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Studies on the biology of wheat aphids in the Gezira (D. R. Sudan)

(Homoptera: Aphididae)

With 4 text figures

1. Introduction

The corn leaf aphid, *Rhopalosiphum maidis* (FITCH), and the greenbug, *Schizaphis graminum* (RONDANI), are common aphid species in all the wheat growing areas, particularly in the irrigated area of the Gezira. They appear on the crop shortly after germination and persist almost to harvest. However, it seems that peak populations of each species occurrat different stages of crop growth and that different species may infest leaf-blades of different stages of maturity. Wheat plants attacked by any of the two aphid species show conspicuous signs of damage the most characteristic of which are those caused by *S. graminum*. The symptoms appear as pale spots with deep reddish or blackish centres which develop around feeding punctures. Destruction of chlorophyll and necrosis, according to WADLEY (1931), are caused by the toxic salivary secretions injected by the insect into the plant tissue. This is in addition to the loss of plant sap caused by the direct feeding of the pest. Heavy grain losses are sometimes caused by this aphid (WOOD jr. 1965, ROBINSON & HSU 1963, DANIELS 1957, and many others).

R. maidis, on the other hand, feeds on the rapidly developing young folded leaf-blades (the whorl) of the plant. The clustering and feeding of large numbers of aphids in the whorl may injure the plant by hindering the exsertation of head from the boot (CARTIER & PAINTER 1956, HOWITT & PAINTER 1956, and others).

The present investigations were carried out on wheat during the years 1967–1971, on the distribution and relative abundance of the two aphid species, on the voltinism, fecundity and longevity of *S. graminum*.

2. The distribution and relative abundance of wheat aphids

In this study, the occurrence of the two aphid species is investigated in relation to the growth of the wheat plant, to the time of appearance and the relative proportions of each species.

2.1. Methods

During seasons 1967–1968 and 1968–1969, regular weekly counts of the two aphid species were made on an unsprayed wheat plot in the Gezira Agricultural Research Farm. A sample of 10 wheat stems was taken at random and a blade-by-blade count of nymphs and adults of each of the two species was made; the youngest leaf-blade was considered as blade number 1, the second youngest as blade number 2 and so on; the maximum number of blades found on a single plant was 7.

The counts permitted direct comparisons to be made of the distribution of the two aphid species in relation to the sequential blade number from the top of the plant to the bottom. This number was indicative of the blade age and consequently of the relative suitability of the blades of each age group as host units.

2.2. Results

A graphical representation of the aphids distribution along the wheat plant during the counts at which both species occurred side by side is giving in Figs. 1 and 2 for season 1967–1968 and season 1968–1969 respectively.

The density of *R. maidis* which fed on the upper (inner) surface of leaf-blades was extremely high on the youngest blades and decreased gradually to very low or nil on the third and fourth blades. These aphids were seldom found on the lowest leaf-blades. There were indications that individual aphids 'migrated' from the young blades they had initially occupied to younger, newly growing blades as the former became unsuitable. Between infested blades, the distribution of aphids followed more or less a particular pattern; the infestation was uniformly distributed from the base to the tip of the youngest central blades and was confined to the proximal areas of the youngest blades of the plant.

Peak numbers of *R. maidis* occurred during the first half of December when there were 50,4 aphids per plant during season 1967–1968 and 91,9 aphids per plant during season

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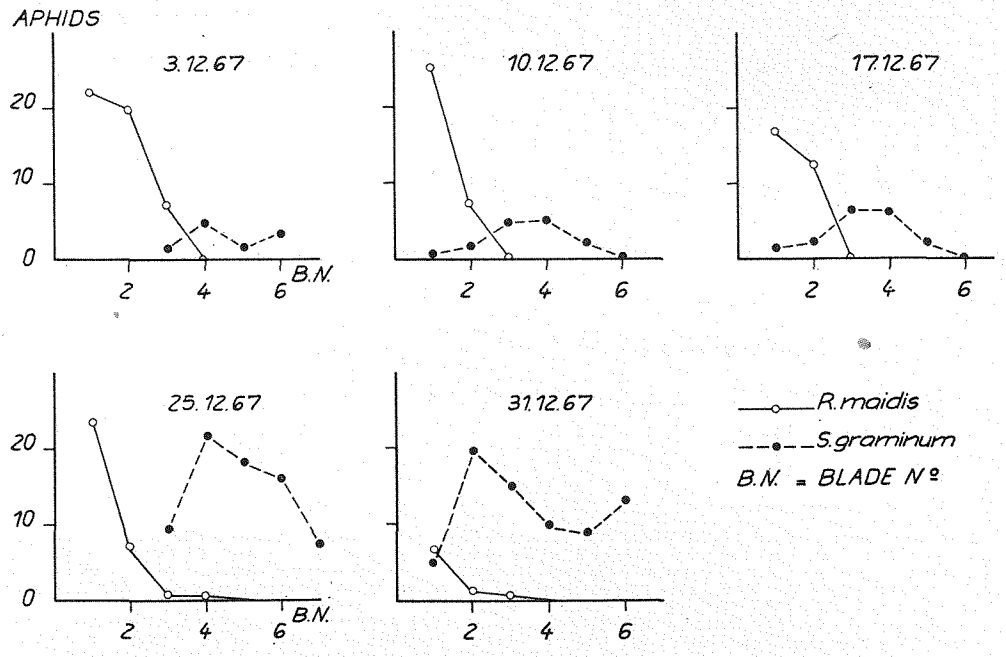

Fig. 1. Blade-by-blade distribution of *Rhopalosiphum maidis* and *Schizaphis graminum* 1967

1968—1969 (Fig. 3). The gradual disappearance of this aphid coincided with the emergence of wheat heads which terminated further growth of young blades, the sites most favoured for feeding and breeding of the insect.

The distribution of *S. graminum* was radically different from that of *R. maidis*. The former species occurred on the lower surface of leaf-blades but sometimes found on the upper surface. Infestation by this aphid was fairly evenly distributed according to blade age but tended to aggregate on the leaf-blades situated at or near the middle of the plant. However, at the early stages of infestation of the crop, the aphids were denser on leaf-blades at and below the middle part of the plant than at the top (Figs. 1 and 2). With the advancement of the season, when the growth of the young blades ceased as a result of emergence of the wheat heads, and the old blades senesced, there seemed to be a progressive movement of aphids towards the upper maturing blades.

Peak numbers of *S. graminum* occurred during the first week of January. Counts revealed 111,6 aphids per plant during season 1967—1968 and 102,9 aphids per plant during season 1968—1969 (Fig. 3). The steady reduction of aphid populations was brought about by the gradually rising temperature and the increasing number of senescing leaf-blades.

3. Voltinism, fecundity and longevity

The following observations were based on records obtained from experiments in which *S. graminum* was reared in a well-ventilated greenhouse from December 1969 to March 1970, the period during which outbreaks of this aphid normally take place on wheat in the field.

3.1. Materials and methods

The rearing programme was started during the second week of December 1969, directly after the first alatae were observed in the field. Six of these alatae were caged separately in the greenhouse and one nymph from each alate parent was used as a founder of a clone; six clones were thus established. The females, and the generations to which they gave rise, were reared each in a small cylindrical cage (about 1 cm long) made of celluloid and covered at one end with afine wire gauze. The open end of the cage was carefully adpressed on the blade where the insect was to be reared. The cage was supported by a piece of cardboard placed on the opposite surface of the blade and secured by a hair clip. The area thus covered by the cage was about 1 sq.cm.

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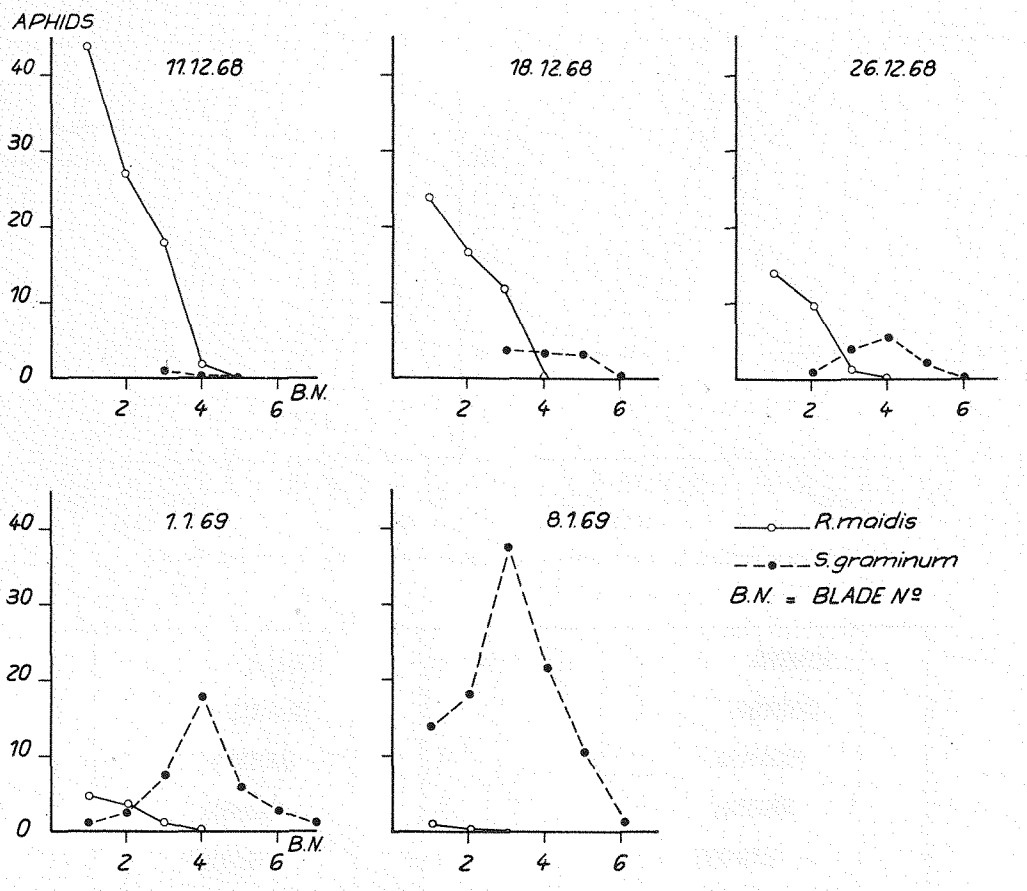

Fig. 2. Blade-by-blade distribution of *Rhopalosiphum maidis* and *Schizaphis graminum* 1968/69

From each female, lines of first born nymphs and of last born nymphs respectively were established and daily observations were made of the date of birth, of the appearance of the different developmental stages, of the rate of reproduction and of the date of death of each of the individuals reared. A complete set of records was obtained for two clones only; the continuity of rearing of females in the rest of the clones was interrupted by the death or loss of the parent.

3.2. Results

3.2.1. Voltinism

The number of generations was calculated for the period between the appearance of the insect in the field and the harvest of the crop. The results are given in Fig. 4.

In clone A, eleven consecutive first born generations were reared. Hence, by considering the founder of the clone as generation I, the maximum number of generations obtained was twelve. The average period between each individual generation and the next (that is from birth to the production of the first off-spring) was 6,2 days, the range varying from 5 to 8 days.

In clone B, there were eleven generations including the founder of the clone. The period between each individual generation and the next ranged between 5 and 9 days with an average of 6,7 days. The life history of generations 11 and 12 in clone A and generations 10 and 11 in clone B were completed a few days after harvest.

By rearing the last born nymphs of the last born parents, two generations were obtained in both clones, the second generation in each clone continued its life history a few days in the post-harvest period. Including the founder of the clone as before, a minimum of three generations occurred in both clones. An average of 32 days elapsed

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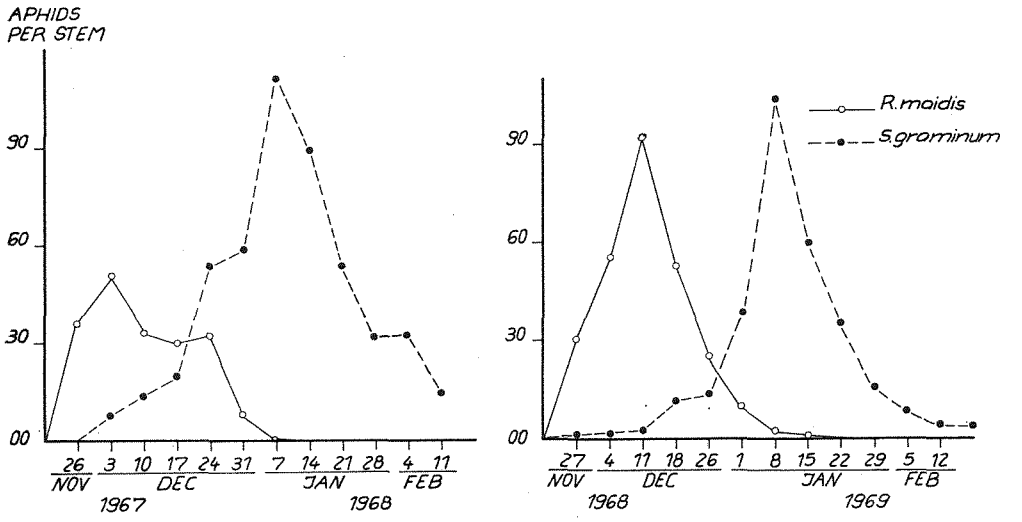

Fig. 3. Seasonal distribution and relative abundance of wheat aphids 1967/68 and 1968/69

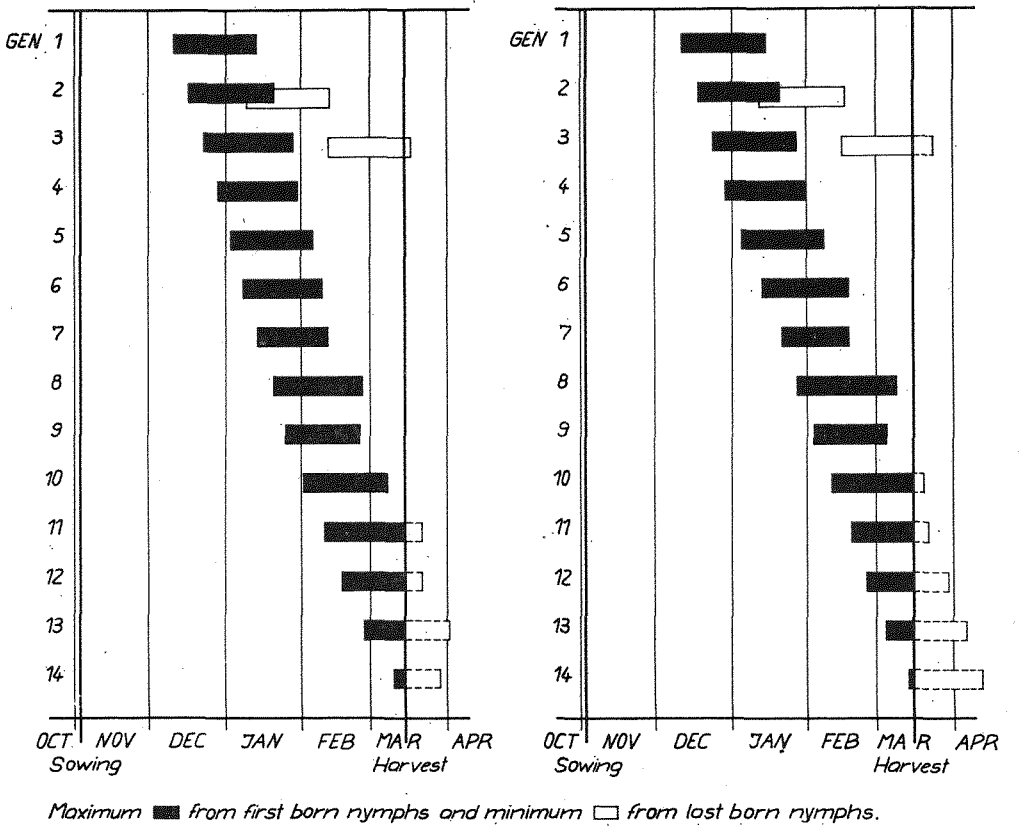

Fig. 4. Number of generations in clone A (left) and in clone B (right) of *Schizaphis graminum*

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between each completed generation and the next, that is, from birth to the end of the reproductive period of the aphid concerned; the range lay between 30 und 34 days.

3.2.1. Development

In *S. graminum* there were normally four instars but occasionally three instars were noted. By counting the exuviae it was found that out of the 27 individuals of this species reared from birth till death, 22 individuals passed through four nymphal instars and only 5 individuals passed through three nymphal instars.

The mean duration of each instar and the total nymphal life are given together with the overall mean minimum and mean maximum temperatures in Table 1. The average nymphal life was 5,3 days, the range lay between 4 and 8 days.

Table 1

Mean duration of nymphal instars and total nymphal life (in days) in *S. graminum*

	1st instar	2nd instar	3rd instar	4th instar	Total nymphal life	Temp. during nymphal life °C	
						Mean min.	Mean max.
Mean (calculated from 27 individuals)	1.6	1.3	1.3	1.3	5.3	15.8	34.7
S. E.	±0.50	±0.48	±0.48	±0.55	±0.82		

Table 2

Mean longevity and fecundity of apterous viviparous females of *S. graminum*

	Total longevity (days)	Adult longevity (days)	Total No. of off-spring	Temp. during adult life °C	
				Mean min.	Mean max.
Mean (calculated from 27 individuals)	33.4	28.1	78.6	16.1	34.7
S. E.	±2.22	±2.81	±13.42		

3.2.2. Longevity and fecundity

The lifespan (from birth to death) and the longevity of the adult apterae (from the fourth ecdysis to death) are given together with the overall mean minimum and mean maximum temperatures in Table 2. The average adult longevity was 28.1 days (range 22 to 34 days) during which the mean fecundity was 78,6 nymphs (range 52 to 116 nymphs). The average total longevity of the female was 33,4 days (range 27 to 40 days).

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Summary

Weekly counts in a wheat field in the central part of the Democratic Republic of Sudan have shown considerable differences in the settling behaviour of *Rhopalosiphum maidis* (FITCH) and of *Schizaphis graminum* (RONDANI). *R. maidis* prefers the upper surface of the youngest blades. *S. graminum*, however, mostly occurs on the upper blade surface, and it aggregates on the blades situated at or near the middle of the plant but is distributed also over the whole plant. The peak infestation of *R. maidis* takes place during the first half of December on the young wheat plants. The aphid disappears when the wheat ears emerge and the growth of young blades ceases. *S. graminum* attains its greatest abundance on the wheat about one month later. After the first alatae of *S. graminum* had appeared in the wheat fields a rearing experiment was started in a well-ventilated greenhouse. The first born nymphs were used for the further propagation, and 10 to 12 generations of *S. graminum* could be attained until the wheat crop was harvested in the field. In connection with these rearing experiments observations on the duration of the development, the fecundity and the life-span were made.

Zusammenfassung

Wöchentliche Zählungen in einem Weizenfeld im mittleren Teil der D. R. Sudan haben beträchtliche Unterschiede im Ansiedelungsverhalten von *Rhopalosiphum maidis* (FITCH) und von *Schizaphis graminum* (RONDANI) ergeben. *R. maidis* bevorzugt die Oberseite der jüngsten Blätter. *S. graminum* kommt im Gegensatz dazu vorwiegend an der Blattoberseite vor und lebt gehäuft an solchen Blättern, die in oder nahe der Mitte der Pflanzen gelegen sind, aber die Aphiden sind außerdem über die ganze Pflanze verteilt. Die Befallsspitze von *R. maidis* erfolgt während der ersten Dezemberhälfte an den jungen Weizenpflanzen. Die Blattlaus verschwindet, wenn die Ähren erscheinen und weiteres Wachstum von jungen Blättern aufhört. *S. graminum* erreicht die maximale Populationsdichte an Weizen ungefähr einen Monat später. Nachdem die ersten Geflügelten von *S. graminum* in den Weizenfeldern erschienen waren, wurde in einem gut durchlüfteten Gewächshaus mit einem Zuchtversuch begonnen. Wenn jeweils die erstgeborenen Larven für die Weiterzucht verwendet wurden, konnten von *S. graminum* bis zu dem Zeitpunkt, zu dem die Weizenfelder abgeerntet wurden, zehn

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bis zwölf Generationen erhalten werden. In Verbindung mit diesen Zuchtversuchen wurden Beobachtungen über Entwicklungsdauer, Fruchtbarkeit und Lebensspanne durchgeführt.

Резюме

Еженедельные подсчеты в пшеничных посевах средней части Демократической Республики Судан показали значительные разницы в поведении *Rhopalosiphum maidis* (FITCH) и *Schizaphis graminum* (RONDANI) при заселении растений. *R. maidis* предпочитает верхнюю сторону самых молодых листьев. В противоположность этому *S. graminum* прежде всего встречается на верхней стороне листьев, расположенных в середине и близ середины растения, а кроме того тли распространяются по всему растению. Максимальное заражение растений *R. maidis* происходит во время первой половины декабря у молодых растений пшеницы. Тли исчезают в тот момент, когда колошение начинается и рост молодых листьев прекращается. Максимальная популяционная плотность *S. graminum* у пшеницы наблюдается примерно 1 месяц позже. После появления первых крылатых *S. graminum* в пшеничных посевах начали опыты их разведения в хорошо проветренной теплице. Если при дальнейшем разведении использовались первые отродившиеся личинки, были получены 10–12 поколений *S. graminum* до уборки урожая пшеницы. В рамках этих опытов были проведены наблюдения по продолжительности развития, плодовитости и продолжительности жизни.

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