

Some Additional Notes on the Relations Between Some Pollinator Bee Species and Weeds in Karacadağ Paddy Fields in Southeastern Anatolia Region, Turkey

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Abstract

Rice is the main food source of more than half of the global population. This study was carried out in Diyarbakır and Şanlıurfa provinces during 2010-2011 to determine the relationship between pollinator bees and their host plant species which are some weeds in Karacadağ paddy cultivation areas located in the southeastern Anatolia Region. Pollinator bees samples were performed biweekly by sweep net through June and October. The weeds in the surveyed fields were determined by random sampling method. As a result of surveys, pollinator bees feed on nectar weeds. During the surveys; *Cichorium intybus* L., *Conyza canadensis* (L.) (Asteraceae), *Mentha spicata* L. (Lamiaceae), *Trifolium arvense* L., *T. haussknechtii* var *haussknechtii* Boiss., *T. resupinatum* L. (Legumineae), *Lythrum hyssopifolia* L. (Lythraceae), *Veronica lysimachioides* (Boiss.), *V. anagallis-aquatica* L. subsp. *oxycarpa* (Boiss.) *Elenevskyi* (Scrophulariaceae), *Physalis* sp. and *Solanum nigrum* L. (Solanaceae) were determined. The presence of these weed species in the surveyed region depends on the presence of pollinator bees. *C. intybus* L. and *Trifolium* spp. are important in apiculture because of their rich nectar and pollen contents and high nutritional values. The pollinator bee species contribute to soil fertilization by increasing nitrogen contents. It is concluded that being the key species increasing the yield of leguminous crops, pollinators also play an important role in the fertilization of soils with nitrogen deficiency.

Keywords — Karacadağ rice, beneficial insects, pollinator bees, weeds.

I. INTRODUCTION

Rice is among the major crops of world's cereal production, and occupies second place after maize. The ecology of southeastern Anatolia region, Turkey is highly favorable for paddy agriculture. Karacadağ rice variety is cultivated in the volcanic foothills of

Karacadağ mountain (Figure 1) and is consumed in the same region where it is produced [24]. Karacadağ rice variety exhibits high resistance to the melting cold snow waters of Karacadağ mountain [2]. In the world, rice was planted on 161 million hectares of land during 2016-17 with total production of 769.65 million tonnes and average yield of 4609 kg ha⁻¹. In the same year the rice was cultivated on 109 thousand hectares with total production of 900 tonnes and average yield of 8218 kg ha⁻¹. Similarly, rice was cultivated on 2103 hectares in southeastern Anatolia region, which produced 9571 tons with average yield of 4551 kg ha⁻¹ [4].

Organic agricultural production is partially adopted by different farmers in various regions of Turkey [3]. During 2016, 23.831 tons of organic agricultural production of 22 products, including rice was produced in Diyarbakır by 1.173 farmers on 4.442 hectares of land. In the same year, 51.268 tons of organic agricultural production of 23 products, including rice was produced in Şanlıurfa by 364 farmers on 12.093 ha of land [23]. The demand for organic rice is gradually increasing due to its usage in rice flour and infant food. Southeastern Anatolia region of Turkey has the potential to meet this need due to its geographical and climatic characteristics and low use of fertilizers and pesticides.

Almost 80% of flowering plants need pollinator insects for pollination, especially bees (Hymenoptera, Apoidea) [21]. At the same time, bees are biological indicators which give the best picture of ecosystem health due to their different life cycles and special habitat requirements. The identification of pollinator species is mandatory before any agricultural development in an area like southeastern Anatolia region having potential for organic agriculture. Although wind plays a main role in rice pollination, the presence of pollinator bee species is important to achieve natural vegetation cover of paddy fields which have been fallowed for a few years. The native bees (Megalichidae and Halictidae) play significant role in crop pollination. Native bee communities could provide full pollination services even for a crop

with heavy pollination requirements. Moths, flies, wasps, bees, beetles, butterflies, and other invertebrates are critically important for ensuring the effective pollination of both cultivated and wild plants [12], [30] and [6].

Another critical issue is the diversity of native bee communities, which is important in providing crop pollination services. These communities exhibit temporal fluctuations and are highly variable across space and time [35], [31]. Different bee species are also differentially effective as pollinators within and among crops [27], [13] and honey bees are known as ineffective or less effective pollinators of selected crops [16], [26].

In the studies investigating the pollinating effects of honey bees (*Apis* spp.), Bumble bees (*Bombus* spp.), Leaf-bending bees (*Megachilidae*) and excavating bees (*Andrenidae*), the members of the family *Halictidae* have also been shown to be very important pollinators [22], [33],[18] and [17].

Some pollinator bees were identified in Karacadag paddy fields [11], but there are no sufficient studies about pollinator bees and their feed host plants at paddy fields in the region. The aim of this study was to reveal the organic agricultural potential of southeastern Anatolia region by determining relations between weeds and some pollinator bee species which are the insurance of natural flora in the paddy fields.

II. MATERIALS AND METHODS

A. Study Area

Field surveys were carried out during 2010-2011 in Diyarbakır (Ergani, Çınar, and Hazro districts) and Şanlıurfa (Siverek district) provinces. A paddy field of at least 2 hectares was selected in each district, and the selected fields were visited biweekly between May and October to carry out surveys. Details of the selected paddy fields are presented below;

Demirli village, Ergani district in Diyarbakır province, 37°56'30.77"N 41°89'55.90"E, 1057 m above sea level (asl)

Kuyuluhöyük village, Çınar district in Diyarbakır province, 37°47'48.89"N 40°09'33.68"E, 766 m asl
Düzevler village, Hazro district in Diyarbakır province, 38°10'07.23"N 40°44'29.87"E, 821 m asl
Üzümlük village, Siverek district in Şanlıurfa province, 37°42'38.07"N 39°14'46.33"E, 630 m asl

B. Determination of pollinator bees and weed species

Bee samples were collected using a sweep net in the selected paddy fields around Karacadag region. The samples collection was performed biweekly

between May and October, i.e., in the time period from rice plantation to harvest.

The first sampling was performed 20 steps inside from the field edge, and subsequent samplings carried out in zigzag fashion. The collected materials were placed in polyethylene transparent bags with blotting paper inside, labelled and brought to the laboratory. Samples were prepared in the laboratory by pinning and labelling for identification.

Quadrates method was used to record the weed species prevailing in the region. The surveys were conducted in 10-15 m² area, where 15 quadrates (50×50 cm) were randomly thrown and weed species present in the quadrates were recorded. The herbarium of the unidentified species was made and the plant species were identified based on morphological characters.



Figure 1: Karacadag paddy cultivation areas in Kuyuluhöyük village, Çınar district in Diyarbakır province (a) and Üzümlük village, Siverek district in Şanlıurfa province (b) in 2011.

III. RESULTS AND DISCUSSION

A. Determination of weed species

A total 11 weed species belonging to 7 families were identified from paddy fields and field edges in the surveyed region (Table 1, Figure 2). All of the pollinator bee species identified are known as pollinators of these weed species [14], [10] and [8].

Table I: Weed species identified in the paddy fields of Karacadag as a result of the field surveys in 2010-2011.

Family	Species	Turkish name	English name
Asteraceae	<i>Cichorium intybus</i> L.	Yabani hindiba	Common chicory
	<i>Conyza canadensis</i> (L.) Cron.	Pire otu	Canadian fleabane
Lamiaceae	<i>Mentha spicata</i> L.	Yarpuz	Wood mint
Fabaceae	<i>Trifolium arvense</i> L.	Tarla üçgülü	Rabbit foot clover
	<i>T. haussknechtii</i> var. <i>haussknechtii</i> Boiss.	Antep üçgülü	-
Leguminosae	<i>Trifolium resupinatum</i> L.	Yaticı tırfıl	-
Lythraceae	<i>Lythrum hyssopifolia</i> L.	Aklarotu	-
Scrophulariaceae	<i>Veronica lysimachioides</i> (Boiss.) M. A.	Maviş	-
	<i>Veronica anagallis-aquatica</i> L. subsp. <i>oxycarpa</i> (Boiss.) Elenevskyi	Su fare kulağı	Speedwell pimpernel
	<i>Physalis</i> sp.	Fener otu	Ground cherry
Solanaceae	<i>Solanum nigrum</i> L.	Köpek üzümü	Black night shade



Figure 2. Some weed species determined in paddy fields. a-Yabani hindiba, *Cicoriun intybus* L., b- Üçgül, *Trifolium arvense* L., c-Fener otu, *Physalis* sp., d- İt üzümü, *Solanum nigrum*.

Karacadag rice is usually cultivated with no-tillage in stony areas of Southeastern Anatolia region, Turkey. In some flat paddy fields in the region for harvest, the combine harvester is used, but the crop is harvested manually (hand-pulling harvesting).

Therefore, fossil fuel consumption remains limited in the region. Herbicide are applied to control narrow and broad-leaved weeds as postemergence period in the region. Another important means of livelihood in the region is animal husbandry, so commercial

fertilizers are rarely used [25], [32]. After the rice harvest, some producers release animals into the fields; thus, preventing stubble burning and providing natural fertilization. [11] identified 53 beneficial insect and spider species from Karacadag paddy fields and argued that natural balance in the region remains intact. Title must be in 24 pt Regular font. Author name must be in 11 pt Regular font. Author affiliation must be in 10 pt Italic. Email address must be in 9 pt Courier Regular font.

In rice agriculture, cultivation is not commended every year in the same field because it will decrease the yield due to soil exhaustion. This recommendation is followed in the region, and the harvested area is left empty for 2-7 years. In this process, the fields reach the natural vegetation cover and used as grassland area for livestock until the next cultivation. In order to support livestock activities and increase nitrogen in the soil for a higher yield, crop rotation of fallow areas with forage legumes is recommended [5]. Another important benefit of growing forage crops in fallow areas is the removal of weeds, which have a negative effect on cereal production. Southeastern Anatolia region has a slopy and high topography, it can be suggested to plant sainfoin [1], which is more resistant to cold and drought than legumes, more fertile than alfalfa, and can be grown in arid, calcareous soils where other plants cannot be grown.

The identification according to morphological characteristics resulted in 11 pollinator bee species belonging to Halictidae [*Halictus resurgens* Nurse, *H. tetrazonianellus* St., *Seladonia pollinosa* (Sichel), *S. smaragdula* (Vachal), *S. cephalica* (Mor.), *Evylaeus pauxillus*, *E. trichopygus* (Bluet.), *E. glabriusculus* (Mor.), *E. convexiusculus* (Sch.), *Lasioglossum discum* (Smith) (Hym.: Halictidae) and Megachilidae [*Megachile deceptor* Perez] (Hymenoptera: Apoidea) families species were recorded by [11] in Karacadag paddy fields. In this study is very important for both weeds around the field and legumes since they are pollinators. The weed species such as *Cichorium intybus* L., *Conyza canadensis* (L.) (Asteraceae), *Mentha spicata* L. (Lamiaceae), *Trifolium arvense* L., *T. haussknechtii* var *haussknechtii* Boiss., *T. resupinatum* L. (Fabaceae), *Lythrum hyssopifolia* L. (Lythraceae), *Veronica lysimachioides* (Boiss.), *V. anagallis-aquatica* L. subsp. *oxycarpa* (Boiss.) Elenevskyi (Scrophulariaceae), *Physalis* sp. and *Solanum nigrum* L. (Solanaceae) need bees for pollination among the identified weed species in the current study.

Various studies have indicated that many species of *Halictus*, *Evylaeus*, *Lasioglossum*, *Seladonia* (Halictidae) and *Megachile* (Megachilidae) genera are active pollinators of commercially cultivated legumes such as *Medicago sativa* L. and *Trifolium pratense* L. [20], [9], [21],[19] and [29]. In fact, it has been stated that species belonging to the Halictidae and Megachilidae families are more effective

pollinators than honey bees in legume species such as alfalfa [20]. In a study where economic contributions were calculated, concluded that these species contributed 23 million dollars to the Polish economy because of their effects on pollination of forage plants [28]. Legumes such as *C. intybus* and *Trifolium* spp., which are naturally spread and are planted in paddy fields in rotation, are important in animal husbandry due to their high nutritional value. These plants are also valuable for apiculture because they have rich nectar and pollen content [32]. Their contribution to fertilization by increasing nitrogen content in the soil leads to both the increase in pollinator bee population and more profitable production in the region.

Many researchers in Turkey have studied the role of native bees in the pollination of agricultural products and weeds. A faunistic study was conducted on the Halictidae (Apiformes: Apoidea: Hymenoptera) family among pollinator bees in Ankara [10] and contributions to the current information about the diversity of the Megachilidae fauna in the Mediterranean region of Turkey [15]. The species “*Halictus tetrazonianellus* Strand, 1909, *Seladonia pollinosa* (Sichel, 1860), *Lasioglossum xanthopus* (Kirby, 1802)” determined in this study were found to be the same as the findings in our study conducted in Karacadag.

IV. CONCLUSION

In Karacadag region, most of the paddy cultivation areas are made in stony areas which are called as iron-free. Sparsely planted areas also constitute the density of weeds. The weed species identified in this study both help the soil to become fertile again and become an important source for bees due to the nectar and nutritional value they contain.

Bees play a significant direct role in plant production due to their activities in pollination. The global annual economic benefit by yield increase due to bees is 65-70 billion dollars [7]. The income obtained from bee products also contributes to the economy. In addition to these visible contributions, bees also have indirect contributions to ecosystems. Although bees do not have a function in direct rice pollination in paddy cultivation areas, they have a significant share in the fertilization of soils, especially with nitrogen deficiency.

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