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Investigations on Feeding Preferences of Adult *Sitona* Weevils (Coleoptera: Curculionidae) in Some Host Plants

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ABSTRACT
In this study, we determined the feeding preferences of *Sitona callosus* Gyllenhal, 1834, *S. cylindricollis* Fåhraeus, 1840, *S. humeralis* Stephens, 1831, *S. longulus* Gyllenhal, 1834, *S. macularius* (Marsham, 1802), *S. obsoletus* (Gmelin, 1790), and *S. puncticollis* Stephens, 1831 species belonging to the genus *Sitona* (Coleoptera, Curculionidae) in alfalfa (*Medicago sativa* L.), black medick (*M. lupina* L.), white clover (*Trifolium repens* L.), soybean (*Glycine max* (L.), birdsfoot trefoil (*Lotus corniculatus* L.), honey clover (*Melilotus albus* Medik.), yellow sweet clover (*M. officinalis* (L.), sainfoin milk vetch (*Astragalus onobrychis* L.), sainfoin (*Onobrychis viciifolia* Scop.), and liquorice (*Glycyrrhiza glabra* L.) (Fabaceae) plants at 25°C±5°C in the laboratory. Plant preference experiments were established with 10 replications and as a result of analysis of variance (P>0.01), plant preference of each species was found to be significant. As a result, *M. sativa* and *T. repens* (100%) were the most preferred by *Sitona* species. Whereas *L. corniculatus* (91.43%), *M. albus* (87.14%), *O. viciifolia* (81.43%), *M. lupina* (78.57%), *M. officinalis* (60.00%), *A. onobrychis* (31.43%) followed, respectively. The least preferred species were *G. glabra* (7.14%) and *G. max* (1.43%).

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ÖZET
Bu çalışmada, *Sitona* cinsine ait *Sitona callosus* Gyllenhal, 1834, *S. cylindricollis* Fåhraeus, 1840, *S. humeralis* Stephens, 1831, *S. longulus* Gyllenhal, 1834, *S. macularius* (Marsham, 1802), *S. obsoletus* (Gmelin, 1790), ve *S. puncticollis* Stephens, 1831türlerinin (Coleoptera, Curculionidae), yonca (*Medicago sativa* L.), şerbetçi otu yoncası (*M. lupina* L.), ak ççgül (*Trifolium repens* L.), soya fasulyesi (*Glycine max* (L.), Gazel boynuzu (*Lotus corniculatus* L.), ak taş yoncası (*Melilotus albus* Medik.), sarı taş yoncası (*M. officinalis* (L.), korungamsı geven (*Astragalus onobrychis* L.), adi korunga (*Onobrychis viciifolia* Scop.) ve meyan (*Glycyrrhiza glabra* L.) (Fabaceae) bitkilerinde beslenme tercihleri laboratuvar ortamında 25°C±5°C'de belirlenmiştir. Bitki tercih denemeleri 10 tekrarlı olarak kurulmuş ve varyans analizi sonucunda (P>0.01) her *Sitona* türünün bitki tercihleri önemli bulunmuştur. Sonuç olarak, *M. sativa* ve *T. repens* (%100) *Sitona* türleri tarafından en çok tercih edilen türler olmuştur. Bunu sırasıyla *L. corniculatus* (%91.43), *M. albus* (%87.14), *O. viciifolia* (%81.43), *M. lupina* (%78.57), *M. officinalis* (%60.00), *A. onobrychis* (%31.43) takip etmiştir. En az tercih edilen türler ise *G. glabra* (%7,14) ve *G. max* (%1,43) olmuştur.

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INTRODUCTION

Within Insecta, the Curculionoidea superfamily of the Coleoptera order is a very important agricultural group with its high species diversity. The genus *Sitona* Germar, 1817, which is very important in terms of agricultural pests belonging to Curculionidae, is represented by more than 100 species identified in the world (Velázquez de Castro et al., 2007). They naturally spread in the Nearctic and Palaearctic regions, but some species have also been distributed in South Africa, Australia, and New Zealand (Phillips & Barratt, 2004). Adults of *Sitona* species feed on shoots and leaves of leguminous (Fabaceae) and germinating plants, causing their death. On the other hand, its larvae, cause serious damage by feeding on both roots and nodules (Scherf, 1964; Danthanarayana, 1967; Plaut, 1976; El-Dessouki & El-Awady, 1978; Aeschlimann, 1980; Syrett, 1992; Murray, 1996; Cantot, 2001). Various studies have been conducted to determine the host plants of *Sitona* species and the damage they cause (Cantot, 1979; Aeschlimann, 1980; Minda-Lechowska, 1980; Cmoluch, 1980; Dieckmann, 1980; Palm, 1996; Blaeser-Dieckmann, 1982; Murray & Clements, 1994). The Leguminosae or Fabaceae family, food for *Sitona* species, is the second largest family of flowering plants in the world with 650 genera and approximately 18,000 species. They spread on almost all continents except Antarctica. Species from this family vary from small grasses of arctic and alpine vegetation to large trees of tropical forests. The most characteristic feature of the family is its unique legume-type fruit and pea-like or bean-like husk. Additionally, the flower structure is very characteristic of the family. It is one of the most economically important families among dicotyledons. Legume seeds are of high quality in terms of protein content and because they contain high nutritional value, legumes are also used for chewing gum, glue, timber, medicinal purposes, human food, animal feed, and green manure (Yılmaz, 2007). IRLC (Inverted Repeat-Lacking Clade) is one of the most derived branches in the Papilionoideae subfamily of the Fabaceae family and they are economically important plants (Duan et al., 2021). IRLC plants can both grow wild in natural habitats and are also cultivated. *Sitona* species usually feed on IRLC plants (Velázquez de Castro et al., 2007). Although adults make the host preference, larval development takes place in plant nodules and then in roots. Additionally, the flower structure is very characteristic of the species. This is why, the larvae are more destructive (Fisher & O'Keeffe, 1979). Cantot (2001) stated that the presence of different nodule types and bacterial species can create a barrier for the larvae. However, the feeding preferences of *Sitona* species in root nodules are important, and same way, the morphological structure and chemical constituents of the leaf may also be key factors (Velázquez de Castro et al., 2007). *Sitona* species, which are agricultural pests by feeding on cultivated legumes, are oligophagous insects (Scherf, 1964). Many studies have been conducted to identify the host plants of *Sitona* species (Cantot, 1979; Aeschlimann, 1980; Minda-Lechowska, 1980; Blaeser-Dieckmann, 1982; Murray & Clements, 1994; Syrett & Emberson, 1997). Studies were carried out to determine the plant preferences of some species belonging to the Sitona genus, which are abundant in nature, under laboratory conditions and to reveal which *Sitona* species can cause damage to which cultivated plants.

MATERYAL and METOD

To determine the host feeding preferences of *Sitona* species in laboratory conditions; *Melilotus officinalis* (L.), *M. albus* Medik., *Medicago sativa*, *M. lupina* L., *Trifolium repens, Lotus corniculatus, Astragalus onobrychis* L., *Onobrychis viciifolia Scop., Glycyrrhiza glabra* L. and *Glycine max* (L.) were collected freshly from the nature. *Sitona obsoletus* Gmelin, *S. cylindricollis* Fåhraeus, *S. callosus* Gyllenhal, *S. humeralis* Stephens, *S. puncticollis* Stephens, *S. macularius* Marsham, and *S. longulus* Gyllenhal adults, which were collected from nature in September-October in sufficient numbers, were brought to the laboratory for the experiments. They were separated in terms of species and gender. After the selected adults were starved for 48 hours in 100 ml jars, 2 individuals (1♀ + 1♂) were released into 9 cm x 2 cm petri. Plants with 3-4 leaves, the stems of which were tightly wrapped with wet cotton, were placed in each petri dish, and moisture was maintained throughout the experiment (Wightman, 1986). The individuals included in the experiment were checked daily and the experiment was terminated after 72 hours. In the evaluations, if at least 3 bites or 1/3 of a leaf were eaten, it was accepted as the food of the insect (Figure 1). Experiments were set up in a randomized plot design with 10 replications for each species at 25°C ± 5°C under laboratory conditions. Variance analysis was performed by subjecting the obtained findings to angle transformation in the JMP Pro 13 statistical package program. A student's test (LSD0.05) was used to group the significant data.

RESULTS AND DISCUSSION

In this study, 7 *Sitona* weevils, which are common in nature and in agricultural fields, the host feeding preferences were investigated on 10 plant species belonging to Papilionoideae (Fabaceae). According to these results, *M. sativa* and *T. repens* (Trifolieae tribe) (100%) were the most preferred by *Sitona* species. The other results include *L. corniculatus* (Loteae) (91.43%), *M. albus* (87.14%) (Trifolieae), *O. viciifolia* (81.43%) (Hedysareae), *M. lupina* (78.57%), *M. officinalis*

(60.00%), (Trifolieae), *A. onobrychis* (31.43%) (Galegeae). The least preferred species were *G. glabra* (7.14%) (Hedysareae) and *G. max* (1.43%) (Phaseoleae) (Figure 2h). As a result of variance analysis in the host plant feeding preference experiments of *Sitona* (Coleoptera, Curculionidae) species, it was found to be important (P>0.01) in terms of plant preference (Table 1).

Figure 1. Feeding behavior experiments of *Sitona* species on host plants in the laboratory.
Şekil 1. *Laboratuvarda Sitona türlerinin konukçu bitkide beslenme davranışı çalışmaları.*

Table 1. The host plant feeding preferences of *Sitona* species in the laboratory condition.
Çizelge 1. Laboratuvar koşullarında Sitona *türlerinin konukçu bitki besleme tercihleri.*

Host species	*Sitona* species*							
	S.ob	***S.cy***	***S.ca***	***S.hu***	***S.pu***	***S.ma***	***S.lo***	**Mean**
Melilotus officinalis	30 df	100 a	20 eg	100 a	50 cd	40 ce	80 ab	**60,00 e**
Melilotus albus	60 bc	100 a	90 a	100 a	100 a	60 bc	100 a	**87,14 bc**
Medicago sativa	100 a	100 a	100 a	100 a	100 a	100 a	100 a	**100,00 a**
Medicago lupina	100 a	0 g	100 a	100 a	100 a	50 cd	100 a	**78,57 d**
Trifolium repens	100 a	100 a	100 a	100 a	100 a	100 a	100 a	**100,00 a**
Lotus corniculatus	100 a	100 a	100 a	40 ce	100 a	100 a	100 a	**91,43 b**
Astragalus onobrychis	20 eg	0 g	20 eg	30 df	100 a	40 ce	10 fg	**31,43 f**
Onobrychis viciifoli	20 eg	100 a	100 a	100 a	100 a	100 a	50 cd	**81,43 cd**
Glycyrrhiza glabra	10 fg	0 g	0 g	0 g	10 fg	20 eg	10 fg	**7,14 g**
Glycine max	0 g	0 g	0 g	0 g	0 g	10 fg	0 g	**1,43 g**
Mean	**54 d**	**60 cd**	**63 bc**	**67 b**	**76 a**	**62 bc**	**65 bc**	**63,86**

CV(%)13.78, $LSD_{0,05}$=Plant 8,22**, Species 6,88**, Host plant feeding X *Sitona* species 21,76**,**=*(P<0.01)* level is important.
***S.ob**: *S.obsoletus*, **S.cy**: *S.cylindricollis*, **S.ca**: *S.callosus*, **S.hu**: *S.humeralis*, **S.pu**: *S.puncticollis*, **S.ma**: *S.macularius*, **S.lo**: *S.longulus*

In the experiments, *S. Callosus* individuals were fed in *M. sativa, M. lupina, T. repens, L. corniculatus, O. viciifoli* (100%) and *M. albus* (90%). It was determined that *A. onobrychis* (20%) and *M. officinalis* (20%) species were less preferred, while *G. glabra* and *G. max* species were not preferred (Figure 2a). In nature Lodos et al. (1978), *S. callosus Astragalus* sp. while Velázquez de Castro et al. (2007) *Medicago* pointed out that it feeds on plants belonging to the genus *Onobrychis, Ononis. S. cylindricollis* individuals were fed on *M. sativa, M. albus, M. officinalis, T. repens, L. corniculatus, O. viciifoli* (100%). *M. lupina, A. onobrychis, G. glabra and G. max* were not fed on (Figure 2b). Although *S cylindricollis* has been reported to feed on *Melilotus* (Bright & Bouchard, 2008), this genus has not been recorded as a host plant *of S. cylindricollis* (Rim et al., 2019). However, in our laboratory studies, it was observed that *S. cylindricollis* fed on *M. officinalis* and *M. albus.* Bird (1947) reported that *S. cylindricollis* caused serious damage by feeding on sweet clover (*M. officinalis*). *S. humeralis* individuals were found to be fully fed on (100%) *M. sativa, M. lupina, M. officinalis, M. albus, T. repens* and *O. viciifolia* plants. It was observed that *L. corniculatus* (40%) and *A. onobrychis* (30%) species were less preferred, while *G. glabra* and *G. max* plants were not preferred (Figure 2c). Aeschlimann (1984) reported that *S. humeralis* is very abundant in perennial species of *Medicago* in the Mediterranean region, but not in annual species. *S. humeralis* has been reported to be found on *Trifolium* and *Melilotus* (Koch, 1992), *Ononis repens* L., *Lathyrus aphacca* L., *T. repens,* and *Pisum sativum* L. (Hoffmann, 1950; Scherf, 1964; Nasredinov, 1975; Koch, 1992). According to Velázquez de Castro et al. (2007), *Medicago* and *Trifolium* plants are the host plants of *S. humeralis.*

In this experiment, it was seen that *S. humeralis* adults were fed with the leaves of *L. corniculatus* and *A. onobrychis* among these plants. In addition, it is known that *S. humeralis* feeds on cultivated *M. sativa* and causes economic damage (Tanasijevic, 1974; Kıvan, 1995; Atanasova, 2012; Arbab & McNeill, 2014;

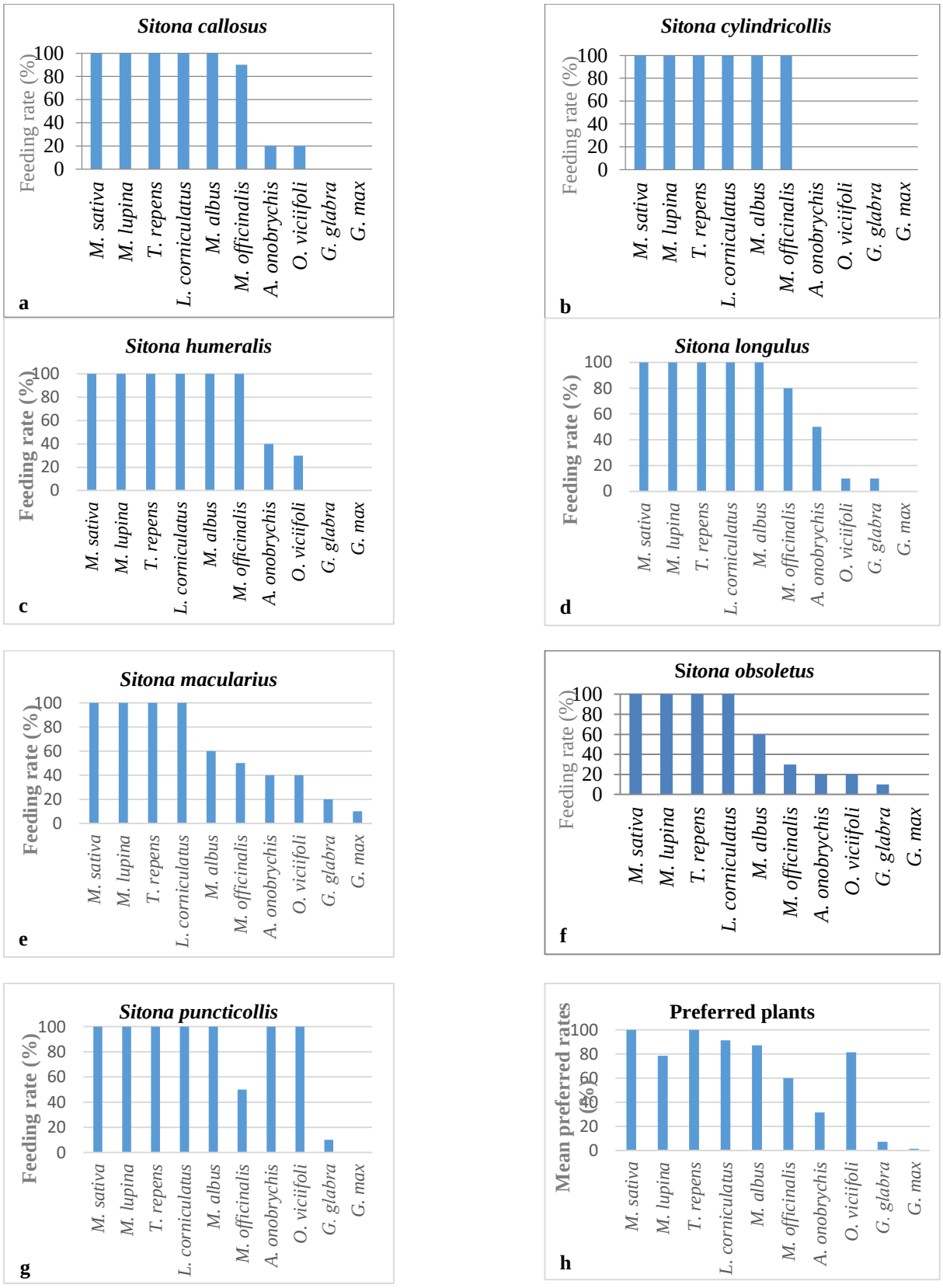

Figure 2. Host feeding preferences of *Sitona* species (a- *Sitona callosus* b- *Sitona cylindricollis*, c- *Sitona humeralis*, d-*Sitona longulus*, e-*Sitona macularius*, f-*Sitona obsoletus*, g-*Sitona puncticollis*, h-Prefered plants).

Şekil 2. Sitona türlerinin konukçu beslenme tercihleri (a- Sitona callosus b- Sitona cylindricollis, c- Sitona humeralis, d-Sitona longulus, e-Sitona macularius, f-Sitona obsoletus, g-Sitona puncticollis, h- Tercih edilen bitkiler).

Gözüaçık et al., 2021). *Sitona longulus* Gyllenhal individuals fully (100%) fed on *M. sativa, M. lupina, T. repens, L. corniculatus, M. albus* and *M. officinalis* plants. It was determined that *O. viciifoli* (50%) was moderate, *A. onobrychis* and *G. glabra* (10%) were very few and *G. max* was not preferred (Figure 2d). Lodos et al. (2003), the plants on which *S. longulus* is found are *M. sativa, Astragalus* sp. Velázquez de Castro et al. (2007) reported that it feeds on plants belonging to *Lathyrus, Medicago, Vicia* genus. *S. macularius* individuals preferred *M. sativa, T. repens, L. corniculatus,* and *O. viciifoli* (100%) much, *M. albus* (60%), *M. lupina* (50%), and *M. officinalis* (40%) moderate, and *G. glabra* (20%) and *G. max* (10%) very little (Figure 2e). Lodos et al. (1978), *M. sativa* and *Vicia* spp. plants may be hosts of *S. macularius* and, Velázquez de Castro et al. (2007) reported that it feeds on plants belonging to the genera *Lupinus*, *Lens*, *Medicago, Onobrychis, Trifolium, Pisum, Vicia.* Hariri (1981) and Solh et al. (1986) stated that *S. macularius* is the main pest of lentil plants in West Asia and North Africa. Tahhan and Hariri (1982) reported that this species is the most abundant *Sitona* species with a rate of 95% among the lentils found in northern Syria. *S. obsoletus* individuals preferred *M. sativa, M. lupina, T. repens,* and *L. corniculatus species* (100%) and *M. albus* (60%), while *M. officinalis* (30%), *A. onobrychis* (20%), *O. viciifoli* (20%) and *G. glabra (*10%) species were found to be less preferred, while they did not prefer *G. max* (Figure 2f). It has been reported that *S. obsoletus* feeds on white clover (*T. repens)* and red clover (*T. pratense*) in temperate meadows (Brudea, 1982; Murray & Clements, 1994; Gerard et al., 2005). Gerard et al. (2007) reported that *S. obsoletus* larvae are the main pest of *T. repens* in New Zealand, reducing yield by 34-35%, and doing the most damage in spring. *S. puncticollis* individuals prefer *M. sativa, M. lupina, M. albus, T. repens, A. onobrychis, O. Viciifoli* and *L. corniculatus* (100%), *M. officinalis* (50%) moderately, *G. glabra* at very low rates (10%), and did not prefer *G. max* (Figure 2g). Velázquez de Castro et al. (2007) expressed that *S. puncticollis*, feeds on species belonging to *Lotus, Lens, Medicago, Melilotus, Trifolium,* and *Vicia* genus as the hosts.

In this study, it was determined that *Sitona* species preferred some Fabaceae plant species that are abundant in nature and cultivated as their food. These plants were preferred by *Sitona* adults *M. sativa*≥ *T. repens* > *L. corniculatus* > *M. albus* > *O. viciifoli* > *M. lupina* > *M. officinalis* > *A. onobrychis* > *G. glabra* respectively. It has been determined that although the species is not the main host of most of the plants it feeds on, it can also feed on other alternative host plants from the same family in order to survive. The presence of several species on the same plant in nature was better understood by this study.

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Researchers Contribution Rate Declaration Summary

The authors declare that they have contributed equally to the article.

Conflicts of Interest Statement

The author declares no conflicts of interest.

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