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Microclimatic Morphs and Plant Distribution Analysis of *Rhopalosiphum maidis* (Fitch) and *Schizaphis graminum* (Rondani) on Wheat

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Abstract: Research was conducted at the experimental fields of the Crop Science Institute, National Agricultural Research Centre, Islamabad during winter 2003. Inqilab-91 wheat variety was sown under Randomized Complete Block Design with three replicates. Data were collected through visual count method weekly. Overall aphid morphs distribution of both aphid species was significantly different during season 2003. Population of *Rhopalosiphum maidis* (Fitch) nymphs peaked to 5.508±1.22 nymphs/plant during mid March. Apterous and alates population peaked 1.293±0.486 and 1.114±0.278/plant, respectively. Morphs population of *Schizaphis graminum* (Rondani) including nymphs, apterous and alates peaked to 20.853±2.35, 3.516±0.771 and 0.375±0.077/plant, respectively. Corn leaf aphid mean population distribution on leaf, stem and spike was significantly different ($F_{12,103}$=4.555, P=0.000; $F_{12,103}$=5.367, P=0.000; $F_{12,103}$=3.224, P=0.001) and non significant on flag leaf ($F_{12,103}$=1.138, P=0.340) during crop season. Greenbug mean population distribution on leaf, stem, flag leaf and spike was significantly different ($F_{12,103}$=12.659, P=0.000; $F_{12,103}$=4.902, P=0.000; $F_{12,103}$=7.147, P=0.000; $F_{12,103}$=3.254, P=0.001) during 2003, respectively.

Key words: *Rhopalosiphum maidis*, *Schizaphis graminum*, wheat, distribution

INTRODUCTION

Wheat (*Triticum aestivum* L.) being a major cereal occupies an eminent place in the economy of our country[1]. It is describe as king of cereals for centuries and contributes to retain this pride even today. It provides about 60% of the calories and 50% of the protein to the human race[2]. It (*Triticum aestivum* L.) belongs to the family Poaceace, tribe Hordeae, is the most important cereal food grain in the world, provides more protein than any other cereal[3]. It contributes 12.1% to the value added in agriculture and 2.9% to GDP[4].

Aphids are the probably most familiar plant pests commonly known as green fly or black fly and there are only few plants that are not liable to be infested by this persistent and destructive insect pest. Majority of aphids suck sap of the leaves and young shoots causing distortion, stunting and sometime premature leaves fall[5]. Aphids colonies persist throughout the year but are most numerous and troublesome in spring and early summer[6]. Aphids reproduce either sexually or parthenogenetically and occur mainly as winter pest in the world[7].

Rabbinge *et al.*[8] reported that more important factors that caused yield losses were powdery mildew and cereal aphids. Aphid's population has been increasing for the last few years on wheat crop and attaining the status of pest in Pakistan[9,10]. In Pakistan, aphid species reported on wheat crop include *Sitobion avenue* (Fabricius), *Schizaphis graminum* (Rondani), *Metapolophium dirhodum* Walker, *Macrosiphum granarium* (Fabricius), *Rhopalosiphum padi* (Linnaeus), *Rhopalosiphum maidis* (Fitch), *Rhopalosiphum rufiabdominalis* Sasaki and *Sipha maydia* Passirinae[11-14].

Wheat is severely attacked by the wheat aphids which affect the production adversely[15-19]. Greenbug, *Schizaphis graminum* (Rondani) is monoecious and exhibit life cycle on Graminae[20]. Corn leaf Aphid, *Rhopalosiphum maidis* (Fitch) is bluish-green with black legs, antennae and cornicles. Corn leaf aphid can be found on corn, sorghum, wheat and barley.

To prevent losses by aphids, several control methods have been used. These include cultural, physical, mechanical, biological, chemical and host plant resistance. Control through chemicals has created a number of problems by killing the beneficial insects and resistance development in the pests. In order to combat the increasing resistance in aphids and to reduce the pesticide load in environment, it is needed to adopt integrated pest management (IPM) strategies.

Abiotic factors affect the physiology and behavior of insects and act as density independent factors which only determine the change in insect population. Abiotic factors can produce physiological effect on insect population in four major ways by modifying activity of endocrine system, survival, development and reproduction[21].

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Keeping in view the importance of cereal aphids on wheat, the present research will be aimed on the following objectives:

- To understand the populations build up of cereal aphid species under field conditions.
- To determine the time and duration at which particular cereal aphid species will infest the wheat.
- To determine the distribution of cereal aphids on different plant parts of various wheat varieties.

MATERIALS AND METHODS

Present research was conducted to study microclimatic distribution of two different cereal aphids species including *Rhopalosiphum maidis* (Fitch) and *Schizaphis graminum* (Rondani) under field conditions. Wheat crop was sown during crop season in the experimental fields of crop science institute (CSI), national agriculture research centre (NARC), Islamabad during 2003.

Inqilab-91 variety of wheat was sown in the experimental field under Randomized Complete Block Design. There were three replication of experimental material with total 24 experimental plots. Total experimental area was 608 m^2 with dimension of 32 m length and 19 m in width. Size of experimental plot was 15 m^2 with dimension of 10 m length and 1.5 m in width. Each experimental plot was sown with six rows of wheat with 25 cm row to row distance and 15 cm plant to plant distance. There was 1 m treatment and replication path.

Random sampling technique was used for the whole crop research period. Two different sampling techniques were followed for cereal aphid population[5].

Plant based sampling: In plant based sampling, the wheat plants were sampled on different growth stages. This included following sampling stages:

- Whole plant based sampling from seedling to tillering stage of wheat.
- Tiller based sampling all leaves and whole selected tiller were sampled after tillering of wheat.
- Flag leaf based sampling included the sampling of cereal aphids population on the flag leaf of wheat crop. Ten flag leaves per plot were sampled.
- Spike based sampling included the sampling of cereal aphis on spikes of wheat crop when at least 50% of plants was having the spike on them and 10 spikes per plot were sampled.

Insect based sampling: In insect based sampling, wheat plant was sampled for morph development. This technique included:

- Morph based sampling of cereal aphids included, the sampling of nymphs, alates and apterous adults.
- Different cereal aphid species were sampled
- Only two species were sampled on specie based sampling for cereal aphids including, *Rhopalosiphum maidis* (Fitch) and *Schizaphis graminum* (Rondani).

Data were recorded on weekly basis on random plant selection in all experimental plots. Data collection started after the wheat seedling emergence and continued until the harvesting of wheat crop. Cereal aphid population was recorded on the basis of insect and plant based sampling techniques. Cereal aphids of wheat crop were collected from the adjacent field of wheat crop as wet preservation in 70% alcohol. Aphids were identified by using different taxonomic characters based on identification keys[20,22]. Data were analyzed by using the different statistical computer software (SPSS 10, STATISTICA 5.0 and Minitab 13.2). Descriptive statistical (mean, standard deviation, standard error, sum) and ANOVA was calculated from the data for results interpretations[23].

RESULTS AND DISCUSSION

Cereal aphids morph distribution was observed weekly on wheat plant. Morphs of aphid include nymph, apterous and alates. Species revealed certain aphid morphs distribution on wheat plants in field.

Corn leaf aphid, *Rhopalosiphum maidis* (Fitch): Aphid morphs distribution of corn leaf aphid was significantly different on weekly basis ($F_{12,103}$=7.043, P=0.000; $F_{12,103}$=7.068, P=0.000; $F_{12,103}$=8.061, P=0.000). Nymph's population appeared during 4th week of January and remained less than one per plant until end of February (Table 1). Maximum population was recorded during March. Population peaked to 5.508±1.22/plant during mid March.

Apterous adult population of *R. maidis* was recorded zero during January. Maximum population ranged from 0.725±0.153 to 1.293±0.486/plant during 9th to 11th week in March. Alates adult peaked to 1.114±0.278/plant during 6th week in February.

Greenbug, *Schizaphis graminum* (Rondani): Nymphs, apterous and alates weekly population was observed significant on wheat plants ($F_{12,103}$=16.882, P=0.000; $F_{12,103}$=16.753, P=0.000; $F_{12,103}$=2.017, P=0.031), respectively. Nymph's population was peaked 20.853±2.35/plant during 3rd week of March (Table 2). Population declined to 1.036±0.255 nymphs/plant towards end of March. Apterous population peaked to 3.516±0.771/plant during 11th week in March. Alates population was recorded maximum during early in the season (0.196±0.085/plant) and 13th week (0.375±0.077/plant) in March 2003.

Table 1: Mean±S.E. for population of *Rhopalosiphum maidis* (Fitch) morphs on wheat

Dates	Nymphs	Apterous	Alates
06-01-2003	0.00±0.00a	0.00±0.00a	0.00±0.00a
13-01-2003	0.00±0.00a	0.00±0.00a	0.00±0.00a
20-01-2003	0.00±0.00a	0.00±0.00a	0.00±0.00a
27-01-2003	0.12±0.08a	0.43±0.15ab	0.00±0.00a
03-02-2003	0.28±0.28a	0.19±0.16a	0.00±0.00a
10-02-2003	0.77±0.25a	0.11±0.08a	1.11±0.28c
17-02-2003	0.23±0.07a	0.03±0.02a	0.33±0.08a
24-02-2003	1.17±0.19ab	0.28±0.06ab	0.005±0.00a
03-03-2003	2.96±0.47bc	0.73±0.15bc	0.01±0.01a
10-03-2003	4.23±0.70cd	1.10±0.15cd	0.16±0.05a
17-03-2003	5.51±2.22d	1.30±0.48d	0.73±0.33b
24-03-2003	0.58±0.51a	0.20±0.10a	0.04±0.02a
31-03-2003	0.12±0.09a	0.00±0.00a	0.03±0.02a

Table. 2: Mean±S.E. for population of *Schizaphis graminum* (Rondani) morphs on wheat

Dates	Nymphs	Apterous	Alates
06-01-2003	0.00±0.00a	0.00±0.00a	0.00±0.00a
13-01-2003	0.00±0.00a	0.00±0.00a	0.00±0.00a
20-01-2003	0.42±0.22a	0.10±0.07a	0.16±0.08ab
27-01-2003	1.17±0.63a	0.15±0.07a	0.20±0.08ab
03-02-2003	0.70±0.32a	0.17±0.09a	0.07±0.05a
10-02-2003	0.93±0.45a	0.16±0.06a	0.17±0.09ab
17-02-2003	0.28±0.13a	0.04±0.02a	0.18±0.07ab
24-02-2003	0.43±0.15a	0.09±0.03a	0.03±0.01a
03-03-2003	1.06±0.38a	0.23±0.07a	0.04±0.02a
10-03-2003	1.74±0.63a	0.40±0.12a	0.18±0.12ab
17-03-2003	20.85±4.71c	3.52±0.77b	0.15±0.11ab
24-03-2003	11.46±2.32b	2.77±0.60b	0.23±0.09ab
31-03-2003	1.03±0.26a	0.45±0.13a	0.37±0.07b

Table 3: Mean±S.E. for numbers of Corn leaf aphid, *Rhopalosiphum maidis* on different plant parts

Dates	Leaf	Stem	Flag leaf	Spike
06-01-2003	0.00±0.00a	0.00±0.00a	0.00±0.00a	0.00±0.00a
13-01-2003	0.00±0.00a	0.00±0.00a	0.00±0.00a	0.00±0.00a
20-01-2003	0.00±0.00a	0.00±0.00a	0.00±0.00a	0.00±0.00a
27-01-2003	0.51±0.20ab	0.00±0.00a	0.00±0.00a	0.00±0.00a
03-02-2003	0.48±0.43ab	0.00±0.00a	0.00±0.00a	0.00±0.00a
10-02-2003	1.99±0.37abc	0.00±0.00a	0.00±0.00a	0.00±0.00a
17-02-2003	0.33±0.08ab	0.00±0.00a	0.00±0.00a	0.00±0.00a
24-02-2003	1.04±0.17ab	0.27±0.15ab	0.12±0.10a	0.03±0.01a
03-03-2003	2.55±0.43bc	0.75±0.36c	0.27±0.21a	0.06±0.01a
10-03-2003	3.46±0.62cd	0.66±0.23bc	0.21±0.12a	1.26±0.77b
17-03-2003	5.00±2.51d	0.92±0.28c	0.24±0.18a	1.38±0.40b
24-03-2003	0.08±0.01a	0.00±0.00a	0.02±0.01a	0.70±0.52ab
31-03-2003	0.08±0.01a	0.00±0.00a	0.01±0.00a	0.05±0.02a
07-04-2003	0.00±0.00a	0.00±0.00a	0.00±0.00a	0.00±0.00a

Percentage distribution of cereal aphids: Percentage morphs distribution of nymphs of *Rhopalosiphum maidis* was observed maximum (70.1%) followed by Apterous (19.2%) and alates (10.6%) on wheat, respectively (Fig. 1 and 2). Nymphs of greenbug was recorded highest (80.3%) and alate adults was minimum (3.5%).

According to Salem[24] infestation of adult females of greenbug (especially winged females) was initiated on wheat as soon as seedling emerged. The winged adult females initiated infestation on wheat seedling at the beginning of the growth season. Nymph population reached the highest counts between mid February to the end of March in both seasons, i.e. during vegetative growth, spike emergence and grain filling. The highest number of nymphs was 504.2 and 158.77 nymphs/tiller for the 1st and 2nd seasons, respectively. Webster and Porter[25] reported that under laboratory conditions, aphid nymphs produced/adult were greatest with green bug (74.3±1.9) and bird cherry-oat aphid (49.4±2.1) on wheat. Akhtar and Khaliq[5] reported that alates of aphid occur least in number than apterous and nymphs. Nymphal stage was most prominent in aphids than other stages of development. Sekhar and Singh[26] concluded that both adults and nymphs of *Rhopalosiphum padi* reduce the yield of crop by infesting leaves and stem of the crop. Nymphs and adults of cereal aphids gradually disappear as the crop move near maturity[27].

All species showed difference in their plant distribution on wheat. Plant distribution was observed on leaf, stem, flag leaf and spike on plant.

Corn leaf aphid, *Rhopalosiphum maidis* (Fitch): Weekly mean population distribution on leaf, stem and spike was significantly different ($F_{12,103}$=4.555, P=0.000 ; $F_{12,103}$=5.367, P=0.000; $F_{12,103}$=3.224, P=0.001) and non significant on flag leaf of ($F_{12,103}$=1.138, P=0.340) during crop season. During start and end of season, mean population on all plant parts was recorded minimum. Peaked population was observed on leaf, stem and spike in 11th week during March. Peaked population on flag leaf was recorded in 9th week (Table 3).

Greenbug, *Schizaphis graminum* (Rondani): Weekly mean population distribution on leaf, stem, flag leaf and spike was significantly different ($F_{12,103}$ = 12.659, P = 0.000; $F_{12,103}$ = 4.902, P = 0.000; $F_{12,103}$ = 7.147, P = 0.000; $F_{12,103}$ = 3.254, P = 0.001) during 2003, respectively. Peaked population was recorded during 11th week in March on leaf, stem and flag leaf of wheat plants. Greenbug population peaked on spike during 13th week in March (Table 4).

Difference was observed in percentage distribution of cereal aphids on different plant parts of wheat (Fig. 3 and 4). Leaf was preferred by *Rhopalosiphum maidis* (69.0%) > spike (15.5%) > stem (11.6%) and flag leaf (3.9%). *Schizaphis graminum* maximum population was observed on leaves (78.6%) > spike (9.6%) > flag leaf (8.7%) and stem (3.1%). Overall cereal aphids preferred the leaf part of plant followed by spike, flag leaf and stem, respectively.

According to Akhtar and Perveen[28] *Schizaphis graminum* and *Rhopalosiphum padi* density per leaf varied from January 9, 1998 to April 14, 1998 and was maximum on February 26, 1998. At the end of February,

Table. 4: Mean±S.E.for numbers of Greenbug, *Schizaphis graminum* on different plant parts

Dates	Leaf	Stem	Flag leaf	Spike
06-01-2003	0.00±0.00a	0.00±0.00a	0.00±0.00a	0.00a±0.00a
13-01-2003	0.00±0.00a	0.00±0.00a	0.00±0.00a	0.00a±0.00a
20-01-2003	0.67±0.24a	0.00±0.00a	0.00±0.00a	0.00a±0.00a
27-01-2003	1.52±0.71a	0.00±0.00a	0.00±0.00a	0.00a±0.00a
03-02-2003	0.94±0.38a	0.00±0.00a	0.00±0.00a	0.00a±0.00a
10-02-2003	1.26±0.48a	0.00±0.00a	0.00±0.00a	0.00a±0.00a
17-02-2003	0.37±0.14a	0.00±0.00a	0.00±0.00a	0.00a±0.00a
24-02-2003	0.39±0.12a	0.03±0.02a	0.02±0.01a	0.16a±0.06a
03-03-2003	0.86±0.30a	0.06±0.04a	0.04±0.02a	0.36±0.07ab
10-03-2003	1.13±0.37a	0.05±0.03a	0.07±0.04a	1.10±0.74bc
17-03-2003	19.83±2.18b	1.25±0.54b	2.24±0.83b	0.93±0.41a-c
24-03-2003	11.83±2.84b	0.16±0.08a	1.88±0.62b	0.74±0.35a-c
31-03-2003	0.29±0.09a	0.00±0.00a	0.07±0.03a	1.50±0.30c
07-04-2003	0.00±0.00a	0.00±0.00a	0.00±0.00a	0.04±0.00a

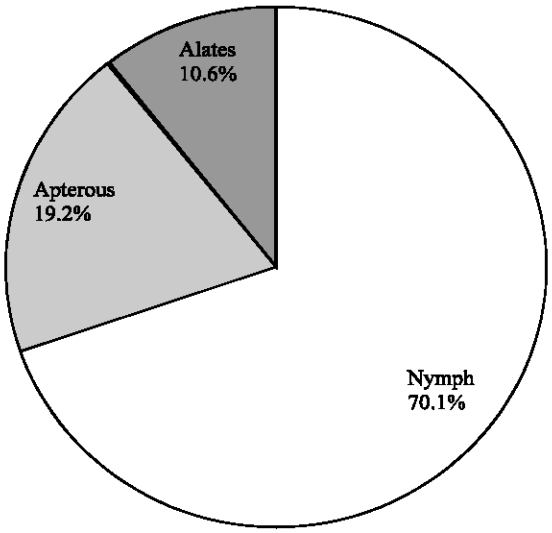

Fig. 1: Morphs distribution of *Rhopalosiphum maidis* (Fitch) on wheat during 2003

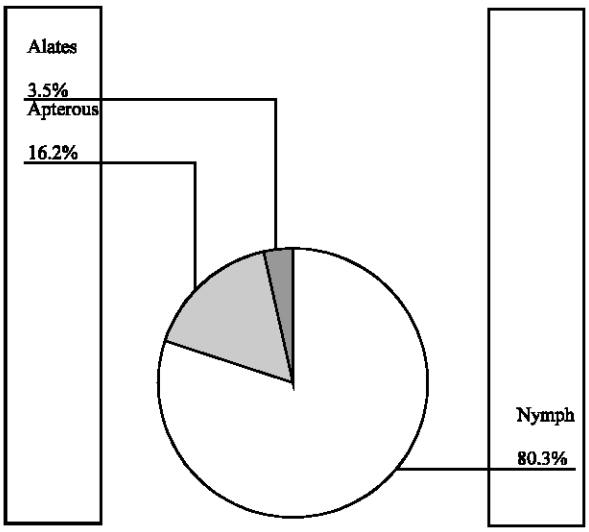

Fig. 2: Morphs distribution of *Schizaphis graminum* (Rondani) on wheat during 2003

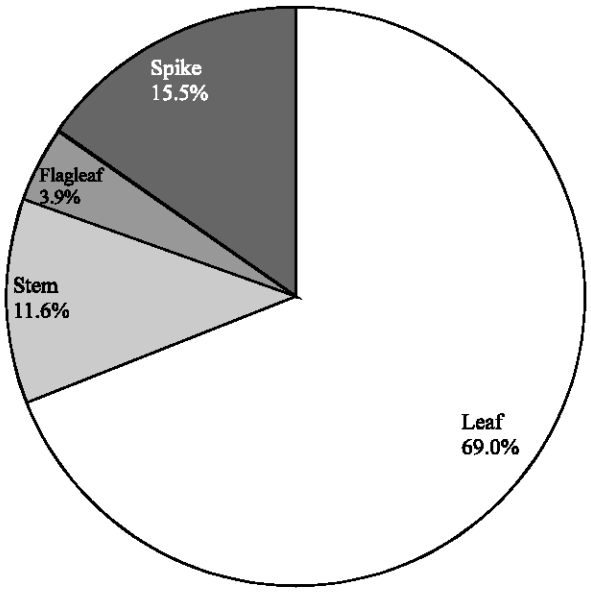

Fig. 3: Distribution of *Rhopalosiphum maidis* on different plant parts of wheat during 2003

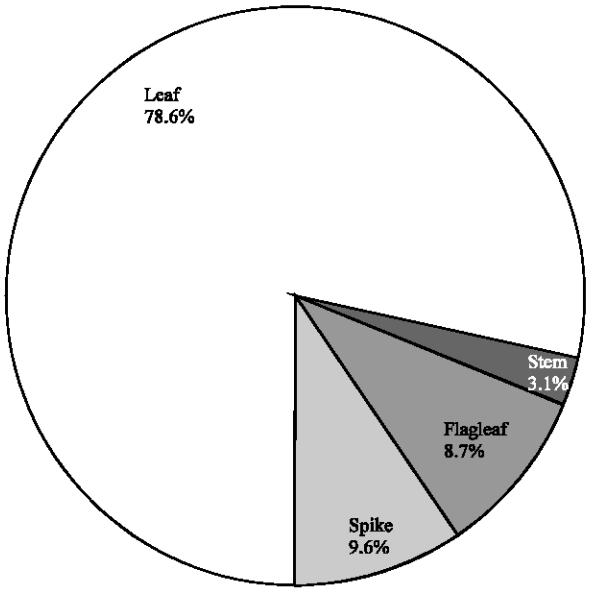

Fig. 4: Distribution of *Schizaphis graminum* on different plant parts of wheat during 2003

aphids started shifting to the ears. Maximum aphid population per ear (48.0) was recorded on March 27, 1998. Sattar *et al.*[29] observed that population reached a peak of 4.545 aphids/leaf during second week of March. With the maturity of the leaves, the aphids shifted to the ears during last week of March and disappeared towards the end of April when the ears were almost dry. The indole alkaloid contents of flag leaves and ears in most resistant lines were higher than those in susceptible lines,

especially in ears. The indole alkaloid content of ears was highly correlated to pest resistance, whereas that of flag leaves was only slightly related to pest resistance[30].

The greater aphid densities were recorded on leaves and spike. Aphids were recorded more on leaves and on succulent terminal portion because of soft nature of leaves and maximum food supply towards terminal portion of the plant. Being a sucking pest aphid prefer to insert their stylets at soft surface with maximum food supply[31]. Sekhar and Singh[26] concluded that both adults and nymphs of *Rhopalosiphum padi* reduce the yield of crop by infesting leaves and stem of the crop. Ahmed[32] reported that a large population of aphid transferred to spike as compared to leaves and stem. Maximum abundance of aphids occurred with the emergence of grain ears at the beginning of the flowering period[33]. According to Sattar *et al.*[29] observation aphid multiplied much rapidly during the reproductive growth stage of the plant resulting in higher number of aphids on plant.

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