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Ecology of Major Predatory Arthropod Complex in Field and Sweet Corn in Hada Al Sham Locality, Western Saudi Arabia

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ABSTRACT. A field study was conducted during 1995 and 1996 to obtain information on the major predatory complexes of Insecta and Araneida on local field and sweet corn varieties at Hada Al-Sham locality, western Saudi Arabia. Results obtained showed the presence of a rich fauna of predatory complex, especially after the whorl stage of plant growth. The major group of this predator complex were coccinellids, which comprised 48% and 68% during the years 1995 and 1996 respectively. There were no significant differences in numbers of the predatory species during 1995 and 1996. Arboreal spiders were represented by six dominant families: *Agelenidae, Araneidae, Clubionidae, Salticidae, Thieridiidae and Thomicidae.*

Introduction

The use of a holistic approach for the reduction of insect pest populations using indigenous predatory arthropods, is considered an integral part of contemporary pest management strategies. The impact of a complex of generalist predatory arthropods needed further critical evaluation to consider their role before natural mortality could be thoroughly exploited in rational management programs. Therefore, inventories of indigenous predaceous insects and spiders were targeted towards achieving the main objectives of identifying species composition of the predatory complex, in order to determine trends in seasonal occurrence, density, biology ecology and distribution. The relationships of these factors were investigated as they are particularly related to population dynamics of key insect pests. The coccinellid beetles (*Coleoptera*) are important polyphagous insectivorous predators (Huffaker and Messenger 1976, Kring *et al.* 1985, Faragalla and Al-Ghamdl 1989). In addition, many lace-wings (*Chrysopidae, Hemerobiidae*) Neuroptera and hover flies (*Syrphidae*) Diptera are specifically aphidophagous and found in high densities in a variety of grassy habitats and agroecosystems (Obryclil 1983, Faragalla *et al.* 1985, Cockfield and Potter 1984, Honek 1988, Orr and Obrychi 1990, Eckschmitt *et. al.* 1997). Moreover, the advent of new technological

innovations in novel methods of insect control has facilitated the practicality of adopting this valuable information in applied biological control programs. The success of mass production and release that has been achieved through sophisticated laboratory rearing of natural hosts on artificial diets has given considerable impetus and are considered important milestones in this area of research, (Singh 1977, Norton *et al.* 1992).

The Arancida (true spiders) are the largest order of Arachnida. Several thousand species are represented in North America (Little 1972), with approximately 30,000 species having been documented in North America (Gertsch 1979, Foelix 1982). They have been reported to have a substantial potential role as biocontrol agents. Many scientists in different crop agroecosystems have investigated them. These agroecosystems include: cotton, wheat, alfalfa and vegetation in general (Riechert and Lockley 1984, Nyffeler and Breene 1992, Nyffeler *et al.* 1992, Sterling *et al.* 1992, Nashnosh and Salam 1993, Greco and Kevan 1994, Shunmugavelu 1997, Riechert and Lawrence 1997); hence, biocontrol together with varietal resistance and crop tolerance to infestation, coupled with the use of selective insecticides, could be used in integrated pest management programs (Kumar and Velusamy 1996).

The Kingdom of Saudi Arabia is currently pursuing ambitious goals for exploiting its agricultural potential to encourage home agricultural production. Especially important are field crops, which are used for food, feed or forages for humans and animal consumption. The ensuing horizontal expansion of agrodesert (Faragalla 1988) in marginal land and transformation of desert land through reclamation into cost-effective productive agriculture has led to the creation of favourable environments for pest infestations. Therefore with the availability of suitable niches, coupled with intensification and introduction of new and hybrid varieties for field, horticultural and greenhouse production, more pest problems are bound to occur (Faragalla, 1983).

Field corn is traditionally grown over large areas and in many regions of the Kingdom for food and fodder. It is reported to be infested by a number of arthropod pests (Martin 1972, Abu Thuriya 1982). Some workers have also documented the existence of a rich fauna of predatory arthropods, especially coccinellids in different natural ecosystems and agroecosystems in Saudi Arabia (Furisch 1979, Holzel 1980, Talhouq 1984, Faragalla *et al.*, 1985).

The objectives of this study were to generate further insights and initiate base-line data about the complex of major predatory arthropods associated with locally grown varieties of field and sweet corn. It is further hoped as a result of this study to obtain biological and ecological information of use in suppressing injurious insect pests. The information obtained would be used in designing a multi-faceted integrated pest management program (IPM) for curbing irrational insect pest outbreaks in the field of corn agroecosystems.

Materials and Methods

Studies were conducted at the College of Metrology and Arid Land Agriculture at Hada Al-Sham, 125 km north east of the city of Jeddah. The study site was an area of approximately 2 donums (a donum = 1000 square meters). All pre-planting agricultural procedures were performed as normal. Three local field corn varieties, Jizan-Yellow, Jizan-White, and Jizan-Composite plus a sweet corn variety, were supplied by local seed sellers and were planted in a randomized complete block design replicated four times

The rectangular layout of the experimental field was divided into 16 plots (4 corn varieties, each with 4 plots). Each plot had an area of ca. 50 (10 x 5) sq. meters i.e. the distance between any 2 adjacent plots was 1.5 meters from all directions This area was used as alleyways (Fig. 1). Within each plot, 6 bi-wall irrigation hoses were laid out at a distance of one meter apart (rows of corn are also planted in the plot). The first and the sixth rows in each plot were considered as guard rows and not included in the data collection. Plants used for evaluation were situated in the middle part of each of the remaining four rows in each plot. Each contained ca. 30 of consecutive plants. The corn varieties were planted along the hoses every 30cm (depending on the position of holes made for water exits along irrigation hoses) and 2 seeds/hill. The plant population was reduced to one plant/hill two weeks post-planting, when poorly growing, unhealthy plants were removed. Corn was planted on October 28, 1995 whereas in the 2nd year corn was planted on October 16, 1996. The corn plants were left for natural infestation by all indigenous entomophagous pests. The sampling area had a rich mixed flora of desert weeds including : *Farsetia romosisma* Hochst., *Zygophyllum simplex* L., *Convolvulus hystrix* Vahl., *Amaranthus graecizans L., Dipterygium glaucum Decne., Aristida sp. L.,Cenchrus* sp. L., & *Calotropis procera* III.

Two methods were used to evaluate the natural insect pest infestation. Plant damage was found to be a suitable index for measuring varietal performance and tolerance to infestation in addition to insect counts, which are usually affected by many factors including parasitism, perdition and insect diseases. The extent of insect damage, based on the general growth appearance and typical symptoms of infestation were categorized using a rating scale suggested by Guthrie et al. 1970. This included slight, mild, medium or heavy infestation depending on the size and extent of leaf feeding and overall plant appearance. Data on leaf feeding for both years began approximately four weeks post planting i.e. on November 25, 1995 and November 14, 1996. In addition data concerning infestation by entomophagous insect pests also included direct hand collection, noting type of leaf feeding, leaf mining, presence of frass and any other related symptoms. Hence, plants at the whorl stage, were thoroughly inspected for the presence of live and different insect stages (eggs, immatures, nymphs, pupae, or adults), or for the symptoms of infestation. Careful attention was given to the predatory Insecta and Araneida, and their numbers recorded. No fertilizers or insecticides were applied to the experimental plots during data collection and all plants were left to reach natural levels of field infestation.

All samples of Insecta and Araneida that were collected during the present study were compared with the voucher specimens of the insect and spider collection at the Department of Biological Sciences, Faculty of Science, King Abdul Aziz University. Unidentified specimens were sent to the British Museum (Natural History) and the Insect Taxonomy Division, Egyptian College for Research Center, Ministry of Agriculture, Cairo, Egypt.

Statistical Methods

The Chi-Square test (X^2) was used to compare the differences between each species of insect predator or spider group which were collected during the whorl stage of the corn plant growth by using Sigma Stat Program (Version 5.1)

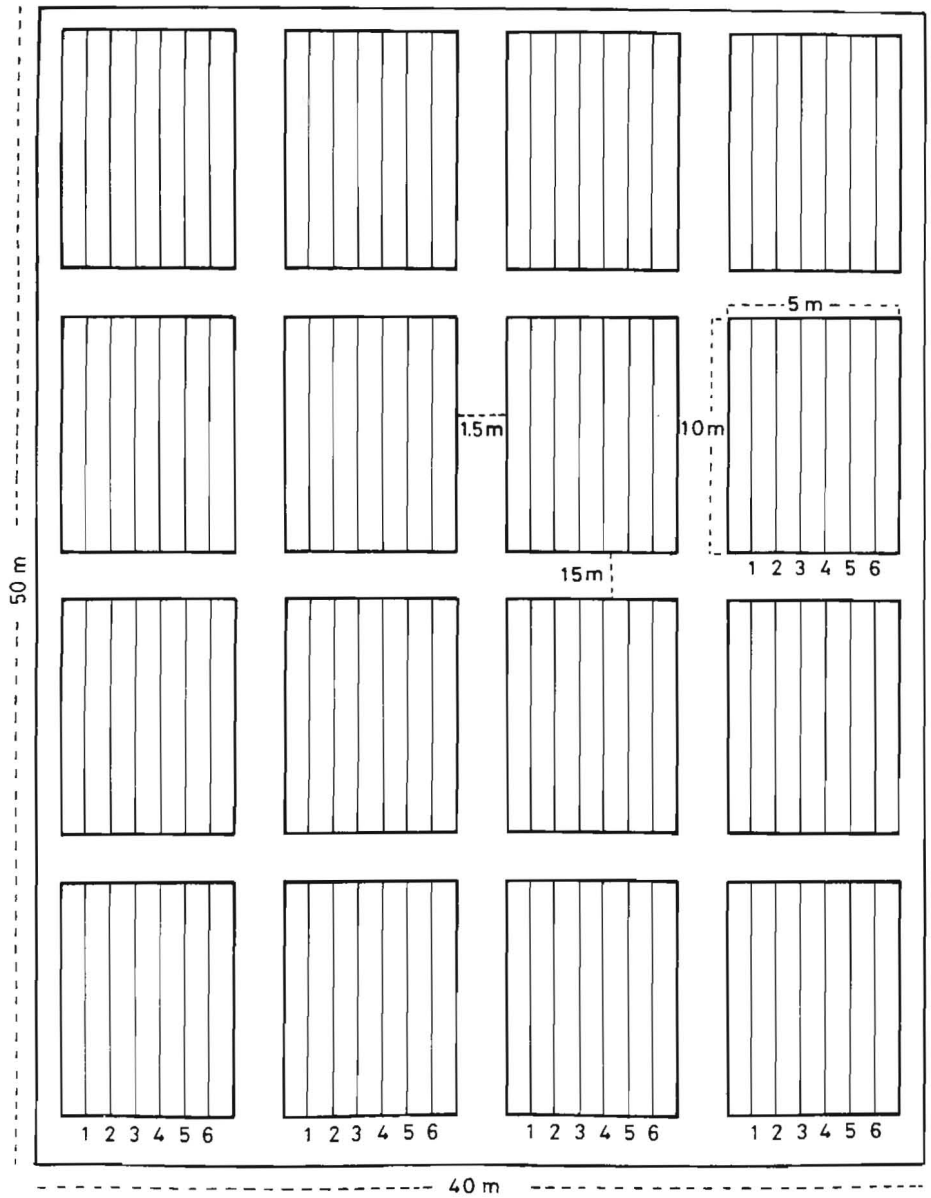

Fig. 1: The rectangular layout of the experimental site of corn varieties (45mX50m), 16 plates each comprised of 6 rows, Hada Al-Sham, Western Saudi Arabia, 1995-1996

Results and Discussion

Data obtained from this field study, showed that field and sweet corn are subjected to a variety of insect pest species including: aphids, aleuriods, mealy bugs, thrips, psyllids, lepidopterous larvae (stem borers) weevils, cicadellids, jassids and grasshoppers (Table. 1). Tables 2 and 5 showed that a rich fauna of predatory insects and spiders were also present. These major predators were found because the high population density of the insect pests was attracting them. The dominant predatory insects were coccinellids, represented by 8 species (Table 2 and 7) with abundant levels of 48% and 68% during the years 1995 and 1996 respectively (Table 7). However, similar densities of true spiders were observed in both years and presented by low numbers which might be attributed to plant height, geometry and architecture (Table 6). These factors predisposed predatory Insecta to occur in high densities as compared with their complementary occurring araneids (Talhouq 1982, Faragalla 1985) who reported that the predaceous insects were more common on this plant than any other predaceous group. The Chi-Square (X^2) test showed that there were no significant differences in numbers during 1995 and 1996 in either Insecta or Arneida (Table 3 and 5).

Data obtained from this study give a clear indication that predators with chewing mouthparts were more abundant than those having sucking mouthparts. Table 3 and 4 showed that the *Orius-Geocoris-Nabis-Deraeocoris* complex is relatively low in numbers as compared to the coccenellid group. Their percentage abundance in both years were 9 and 5.6 respectively (Table 7). However, the second group of insect predators, *chrysopids C. carnea, C. vulgaris*, comprised 15% and 6.4% in 1995 and 1996 respectively (Table 7). The third group of this major predatory complex was the Araneida and comprised 14.6% and 11.0% during the years 1995 and 1996 respectively. These results showed that true spiders comprised a major portion of the predatory complex. Hence our findings are in line with other workers (Talhouq 1982, Kring *et al.* 1985, Faragalla and Ibrahim 1990, Nyffeler and Breene 1992, Kumar and Velusamy 1996) who reported on the rich spider fauna in field crops including sorghum, wheat and rice. No comparisons were made on the fauna of field and sweet corn varieties but we did clearly observe more insect infestation on sweet corn, manifested as poor growth, appearance of shot holes on leaves, broken leaves and an appreciable degree of leaf feeding symptoms.

From this study we observed that the populations of the major predatory Insecta and Araneida were more abundant during the whorl stage of corn plant growth. The coccinellid group was dominant during both years, which suggests that it can play an important role in decreasing densities of key pests on field corn plants. Furthermore, Faragalla and Al-Ghamdl (1989) reported that the coccineillids in alfalfa agroecosystems were the main insect predators feeding voraciously on a varied assemblage of insect pests including: aphids, aleurodids, mealybugs, coccids, psyllids and scale insects, in addition to eggs and small instar larvae of many moths, butterflies and weevils. We conclude that coccinellids might be considered a suitable candidate for suppressing high insect populations, but in order to be included in an IPM program, further studies are needed in the areas of the synchrony with the target insect pest species, laboratory mass rearing and release programs in Saudi Arabia. We recommend more field studies documenting the indigenous predator fauna, with the objective of selecting a potential candidate or candidates that can be mass produced and then released in corn agroecosystems as part of an integrated pest management programs of key pests.

Table 1 : Major entomophagous insect pests collected from field and sweet corn in Hada Al-Sham, Western Saudi Arabia 1995-1996

Orthoptera	Tettigonidae	Mottled-green grasshopper	*Econocephalus varius* WALKER	+ +
		Green grasshopper	*Truxalis procera* KLUG	+
			Homorocoryphus nitidulus SCOPOLI	+
	Acrididae	Red-winged grasshopper	*Acrotylus insubricus* (SCOPOLI)	+ +
		Rice grasshopper	*Ailopus strepens* (LATREILLE)	+
		Dark-veined grasshopper	*Ailopus thalassinus* (FABRICIUS)	+
		Yellow-winged grasshopper	*Morfacris fasciata* THUNBERG	+
		Dark-stripped grasshopper	*Pyragomorpha cognata* KLUG	++
		Egyptian locust	*Anacridum aegyptium* (LINNEAUS)	+
Heteroptera	Cicadellidae	Green leaf hopper	*Empoasca lybica* (DEBERG)	+ +
		Leaf hopper	*Platypleura* sp	+
		Wheat leaf hopper	*Pasmotettix alienus* (DAHLB)	+ +
	Coreidae	Plant bug	*Anopleonemis curuipes* (FABRICIUS)	+ +
		Plant bug	*Stenocephalus pallidus* SING	+
		Plant bug	*Cydnus pilosusn*	+
	Pentatomidae	Green stink bug	*Acrosternum millieri* (M/R)	+ + +
		Black bug	*Aspongopus vidiatus* KLUG	+ +
		Plant bug	*Calidea duedecimpunctata* FABRICIUS	+

++++heavy infestation-+++medium infestation-++mild infestation-+slight infestation

Table 2: Predacious arthropods collected from local varieties of field and sweet corn in Hada Al-Sham locality, Western Saudi Arabia, 1995-1996

HEMIPTERA
Anthocoridae
Orius sp.
Lygaeidae
Geocoris sp.
Nabidae
Nabis sp.
Miridae
Deraecoris sp.
COLEOPTERA
Cicindellidae
Cicindela mealancholica FABRICIUS
Coccinellidae
Coccinella septempunctata LINNAEUS
Coccinella-9-punctata LINNAEUS
Coccinella undecimpunctata LINNAEUS
Chilocorus bipustulatus LINNAEUS (=*Coccinella bipustulatus* LINNAEUS)
Adonia variegata GOEZE
Cydonia (=*Chilomenes*) *propinqua* MULSANT
Cydonia propinqua Var. *posticalis* FAIRM
Cydonia (=*Chilomenes*) *vicina* MULSANT
Coccinella sp. (unidentified)
NEUROPTERA
Chrysopidae
Crysopa carnea STEPHENS
Chrysopa vulgaris SCHNEIDER
DIPTERA
Syrphidae
No further identification
HYMENOPTERA
Formicidae
Formica sp.
Camponotus compressus FABRICIUS
Sphecidae
Ammophila sp.
ARANEIDA[a] ([a] : Total of both immatures and adults)
Agelenidae
No further identification
Aranеidae
Agriop sp.
Clubionidae
Micaria sp.
Salticidae
No further identification
Theridiidae
No further identification
Thomisidae
No further identification

Table 3: Major species of predaceous insects collected from local field and sweet corn varieties at the whorl stage of plant growth, Hada Al-Sham, Western Saudi Arabia, 1995-1996

Weekly Sampling After Whorl Stage													
	1995						1996						X^2 and P-value
Insect Genus/Species	1	2	3	4	5	6	1	2	3	4	5	6	X^2=Test/P-value
Orius sp.	01	02	00	03	01	00	01	01	01	03	02	01	X^2=2.455 P<0.78
Gecoris siculus	02	01	04	00	01	02	01	02	01	01	02	01	X^2=3.960 P<0.55
Nabis capsiformis	02	03	05	01	00	00	01	00	01	00	01	02	X^2=9.018 P<0.10
Deraecoris sp.	03	02	02	00	02	01	03	00	02	03	04	00	X^2=6.539 P<0.25
Cincindela melancholica	02	04	01	02	03	00	01	01	02	03	01	00	X^2=2.986 P<0.56
Coccinella septempunctata	05	06	07	10	04	06	02	03	10	15	16	10	X^2=8.894 P<0.11
C.-9- punctata	04	04	09	12	04	04	05	03	08	16	14	12	X^2=6.096 P<0.29
C. undecimpunctata	04	03	05	08	03	03	03	06	09	18	18	20	X^2=8.279 P<0.14
Chilocorus bipustulatus	03	03	07	10	04	03	04	03	08	16	17	18	X^2=7.978 P<0.15
Adonia variegata	04	05	06	10	05	06	06	05	10	20	17	20	X^2=3.869 P<0.56
Cydonia (=Chilomones) Propinqua	02	02	02	08	02	04	07	05	09	08	10	07	X^2=5.240 P<0.38
Cydonia (=Chilonenes) Vicina	02	04	02	05	02	00	05	05	07	08	06	13	X^2=7.401 P<0.19
Chrysopa Carnea	04	05	07	08	07	06	02	03	04	06	07	00	X^2=4.765 P<0.44
Chrysopa vulgaris	03	04	08	02	04	05	04	03	02	04	04	02	X^2=4.867 P<0.43
Spaerophoria flavicauda	01	01	01	02	01	02	01	01	03	02	01	02	X^2=0.788 P<0.97
Camponotus campressus	04	03	04	03	05	02	06	04	03	03	04	04	X^2=1.269 P<0.93

Chi-square (X^2) test applied to compare differences in number of each insect predator during the years 1995 and 1996 with 11 degrees of freedom.

Table 4: Variation in density of predaceous insects on local field and sweet corn varieties, Hada Al-Sham, Western Saudi Arabia, 1995-1996.

Insect genus / species	Mean ± SD / 1995	Mean ± SD / 1996
Orius sp.	1.17 ± 1.17	1.50 ± 0 84
Gecoris siculus	1.67 ± 1.37	1.33 ± 0.52
Nabis capsiformis	1.83 ± 1.94	0.83 ± 0.75
Deraeocoris sp.	1.67 ± 1.03	2.00 ± 1.67
Cicindela melancholica	2.00 ± 1.41	1.33 ± 1.03
Coccinella septempunctata	6.33 ± 2.07	9.33 ± 5.85
C. -9- punctata	6.17 ± 3.49	9.67 ± 5.16
C.undecimpunctata	4.33 ± 1.97	12.33 ± 7.23
Chilocorus bipustulatus	5.00 ± 2.90	11.00 ± 6.81
Adonia variegata	6.00 ± 2.10	13.00 ± 6.87
Cydonia (=Chilomones) propinqua	3.33 ± 2.42	7.67 ± 1.75
Cydonia (=Chilonenes) vicina	2.50 ± 1.76	7.33 ± 3.01
Chrysopa carnea	6.17 ± 1.47	3.67 ± 2.58
Chrysopa vulgaris	4.33 ± 2.07	3.17 ± 0.98
Sphaerophoria flavicauda	1.33 ± 0.51	1.67± 0.82
Camponotus campressus	3.50 ± 1.05	4.00± 1.09

Table 5: Major families of true spider (*Araneomorphae*) on local field and sweet corn varieties Hada Al-Sham, Western Saudi Arabia, 1995-1996.

	Weekly Sampling After Whorl Stage												
	1995						1996						
Family	1	2	3	4	5	6	1	2	3	4	5	6	X^2-Test/P-value
Agelenidae	01	01	02	00	03	04	01	02	04	01	02	00	X^2=6.166 P<0.29
Araneidae	01	01	02	03	03	04	02	02	03	02	00	01	X^2=5.349 P<0.37
Clubionidae	01	01	02	02	02	02	03	02	02	03	03	02	X^2=0.764 P<0.97
Salticidae	01	00	00	02	02	02	00	01	03	01	02	01	X^2=7.333 P<0.19
Theridiidae	01	01	00	01	01	02	01	02	02	01	01	03	X^2=1.636 P<0.89
Thomicidae	01	02	02	03	02	04	01	02	02	01	04	04	X^2=1.667 P<0.89

Table 6: Major families of true spider (*Araneomorphae*) on local field and sweet corn varieties Hada Al-Sham, Westren Saudi Arabia, 1995-1996.

Family	Mean ±SD/1995	Mean ±SD/1996
Agelenidae	1.83±1.47	1.67±1.37
Araneidae	2.33±1.21	1.83±1.47
Clubionidae	1.67±0.52	2.50±0.55
Salticidae.	1.17±0.98	1.17±1.17
Theridiidae	1.00±0.63	1.67±0.82
Thomicidae	2.33±1.03	2.33±1.37

Table 7: Abundance (%) of the dominant foliage-dwelling predatory arthropod complex on local field and sweet corn varieties, Hada Al-Sham, Western Saudi Arabia, 1995-1996.

Order / Family	Predators species	% Total Predators in 1995	% Total Predators in 1996
HEMIPTERA			
Anthocoridae	*Orius* sp.	01.6	01.4
Lygaeidae	*Geocoris siculus* Fieb	02.4	01.2
Nabidae	*Nabis capsiformis*	02.6	01.0
Miridae	*Deraecoris* sp.	02.4	02.0
DIPTERA			
Syrphidae		02.4	02.0
NEUROPTERA			
Chrysopidae	*Chrysopa* spp.	15.0	06.4
HYMENOPTERA			
Formicidae	*Camponotus compressus*	05.0	04.0
	Formica spp.	02.4	04.0
COLEOPTERA			
Cicindellidae	*Cicindela melancholica* F	03.0	01.2
Coccinellidae	*Coccinella-7-punctata.*	09.0	09.0
	Coccinella-9-punctata	09.0	09.0
	Coccinella undecimpunctata	06.1	12.0
	Chilocorus bipustulatus	07.0	10.3
	Adonia variegata	08.5	12.1
	Cydonia propinqua var. *posticalis*	04.7	08.4
	Cydonia (=*Chilomenes*) *vicina* Var. *subsignata*	03.6	07.1
ARANEIDA			
Araneida spp.		14.6	11.00

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بيئية معقد المفصليات المفترسة على نباتات الذرة الشامية الحقلية والسكرية في هدا الشام بالمنطقة الغربية من المملكة العربية السعودية

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المستخلص: لقد تم إجراء (2000) دراسة حقلية أثناء عامي 1995 ، 1996م للحصول على بيانات عن معقد المفصليات المفترسة من الحشرات والعناكب على أصناف محلية من الذرة الشامية الحقلية والسكرية في منطقة هدا الشام بغرب المملكة العربية السعودية، ولقد أوضحت البيانات التي تم الحصول عليها وجود فونا محلية غنية تكون هذا المعقد خاصة بعد وصول النباتات إلى مرحلة الدوارة من النمو.

واتضح أن أكبر مكونات هذا المقعد هي خنافس الدعاسيق وكانت نسبة وجوها 48%, 69% أثناء عامي 1995, 1996 بالتوالي.

وأوضح اختبار المربع اللاتيني عدم وجود فروقاً معنوية في أعداد الأنواع المفترسة التي تم الحصول عليها أثناء فترة عامي الدراسة، لقد كانت معظم أنواع مجموعةالعناكب الحقيقية تتبع مجموعة الأنواع الشجرية وتمثلت في 6 عوائل سائدة وتشمل عوائل العشبيات ، الروتيلات ، الصولجانيات ، الوثابات ، واليونانيات والسرطانيات .