiye, Ministry of Agriculture and Forestry, General Directorate of Agricultural Research and Policies (TAGEM/BSAD/B/21/A2/P1/2562).

References

Aksu HH. [Geographical information systems (GIS) based distribution of relative humidity in Adana, Turkey]. Proceedings of International Geography Symposium; October 13, 2016; Ankara, Turkey. 2016. p 845-58. Turkish.

Cierjacks A, Pommeranz M, Schulz K, Almeida-Cortez J. Is crop yield related to weed species diversity and biomass in coconut and banana fields of northeastern Brazil? Agric Ecosys Env. 2016;220:175-83. Available from: https://doi.org/10.1016/j.agee.2016.01.006

Davis PH, editor. Flora of Turkey and the East Aegean Islands. Edinburgh: Edinburgh University; 10 Volumes, 1965-1988.

Sarmento HGSS, Campos Filho JM, Aspiazú I, Rodrigues TM, Ferreira EA. [Phytosociological survey of weeds in banana plantations in the Gorutuba River Valley, northern Minas Gerais]. Rev Agroamb. 2015;9(3):308-16. Portuguese. Available from: https://doi.org/10.18227/1982-8470ragro.v9i3.2314

Duran C, Günek H. [Effects of the ecological factors on vegetation in river basins of northern part of Mersin city (South of Turkey)]. Biol Div Conserv. 2010;3(3):137-52. Turkish.

Food and Agriculture Organization of the United Nations – FAO. Crops and livestock products. Faostat. 2023[access May 31, 2023]. Available from: https://www.fao.org/faostat/en/#data/QCL/visualize

Fongod AGN, Focho DA, Mih AM, Fonge BA, Lang PS. Weed management in banana production: the use of *Nelsonia canescens* (Lam.) Spreng as a nonleguminous cover crop. Afr J Envir Sci Technol. 2010;4(3):167-73. Available from: https://doi.org/10.5897/AJEST09.154

Gök Y, Zaman S. [The geographical foundations of banana production in Anamur]. East Geogr Rev. 2003;9:183-208. Turkish.

Gubbuk H, Pekmezci M. Comparison of open–field and protected cultivation of banana (*Musa* spp. AAA) in the coastal area of Turkey. New Zealand. J Crop Horticult Sci. 2004;32(4):375-78. Available from: https://doi.org/10.1080/01140671.2004.9514318

Isaac WP, Brathwaite RAI, Cohen JE, Bekele I. Effects of alternative weed management strategies on *Commelina diffusa* Burm. infestations in Fairtrade banana (*Musa* spp.) in St. Vincent and the Grenadines. Crop Protect. 2007;26(8):1219-25. Available from: https://doi.org/10.1016/j.cropro.2006.10.019

Işık M, Aydinşakir K, Dinç N, Büyüktaş N, Tezcan A. [Evaluation of temperature-humidity index values on dairy cattle in Antalya conditions]. Mediterr Agric Sci. 2016;29(1):27-31. Turkish.

Karaca C. [Spatial distribution of heat stress and measures to be implemented on dairy cattle breeding in Hatay climate conditions]. MKU J Agric Sci. 2021;26(3):801-7. Turkish.

Karakuş N, Selim S. [Temporal and spatial distribution of outdoor thermal comfort conditions: The case of Konyaaltı-Antalya, Turkey]. J Grad School Nat App Sci. 2022;13(2):259-69. Turkish.

Korkmaz H, Fakı G. [The climatic features of the Kuseyr Plateau]. MKU J Soc Sci Inst. 2009;6(12):324-50. Turkish.

Lanza TR, Machado AFL, Martelleto LAP. Effect of planting densities of "Brs Princess" banana tree in the suppression of weeds. Planta Daninha 2017;35:1-11. Available from: https://doi.org/10.1590/S0100-83582017350100054

Turkish State Meteorological Service. [Climate assessment for 2021]. Ankara: Ministry of Environment, Urbanization and Climate Change; 2021. Turkish.

Turkish State Meteorological Service. [Climate assessment for 2022]. Ankara: Ministry of Environment, Urbanization and Climate Change; 2022. Turkish.

Turkish State Meteorological Service. [Cities & holiday resorts]. Ankara: Ministry of Environment, Urbanization and Climate Change; 2023[access Aug 04, 2023]. Turkish. Available from: https://www.mgm.gov.tr/veridegerlendirme/il-ve-ilceler-istatistik.aspx?k=A

Moura Filho ER, Macedo LPM, Silva ARS. [Phytosociological survey of weeds in banana]. Holos. 2015;31(2):92-7. Portuguese.

Özkil M, Torun H, Eymirli S, Üremiş İ, Tursun N. [Determination of weed frequencies and densities in sunflower (*Helianthus annuus* L.) fields in Adana province]. MKU J Agric Sci. 2019;24(2):87-96. Turkish.

Quintero-Pertúz I., Carbonó-Delahoz E, Jarma-Orozco A. Weeds associated with banana crops in magdalena department, Colombia. Planta Daninha. 2020;38:1-13. Available from: https://doi.org/10.1590/S0100-83582020380100015

Ragas REG, Mangubat JR, Rasco ET. Weed density and diversity under two weed management practices in sloping lands of banana plantation in Davao City, Philippines. Mindanao J Sci Technol. 2019;17:167-82.

Sakarkaya M. [Structural investigation of modern bannas greenhouse established in eastern mediterranean region] [thesis]. Sarıçam: University of Çukurova; 2022. Turkish.

Santos GC, Maia VM, Aspiazú I, Pereira MCT, Donato SLR, Nobre, DAC (2019). Weed interference on 'Prata-Anã' banana production. Planta Daninha 2019;37:1-9. Available from: https://doi.org/10.1590/S0100-83582019370100150

Soylu S, Sertkaya E, Üremiş İ, Bozkurt İA, Kurt Ş. [Prevalence and incidence of important disease agents, insects and weed species in lettuce (*Lactuca sativa* L.) growing fields in Hatay Province]. MKU J Agric Fac. 2017;22(1):23-33. Turkish.

Turkish Statistical Institute – TUIK. [Crop production statistics]. Ancara: Turkish Statistical Institute; 2022[access Nov 23, 2022]. Turkish. Available from: https://biruni.tuik.gov.tr/medas/?kn=92&locale=tr

Türkay C. [The determination of natural ventilation efficiency and chatacteristics in banana greenhouse in Anamur region] [thesis]. Sarıçam: University of Çukurova; 2007. Turkish.

Üremiş İ, Sertkaya E, Sertkaya G, Yıldırım AE. [Determination of Weed Species and Their Frequency and Density in Apricot Orchards in Hatay Province]. MKU J Agric Fac. 2013;18(2):47-54. Turkish.

Üremiş İ, Soylu S, Kurt Ş, Soylu EM, Sertkaya E. [Evaluation of weed species, their frequencies, densities and current status in carrot fields in Hatay province]. J Tek Agric Fac. 2020;17(2):211-28. Turkish.

Wang Y, Zhang W, Goodwin PH, Zheng SJ, Li X, Xu S. Effect of natural weed and Siratro cover crop on soil fungal diversity in a banana cropping system in southwestern China. Front Microbiol. 2023;14:1-11. Available from: https://doi.org/10.3389/fmicb.2023.1138580

Yılmaz E, Kadıoğlu İ, Kitiş YE. [Determination of prevalence and density of weed species and their distribution according to ecological parameters in banana (*Musa cavendishii* Lam. ex. Payton) orchards in Antalya Province]. Turkish J Weed Sci. 2019;22(1):79-95. Turkish. Available from: https://dergipark.org.tr/tr/pub/tjws/issue/46839/568719