J. Agric. Sci. Mansoura Univ., 32 (4): 3113 - 3122, 2007

IMPACT OF NPK FERTILIZERS, WHEAT VARIETIES AND THEIR INTERACTIONS ON THE INFESTATION WITH CEREAL APHIDS AND LEAFMINER, YIELD AND ITS COMPONENTS

El-Rawy, A.M.*; M.A. Khaled and Soad M. Osman***
*** Plant Protection Research Institute, ARC, Dokki, Giza, Egypt.**
**** Wheat Department, Field Crop Research institute, ARC, Giza, Egypt.**

ABSTRACT

Field experiments were carried out at Bahtim Agricultural Research Station Farm during the two successive wheat seasons (2004/05 and 2005/06) to study the effect of four NPK combinations on aphid and leafminer infestation of Gemiza 7 and 9 varieties in addition to study effects of these combinations on some agronomic characters.

Increasing the nitrogen rate tended to increase aphid and leafminer infestation. The best combinations were that of 70 and 75kgN/fed., low infestation but produced the heaviest grain yield.

Gemiza 9 exhibited longer periods to heading (94.5 days) and to maturity (146.5 days), more spikes 389.1/m^2 and heavier yield either of grains (20.4 ardab/fed.) or of straw (7.3 ton/fed.). While, Gemiza 7 exhibited taller plants (107.2 cm) and heavier 1000-grain weight (51.2 gm). The variety Gemiza 9 proved to be more tolerant against aphids, it harbored the highest numbers of colonies but in the same time produced relatively a heavier grain yield.

While the interaction between varieties and NPK rates affected significantly the aphid and leafminer infestation, it had no effect on any of the varietal traits undertaken in this study.

INTRODUCTION

Wheat, (*Triticum aestivum* L.) is the most important cereal crop in the world. Because of the difficulties facing the horizontal expansion for production increase in Egypt, the vertical yield increase is the main possible mean which could be achieved by developing high yielding varieties, good cultural practices i.e. fertilization and pest management (Shehab El-Din, 1993). During the last few years, cereal aphids have become serious insect pests attacking wheat plants in Egypt. These pests cause a serious damage to the plants either directly by sucking juice or indirectly as a vector of diseases, their losses to the crop were estimated by 7-18.7% in Middle Egypt (Ghanem *et al.*, 1984).

The leafminer, *Agromyza nigrella* (Rondani) attacks wheat in Egypt with 2-90% infestation and 10.7% loss in grain yield (El-Serwy, 1994 and 1999a).

The balance between N, P and K fertilizers is critical for crop production. Each element affects the uptake of the others, phosphorus absorption is a common consequence of adding nitrogen fertilizer, Grunes (1959). Also, this balance can change the physiology of the plant as food for insects (Coaker, 1987) particularly aphids which are very sensitive to this change, Van Emden (1966) and Sharshar *et al.* (2000). Level of leafminer infestation is also affected as reported by El-Serwy (1998 and 1999b).

However, aphids and leafminer are considered two of the important pests attacking wheat plants causing sever reduction in the yield, Ghanem *et al.* (1984) and El-Serwy (1999a).

This work aimed to study the effects of nitrogen, phosphorus and potassium (NPK) combinations on aphid and leafminer infestation of Gemiza 7 & 9 wheat varieties in addition to study their effects on some agronomic characters, yield and yield components.

MATERIALS AND METHODS

Field experiments were carried out at Bahtim Agric. Res. Station during two successive wheat seasons of 2004/05 and 2005/06.

The experiments were sown on 6-12-2004 and 12-12-2005 using a split plot design with four replicates. The wheat varieties were allocated to the main plots, while NPK treatments were randomaly laid out as sub-plots. Each sub-plot measured 11.4 m^2 (18 rows with 3 m long and 20cm apart). No insecticidal applications were applied and four fertilizer rates of NPK were used as follows:

a. 60 kg N + 10 kg P_2O_5 + 12 kg K_2O/fed.
b. 70 kg N + 15 kg P_2O_5 + 24 kg K_2O/fed.
c. 75 kg N + 15 kg P_2O_5 + 0 kg K_2O/fed (recommended).
d. 90 kg N + 20 kg P_2O_5 + 36 kg K_2O/fed.

Soil samples were taken from the experimental sites before planting and subjected to chemical analysis, the results are shown in Table (1).

Table 1: Chemical soil characteristics of the experimental site during the two seasons, 2004/05 and 2005/06.

Chemical properties	2004/05	2005/06
PH (1:2.5, soil: water suspension)	8.41	8.20
EC (1 : 5, soil: water extract)	0.38	0.42
Available – N (ppm)	50	45.3
Available – P (ppm)	25.7	18.6
Available – K (ppm)	360	382

Phosphorus was applied in the form of calcium superphosphate (15% P_2O_5) after land preparation. Nitrogen was added in the form of ammonium nitrate (33.5% N) at three doses i.e. 20% at sowing, 40% at tillering and 40% at elongation stage. Potassium was applied in the form of potassium sulphate (48% K_2O) at elongation stage. The other normal cultural practices were applied as recommended.

To determine aphid population and leafminer infestation, weekly samples each ten plants, starting from 1st Feb. to 20th April, were picked up at random from each sub-plot to record number of aphids (*Schizaphis graminum, Rhopalosiphum padi, Sitobion avenae* and *Rhopalosiphum maidis*) and, in the same time, no. of *Agromyza nigrella* mines and alive larvae/25 leaves.

Agronomic data recorded in the two growing seasons were: days to heading and to maturity, plant height, number of spikes/m^2, number of grains/spike, 1000-grain weight and yield of grain and straw.

Statistical analysis of results according to SAS (1996) were carried out in this work.

RESULTS AND DISCUSSION

The present research aimed to clarify the effects of two wheat varieties (Gemiza 7 & 9) under four rates of NPK fertilizers and their interactions on different aphid species and the leafminer *A. nigrella* in addition to their effects on the yield and yield components. The obtained results are as follows:

1- Effects on insects:

The results illustrated in Table (2) showed counts of four aphid species recorded on Gemiza 7 and 9 wheat varieties during 2004/05 and 2005/06 seasons. These counts pointed to that, Gemiza 9 was relatively more favourable for the aphid, received higher counts ranged 391.1-717.7 individuals/40 plants in the first season and 302.6-652.8 individuals/40 plants in the second season. Gemiza 7 harbourd lower counts, 300.4-500.7 and 240.7-461.3 individuals/40 plants in the two considered season, respectively. This varietal effect appeared before by Sharshar *et al.* (2000), they found that, Sakha line 202 proved to be more tolerant against aphids comparing with Sids 9.

This trend of infestation agrees with the fact that, increasing the nitrogen fertilizer rate enhances the infestation with insects specially those feed on the plant sap as aphid. These results are confermed by Waghray and Singh (1965) neither phosphorus nor potassium influnced the fecundity of *Aphis craccivora* but low and high rates of fecundity were associated with the plants containing low and high levels of nitrogen, respectively. Also, Slman (1997) mentioned that, the density of cereal aphids showed a significant positive response to the higher rates of nitrogen and their interactions with P_2O_5. The latter auther (2002) added also that, the highest rate of nitrogen (95 kg/fed.) significantly increased the population of *Rhopalosiphum padi* and *Schizaphis graminum*. In the same respect, Mahmoud (2005) reported that, the highest number of cereal aphids was recorded on wheat plants supplied with 125 kgN/fed as compared with 75 and 100 kgN/fed.

Concerning the aphid species, regardless of NPK treatments, the green bug *S. graminum* was the most domenant species, 277.1-169.9 indiv./40 plants of Gem. 7 represented 72.6-51.0% of the total aphid population through the two seasons. The counts of the other species; *R. padi*, *Sitobion avenae* and *Rhopalosiphum maidis* were clearly low and represented 17.3-22.0, 8.6-21.3 and 1.5-5.7% only, respectively, Table (2). Similar counts were recorded on Gem. 9 plants, *S. graminum* gave the highest density (71.6-47.1%) followed by the other three species as 14.6-21.1, 11.8-24.5 and 2.0-7.3%, respectively.

Table 2 : Mean numbers of four aphid species/40 plants of Gemiza 7 & 9 varieties under different rates of NPK during the two successive seasons 2004/05 and 2005/06.

Season	N+P+K (Kg)	Gemiza 7					Gemiza 9					General mean
		S. graminum	*R.padi*	*S.avenae*	*R.maidis*	Total	*S. graminum*	*R.padi*	*S.avenae*	*R.maidis*	Total	
2004/05	60+10+12	221.0	51.2	24.2	4.0	300.4 cd	284.2	53.5	48.7	4.7	391.1 cd	345.8 cd
	70+15+24	245.7	59.5	24.7	4.7	334.6 bc	311.0	60.2	54.5	6.2	431.9 bc	383.3 bc
	75+15+0 (recommended)	285.7	67.5	33.2	5.7	392.1 b	401.5	85.5	69.7	12.0	568.7 ab	480.4 b
	90+20+36	356.0	86.0	50.0	8.7	500.7 a	514.5	109.0	75.5	18.7	717.7 a	609.2 a
	Mean	277.1	66.1	33.0	5.8	382.0 a	377.8	77.1	62.1	10.4	527.4 b	-
	% population	72.6	17.3	8.6	1.5	-	71.6	14.6	11.8	2.0	-	-
2005/06	60+10+12	118.5	58.7	52.0	11.5	240.7 cd	139.2	68.7	79.7	15.0	302.6 cd	271.7 cd
	70+15+24	136.7	60.7	65.7	13.7	276.8 bc	192.0	90.2	113.7	25.5	421.4 bc	349.1 bc
	75+15+0 (recommended)	190.0	75.0	73.7	16.0	354.7 b	228.7	102.5	125.7	33.5	490.4 ab	422.6 ab
	90+20+36	234.2	99.2	92.7	35.2	461.3 a	319.7	131.7	138.2	63.2	652.8 a	557.1 a
	Mean	169.9	73.4	71.0	19.1	333.4 a	219.9	98.3	114.3	34.3	466.8 b	-
	% population	51.0	22.0	21.3	5.7	-	47.1	21.1	24.5	7.3	-	-

As for *Agromyza nigrella* counts, the data found in Table (3) showed an opposite varietal trend against the infestation. Gem. 7 variety was more, relatively, susceptible, harbourd 16.8-13.8 alive larvae/100 leaves which caused 20.6-16.7 mines in 18.8-14.6% of the total leaves. The other variety received 13.3-11.6 alive larvae/100 leaves made 16.2-13.2 mines in 14.3-12.4% only of all leaves.

With regard to the fertilizer results, it could be noticed that, the infestation by this leafminer was increased, as in case of the aphids, with increasing the NPK rates, Table (3). The larval population increased from 11.6-13.4 to 14.5-17.3/100 leaves when the rates were increased from 60 + 10 + 12 to 90 + 20 + 36 Kg. Consequently, the number of mines as well as the infested leaves (%) were increased from 12.5-15.8 to 18.3-22.6 and from 11.9-14.7 to 15.5-19.6, (2006-2005) respectively. These results are in agreement with findings of El-Serwy (1998 & 1999b), the percentage of infested leaves and number of mines and alive *A. nigrella* larvae on wheat were significantly increased by increasing nitrogen levels. Also, Slman *et al.* (2002) showed that, density of *A. nigrella* larval population was significantly in a positive relation with nitrogen level.

Table 3: % Infested leaves and mean number of mines and alive *A. nigrella* larvae/100 leaves of Gemiza 7 and 9 wheat varieties under different rates of NPK during 2004/05 and 2005/06 seasons.

Season	N+P+K (Kg)	Gemiza 7			Gemiza 9			Mean		
		Infested leaves (%)	No. of mines	No. of alive larvae	Infested leaves (%)	No. of mines	No. of alive larvae	Infested leaves (%)	No. of mines	No. of alive larvae
2004/05	60+10+12	16.2 cd	17.0 cd	14.2 cd	13.2 cd	14.5 cd	12.5 cd	14.7 cd	15.8 cd	13.4 cd
	70+15+24	17.0 c	18.0 c	15.0 c	13.7 bc	15.0 c	13.0 abc	15.4 c	16.5 c	14.0 c
	75+15+0 (recommended)	18.5 b	21.2 b	17.5 b	14.7 ab	16.2 b	13.7 ab	16.6 b	18.7 b	15.6 b
	90+20+36	23.5 a	26.2 a	20.5 a	15.7 a	19.0 a	14.0 a	19.6 a	22.6 a	17.3 a
	Mean	18.8 a	20.6 a	16.8 a	14.3 b	16.2 b	13.3 b	-	-	-
2005/06	60+10+12	12.7 d	13.7 d	12.5 cd	11.0 cd	11.2 cd	10.7 cd	11.9 d	12.5 d	11.6 cd
	70+15+24	13.7 c	15.5 bc	13.0 c	11.7 bc	12.5 bc	11.0 bc	12.7 c	14.0 c	12.0 bc
	75+15+0 (recommended)	15.0 b	16.5 b	13.7 b	12.7 b	13.7 b	12.0 ab	13.9 b	15.1 b	12.9 b
	90+20+36	17.0 a	21.0 a	16.2 a	14.0 a	15.5 a	12.7 a	15.5 a	18.3 a	14.5 a
	Mean	14.6 a	16.7 a	13.8 a	12.4 b	13.2 b	11.6 b	-	-	-

2- Effects on the yield :

The effects of the two tested varieties, NPK rates and their combinations on wheat yield and yield components are illustrated in Table(4).

Table 4 : NPK fertilizer rates in relation to agronomic characters of Gemiza 7 & 9 varieties during two seasons 2004/05 and 2005/06.

Season	N+P+K (Kg)	Days to heading			Days to maturity			Plant height (cm)			No. of spikes/m²			No. of grains / spike			1000-grain wt (gm)			Grains/fed. (ardab)			Straw/fed. (ton)		
		Gemiza 7	Gemiza 9	Mean	Gemiza 7	Gemiza 9	Mean	Gemiza 7	Gemiza 9	Mean	Gemiza 7	Gemiza 9	Mean	Gemiza 7	Gemiza 9	Mean	Gemiza 7	Gemiza 9	Mean	Gemiza 7	Gemiza 9	Mean	Gemiza 7	Gemiza 9	Mean
2004/05	60+10+12	90	94	92 a	138	146	142 A	106.13	102.50	104.32 a	358.25	367.00	362.62 d	52.75	53.66	53.21 a	51.91	47.62	49.77 bc	17.59	20.90	19.24 cd	5.29	6.81	6.05 d
	70+15+24	90	94	92 a	138	146	142 a	107.50	105.25	106.38 a	380.50	386.25	383.38 c	53.31	56.00	54.66 a	54.14	50.66	52.40 a	20.30	22.10	21.20 a	5.86	7.36	6.61 bc
	75+15+0 (recommended)	90	94	92 a	138	146	142 a	106.25	102.37	104.31 a	395.50	407.00	401.25 ab	52.50	54.20	53.35 a	54.40	48.70	51.55 ab	20.80	21.10	20.95 ab	6.29	7.68	6.98 b
	90+20+36	90	95	93 a	139	147	143 a	109.25	105.50	107.38 a	400.00	413.00	406.50 a	51..00	53.47	52.24 a	50.15	45.93	48.04 cd	18.83	18.90	18.86 c	6.85	8.20	7.52 a
	Mean	90 a	94 b	-	138 a	146 b	-	107.28 A	103.90 b	-	383.56 a	393.31 b	-	52.39 a	54.33 b	-	52.65 a	48.23 b	-	19.38 a	20.75 a	-	6.07 a	7.51 b	-
	Interactions	NS			NS			NS			NS			NS			NS			NS			NS		
2005/06	60+10+12	90	94	92 a	139	146	143 a	105.75	102 50	104.12 a	347.25	354.75	351.00 cd	51.25	52.35	51.80 A	48.56	43.90	46.23 bc	17.42	19.50	18.46 cd	5.26	6.42	5.84 cd
	70+15+24	90	95	93 a	139	147	143 a	106.75	105.00	105.88 a	369.75	385.00	377.38 abc	52.80	53.67	53.24 a	51.55	48.50	50.03 a	19.80	21.00	20.40 a	5.65	6.71	6.18 bc
	75+15+0 (recommended)	90	95	93 a	139	147	143 a	106.25	102 50	104.38 a	372.50	397.50	385 00 Ab	51.20	53.47	52.34 a	51.65	46 04	48.85 ab	20.00	20.58	20 29 ab	6.09	7.02	6.55 b
	90+20+36	91	95	93 a	140	148	144 a	109.50	105 00	107.25 a	385.75	402.00	393 88 a	49.20	51.80	50.50 A	47.12	43 60	45.36 cd	18.50	18.92	18.71 c	6.76	7.76	7.26 a
	Mean	90 a	95 b	-	139 a	147 b	-	107.06 a	103 75 b	-	368.81 a	384.81 b	-	51.11 A	52.82 b	-	49.72 a	45.51 b	-	18.93 a	20.00 a	-	5.94 a	6.98 b	-
	General mean	90	94.50	-	138.50	146.50	-	107.20	103.80	-	376.19	389.06	-	51.75	53.58	-	51.19	46.87	-	19.16	20.38	-	6.01	7.25	-
	Interactions	NS			NS			NS			NS			NS			NS			NS			NS		

Data in this table pointed that, the Gemiza 7 variety had better varietal traits; lasted significantly a shorter period either to the heading (90 days) or maturity stage (138.5 days) in both seasons. In the same time, this variety had a longer height, about 107.2cm comparing with about 103.8cm with Gemiza 9 variety. All previous traits were, neely, not affected with increasing the fertilizer rate within each variety.

As for number of spikes, it was significantly higher in case of Gemiza 9 (389.1/m^2) than that in the other variety (376.2/m^2), Table (4). Also, the spikes gave more grains, 53.6 compared with 51.8 grains/Gemiza 7 spike. In both varieties and seasons, this number increased positively with the different levels of NPK fertilizers. While it recorded 358.3 spike/m^2 under the least NPK level, it reached 400.0 spike/m^2 under the highest level for Gemiza 7 in the first season. The same trend was noticed also for the same variety during the second season; 347.3 and 368.8 spike/m^2 for the two NPK levels, respectively. Also, similar results were obtained for Gemiza 9 variety, number of spikes increased from 367.0 to 413.0 and from 354.8 to 402.0/m^2 in 2004/05 and 2005/06 seasons, respectively, Table (4).

Concerning the number of grains in the spike, data in the same table pointed to that, Gemiza 9 relatively had more grains 54.3 and 52.8 compared with 52.4 and 51.1 grains for Gemiza 7 spike in hte first and second seasons, respectively. In the same time, the mean values had no stable trend opposite the NPK levels in both seasons, the same observation was detected with the 1000-grain wt values, Table (4). Regardless of the fertilizers, mean weight of 1000 grains was significantly heavier in case of Gemiza 7 (52.7 and 49.7 gm) than that of Gemiza 9 (48.2 and 45.5gm). These values clear that, Gemiza 9 had significantly more spikes/m^2 as well as more grains/spike, so, it produced heavier grain yield (20.75 and 20.00 ardab/fed.) than that of Gemiza 7 (19.38 and 18.93 ardab/fed.) in both seasons, respectively.

With regard to the straw yield, the data in Table (4) showed that, in general, the production gained from Gemiza 9 (7.51 and 6.98 ton/fed.) was significantly heavier than that from the other variety (6.07 and 5.94 ton/fed.) in both respective seasons. In the same time, a positive trend in the straw weight means was detected with increasing the NPK rates for both varieties. The weights were, 6.05, 6.61, 6.98 and 7.52 ton/fed in the first season and 5.84, 6.18, 6.55 and 7.26 ton/fed in the second season opposite the four fertilizer levels, arranged ascendingly, respectively.

The variations in most previous varietal characters were due to genetic effects, Abdel-Gawad *et al.* (1986) and Gwal *et al.* (1999). Also, Sharsher *et al.* (2000) recorded the highest increase in days to heading or maturity and grain yield for Sakha line 202 and Sakha 69 only between the other tested varieties. On the other side, Ibrahim and Abdel-Aal (1991) attributed the increase in 1000-grain weight and grain yield/fed to a certain levels of NPK comparing with the untreated plants. Also, Kheiralla *et al.* (1993) showed that, grain yield was significantly increased with increasing N up to 70 kg/fed. In this respect, Mitkees *et al.* (1994) added that, the most economic yield performance was obtained at the base of 15 kg K_2O_5 and 24 kg K_2O/fed for the cultivated lands.

A general view to the all previous results reveals that, the infestation with all mentioned aphid species as well as *A. nigrella* fly was increased with raising the fertilizer rate in both varieties. While Gemiza 9 variety was more preferable for the aphids, harboured more numbers of colonies, Gemiza 7 was better for the fly, received a higher infestation. In the same time, Gemiza 9 had a promounced tolerance against the infestation, gave higher numbers of spikes/m^2, grains/spike and consequently gave a heavier grain yield. Also, it could conclude that, the insect infestation was clearly decreased with the lower fertilizer rate treatments (70 and 75 kgN/fed.) and, in the same time, gave the heaviest grain yield.

Data illustrated in Table (4) pointed to that, the interaction between the tested varieties and NPK rates did not show any significant effect on all studied wheat traits. These results are in agreement with those obtained by Sadek (1988) and Sharshar *et al.* (2000), the interaction between genotypes and NPK rates had no significant effects in all studied wheat traits. On the contrary, the interaction revealed significant effects on the aphid and leafminer infestation as shown in Tables (2 & 3).

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تأثير كل من التسميد (ن- فو- بو) والأصناف وكذلك التداخل بينهما على إصابة القمح بالمن وصانعة أنفاق الأوراق وعلى محصول الحبوب ومكوناته

عادل محمد الراوي*، محمد عبد الكريم خالد ** و سعاد محمد عثمان*

*** معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الدقي – جيزة – مصر.**

**** قسم القمح – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية – جيزة مصر.**

أجريت التجارب بمزرعة محطة البحوث الزراعية ببهتيم (قليوبية) خلال موسمي ٢٠٠٤/٢٠٠٥، ٢٠٠٥/٢٠٠٦ بهدف دراسة تأثير أربعة معدلات من التسميد الثلاثي (النيتروجيني، والفوسفور، والبوتاسيوم) على إصابة صنفي القمح جميزة ٧، ٩ بحشرات المن وصانعة أنفاق الأوراق وكذلك تأثير هذه المعدلات على بعض الصفات المحصولية لكلا الصنفين.

أوضحت الدراسة أن الصنف جميزة ٩ كان أكثر تحملا للإصابة بالمن، فبرغم تواجد هذه الافة عليه بأعداد أكثر إلا أنه أعطى محصولا من الحبوب أكثر نسبيا منه في الصنف الأخر – كما اتضح ان زيادة معدلات عناصر التسميد الثلاثي تزيد من تعداد حشرات المن وصانعة أنفاق الأوراق وأن أفضل المعدلات هي التي أحتوت على ٧٠، ٧٥ كجم نيتروجين/فدان حيث كانت الإصابة منخفضة والمحصول الناتج هو الأكثر وزنا.

كذلك أشارت الدراسة إلى أن الصنف جميزة ٩ إحتاج لفترات أطول سواء لبلوغ طور طرد السنابل (٩٤,٥ يوم) أو لبلوغ طور النضج (١٤٦,٥ يوم)، لكنه أعطى سنابل أكثر عددا (٣٨٩,١/م^2) ومحصولا أكثر سواء من الحبوب (٢٠,٤ إردب/فدان) أومن القش (٧,٣ طن/فدان)، من ناحية أخرى أظهرت النتائج أن نباتات الصنف جميزة ٧ كانت أطول (١٠٧,٢سم) وأن وزن الف حبة منه كانت أثقل (٥١,٢جم).

أظهرت الدراسة كذلك أن التفاعل بين معدلات التسميد الأربعة وبين صنفي القمح لم يكن له تأثير معنوي على صفاتهما المحصولية في حين ظهر هذا التأثير على تعداد كل من المن وصانعة أنفاق الأوراق.

بهذا يمكن الإشارة إلى إمكانية زراعة صنفي القمح جميزة ٧، ٩ في منطقة جنوب الدلتا مع استعمال معدلات تسميد (نيتروجين + فوسفور + بوتاسيوم) معتدلة للحصول على محصول جيد.