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EFFECT OF PRECEDING WINTER CROPS AND BIOLOGICAL FERTILIZATION ON GROWTH AND YIELD OF RICE UNDER DIFFERENT LEVELS OF NITROGEN FERTILIZATION

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ABSTRACT

Two field experiments were carried out at Tag El-Ezz, Agric. Res. Station during the two successive summer seasons 2000 and 2001 to study the combined effect of two winter preceding crops, i.e. clover (*Trifolium alexandrinum,* L.) and wheat (*Triticum aestivum*), three levels of nitrogen (30, 45 and 60 kg N/fad) and biological fertilizer (Cyriallen) at the rates of zero, 300 and 600 g/fad on growth, yield and yield components of rice (Sakha 101 variety). The main results can be summarized as follows:

1- Preceding winter crops had significant effects on plant height, flag leaf area, number of panicles/m^2, number of grains/panicle, 1000 grain weight as well as grain and straw yields/fad in both seasons while panicle weight was markedly affected in the first season only. Aforementioned traits were superior when rice grown after clover than wheat in sequence rotation.

2- Raising nitrogen fertilizer levels up to 60 kg N/fad had significantly increased all the studied characters in both seasons.

3- Biological fertilization by cyriallen application at the rate of 600 gm/fad markedly recorded the highest mean values in all the studied characters.

4- In both seasons the interaction between the previous winter crops and nitrogen level had significant effects on number of panicles/m^2, panicle weight and grain yield (t/fad).

Furthermore the interaction between preceding crops and biological fertilizer rates had significant effects on panicle weight and grain yield (t/fad). Also the interaction between nitrogen levels and biological fertilizer rates (cyriallen) had significant effects on, flag leaf area, panicle weight, 1000 grain weight, grain and straw yields (t/fad) and finally there were a significant effects for the interaction between preceding crops, nitrogen levels and biological fertilizer rates on grain yield/fad where the highest grain yield/fad was achieved with fertilizing rice with 45 kg/fad under the rate of 600 gm cyriallen/seeds/fad when the preceding winter crop was berseem.

INTRODUCTION

Rice (*Oryza sativa,* L.) is one of the major cereal crops in the Egyptian agricultural crop rotation. Its importance lies not only in its usage as a basic food for the majority of population, but also to its role in food security programs and as an exportable crop. Most farmers cultivate it after different winter crops such as berseem and wheat. Most researches reported that the leguminous crop berseem was the best for precursors than wheat because it have the ability to improve soil fertility and save mineral nitrogen. In this respect, Roszak (1973), Rao and Sharma (1975) found that the legumes are considered the most important one in crop rotation system for their role in increasing the soil fertility level especially content from nitrogen. Chatterjee *et*

al. (1978) reported that legumes greatly increase nitrogen in the soil when their roots are turned into the land.

Metwally *et al.* (1994), Bassal *et al.* (1996), Metwally (1997), El-Wehaishy (1998) and Ebaid an d Ghanem (2000) they concluded that grain yield and its attributing variables were superior when the previous crop was legume compared with that after non legume.

With respect to mineral nitrogen fertilizer level effects, Abd El-Rahman (1992) indicated that the application of 144 kg N/h to rice resulted in the highest plant, 1000 grain weight, number of grains/panicle, grain and straw yields. Similar conclusions were reported by Bassal *et al.* (1996) and Sharief *et al*. (1998) showed that raising nitrogen levels up to 60 kg N/fad significantly increased grain yield of rice and its attributing variables. Ebaid and Ghanem (2001) stated that increasing nitrogen level up to 165 kg N/ha significantly increased in rice grains and Bassal and Zahran (2002) found that the combination between biofertilizer and 40 kg N/fad treatment gave the highest grain yield.

Many reports induced that biological fertilization supply plants with their requirements from nitrogen, reduce the application of expensive mineral fertilizer, consequently lead to decrease the production costs and pollution rates in soil and water. Such results reported by Watanabe and Lin (1984), Nayak *et al.* (1986), Wang *et al.* (1987), Gopalaswamy and Vidhyasekaran (1988), Subramanian and Rangarajan (1990), Heulin *et al.* (1991), Jena *et al.* (1992), Faysal (1998) and Bassal and Zahran (2002) where they found that inoculates of *Azospirillum* to grains or to soil or to grains and soil significantly increased grain and straw yields in all cases.

MATERIALS AND METHODS

Two field experiments were carried out at Tag El-Ezz Agricultural Research Station, Dakahlia Governorate in 2000 and 2001 seasons to study the combined effect of preceding winter crops (berseem and wheat), mineral nitrogen (ammonia sulphate (20.5 % N) and biological fertilizer (cyriallen) and their interaction on growth and yield of rice (Sakha 101 variety). The sowing was on 15th and 10th May in the first and second seasons respectively.

A split-split plot design with four replications was used. The two preceding crops (berseem and wheat) located in the main plots, the three mineral nitrogen levels (i.e., 30, 45 and 60 kg N/fad) occupied the sub plots and three rates of biological fertilizer (cyriallen), zero, 300 and 600 gm/seeds/fad were allocated to the sub-sub plots. The experimental unit was 4.2x5.0 m occupying an area of 21.0 m^2, i.e 1/200 faddan. Rice was planted by dibbling in hills 20x20 cm (8-10 grains/hill) method which was used. Ammonia sulphate (20.5 %) was as a source of mineral nitrogen was used and the N fertilization amount was applied twice in two equal portions. The first after 25 days and the second after 45.D.A.S. The source of biological fertilizer was (cyriallen) which include *Azospirillum sp.* inform bacterial inoculation which brought from in the Agricultural Research Center, The inoculant was in powder form. It added to the grains as recommended by Ministry of Agriculture. The other usual agricultural practices of growing rice

were conducted as recommended by Ministry of Agriculture and Land Reclamation.

The studied characters:

At harvest time, guarded plants of one square meter hills were taken at random from the inner area of each experimental unit to estimate the following characters:

1- Plant height (cm) 2- Flag leaf area (cm^2)
3- Number of panicle/m^2 4- Number of grains/panicle
5- Panicle weight (gm) 6- 1000 grain weight (gm)

The plants in the inner two square meters of each experimental unit were harvested, collected together, labeled, thrashed and the grain were separated. The grain yield was recorded in kg/square meter for each separately, then it converted to record grain yield in t/fad, then calculated the two following characters:

7- Grain yield (t/fad) 8- Straw yield (t/fad)

Soil analysis:

Samples of soil were taken at random from the soil depth of 0-20 cm from all sites of experiments. This was done after harvesting the preceding winter crops and also after rice harvesting. Nitrate in soil samples were determined according to Kieldahl method as described by Jackson (1958). Available P according to Olsen *et al.* (1954) and exchangeable K was estimated by flame photometerically using E.E.L flame photometer as mentioned by Richards (1945).

Obtained data were subjected to the statistical analysis as the usual technique of analysis of variance (ANOVA) of the split-split plot design (Gomez and Gomez, 1984). The treatment means were compared using the least significant difference (LSD) according to the procedure outlined by Waller and Duncan (1969).

RESULTS AND DISCUSSION

Rice grain yield and major of its components as affected by the studied factors; the preceding crops, mineral nitrogen levels and biological fertilizer (cyriallen) are listed in Table (1).

1- Preceding crop effects:

Data presented in Table (1) showed that the preceding crops had significant effects on plant height, flag leaf area, number of panicles/m^2, number of grains/panicle, 1000 grain weight, grain and straw yields/fad in both seasons, while panicle weight was significantly affected in the first season only. The highest means values of all the studied characters were obtained when the preceding crop was berseem. The highest grain yield recorded 4.274 and 4.618 t/fad in the first and second seasons respectively. On the other hand rice grain yield recorded 3.776 and 4.161 t/fad when the previous winter crop was wheat in both seasons, respectively. The increase in grain yield/fad obtained after berseem as preceding crop could be attributed mainly

to the high level of soil fertility after clover plantation due to the effect of nitrogen fixation by Rizobium and left within the soil for rice which in turn increased most yield attributes, i.e. number of panicles/m^2, number of grains/panicle, panicle weight and 1000 grain weight. Generally, rice grown after legume crop produced more yield and higher yield components that non legume crop. This is mainly because non legume crop remove higher amounts of soil nutrients than legume crop. These results could also be attributed to the fact that nitrogen contributed from the residual soil nitrogen conservation. On the other hand, the residual effect of legume, compared with non legume to sub sequent crops is partly due to lower quantities of soil nitrogen removed from soil and fertilizer. Similar conclusions were reported by Moursi and Hindy (1962), Rozak (1973), Metwally *et al.* (1994), Bassal *et al*. (1996), Metwally (1997), El-Wehaishy (1998) and Ebaid and Ghanem (2000).

2- Mineral nitrogen level effects:

Nitrogen levels exerted significant effects on all the studied traits in both seasons, Table (1). Increasing nitrogen levels from 30, 45 and 60 kg N/fad significantly increased plant height, flag leaf area, number of panicles/m^2, number of grains/panicle, panicle weight, 1000-grain weight, grain and straw yields (t/fad). Application of nitrogen at the levels 30, 45 and 60 kg N/fad yielded of averages 3.616, 4.214 and 4.246 t/fad in the first season, then 3.716, 4.659 and 4.795 t/fad in the second season, in the same respective order. Application of 60 kg N/fad maximized the grain yield/fad could be recommend under such conditions. The increase in grain yield/fad may be attributed to the role of nitrogen in activation the growth and encouragement of merstematic activity of the rice plant the reflects increases in photosynthetic metabolism that increasing yield components, i.e. number of panicles/m^2, number of grains/panicle, panicle weight and 1000-grain weight. Similar trend were obtained by Abd El-Rahman *et al.* (1992), Bassal *et al.* (1996), Said *et al.* (1998), Ebaid and Ghanem (2001) and Bassal and Zahran (2002).

3- Cyriallen (biological fertilizer) effects:

Results indicated that cyriallen at the rate of 600 gm/seeds/faddan was more benefit for rice plants, where caused remarkable increase in yield and yield attributes i.e, plant height, flag leaf area, number of panicles/m^2, number of grains/panicle, panicle weight, 1000 grain weight, grain and straw yields (t/fad) compared with application of 300 and zero gm cyriallen/fad.

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2.3

4.5

Rice grain yield recorded 3.655, 4.134 and 4.287 in the first season then 3.994, 4.505 and 4.671 in the second season when cyriallen added at the rates of zero, 300 and 600 g/fad, respectively in both seasons, Table (1), such increase could be attributed mainly to the role of *Azospirillum* bacteria in fixing the nitrogen in the soil. The increment of grain yield may be due to that nitrogen is known to be essential element nucleic acids and proteins that allow plants to grow and increase the growth of leaf area that increased light interception and then increased leaf photosynthetic rates resulting in more accumulated crop biomass that increased number of grain /panicle, panicle weight and 1000-grain weight that influencing grain crop yields. Similar results were obtained by Subramanian and Rangarajan (1990), Heulin *et al.* (1991), Jena *et al.* (1992), Fasyal (1998) and Bassal and Zahran (2002) they found that inoculates of *Azospirillum* to grains or to soil or to seed and soil, significantly increased grain and straw yields of rice in all cases.

4- **Interaction effects:**

The interaction between preceding crops and nitrogen levels had significant effects on number of panicle/m^2, panicle weight (g) and grain yield/fad. The highest mean values were 395.4, 3.1 and 4.623 in the first season and 404.2, 3.2 and 4.887 in the second season, respectively, where recorded under the combination of 45 kg N when the previous winter crop was berseem, as shown in Table (2).

A significant effect for the interaction between preceding crops and cyriallen rates on panicle weight and grain yield which maximum means values in both seasons were obtained with application of the rate of 600 gm cyriallen/seeds/fad when the preceding was berseem, as shown in Table (3).

Data in Tables (4&5) showed that there were significant effects for the interaction between nitrogen levels and cyriallen rates on flag leaf area and straw yield/fad. The highest mean values were recorded with adding 60 kg N/fad under the rate of 600 gm cyriallen/seeds/fad in addition maximum values of panicle weight, 1000-grain weight and grain yield/fad were obtained when fertilized with 45 kg N/fad under the rate of 600 gm cyriallen / seeds/fad in both seasons. Similar results recorded by Omar *et al.* (1989) and Bassal and Zahran (2002) where they found that the combination between biofertilizer and 40 kg N/fad treatment gave the highest grain yield.

Table (6) recorded a significant effect to the interaction between preceding crops, nitrogen levels and cyriallen rates on grain yield/fad. It could observed that the highest grain yield of rice was 5.045 and 5.226 t/fad in the first and second seasons respectively were obtained with adding 45 kg N under the rate of 600 gm cyriallen/seeds/fad when the preceding winter crop was berseem.

5. Chemical analysis of soil:

Chemical analysis of soil is shown in Table (7). Samples of soil were taken after harvesting the preceding crops and also after harvesting rice. The analysis results indicated that the highest N content of soil was shown after harvesting berseem and the lowest values noticed after wheat harvesting. These results indicate that legume residues had higher nitrogen content than

non-legume crops. These results were confirmed by Rao and Shama (1975). The data also indicated that the lowest P content was found after the removal of berseem. This could be attributed to the relatively greater P consumption occurred by legume crop. The data may suggest that berseem plants had higher capability to absorb P and K contents and hence to remove soil soluble P and K than did by wheat. The data also show that wheat plants reduced soil content of these nutrients especially N-content to less than the half of that recorded after harvesting berseem.

Table (6): Means of grain yield (t/fad) as affected by the interaction between preceding crops, nitrogen levels and cyriallen rates in both seasons.

Seasons		2000			2001		
Preceding crops	**N-levels (kg/fad)**	**0**	**300**	**600**	**0**	**300**	**600**
Berseem	30	3.522	3.759	4.054	3.459	4.162	4.501
	45	3.994	4.829	5.045	4.451	5.127	5.226
	60	4.133	4.779	4.354	4.633	5.066	4.941
Wheat	30	3.057	3.445	3.861	3.105	3.359	3.710
	45	3.531	3.872	4.014	3.964	4.479	4.704
	60	3.695	4.122	4.342	4.350	4.833	4.945
F- test		**			**		
LSD at 5%		0.091			0.162		
at 1%		0.123			0.219		

Table (7): Available N, P and exchangeable K (ppm) as well as pH of soil after preceding crops and after rice harvesting.

	2000							
Soil content (ppm)	**Preceding winter crops**		**Rice after berceem (Kg N/fad)**			**Rice after wheat (Kg N/fad)**		
	Berseem	**Wheat**	**30**	**45**	**60**	**30**	**45**	**60**
N	54.7	31.9	19.6	24.8	30.2	11.9	14.2	16.8
P	9.6	13.4	5.0	5.3	6.6	6.2	6.3	8.1
Ex. K	329.1	402.3	286.4	340.0	365.1	263.0	301.2	319.4
pH	7.6	8.1	8.0	7.8	7.7	8.2	8.0	7.8
	2001							
N	59.7	34.9	22.1	27.8	33.4	13.6	16.2	19.3
P	10.3	16.1	5.3	6.0	7.1	6.3	8.1	8.7
Ex. K	343.0	423.1	307.0	364.0	402.0	296.0	317.0	376
pH	7.5	7.7	7.7	7.6	7.5	7.9	7.7	7.5

It could be stated that application of N-fertilizer at 45 kg N/fad together with grain inoclulation with cyriallen at 600 gm/seed/fad after berseem in rotation sequence could be recommended for maximum and remarkable yield of rice under the site of experimentation.

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تأثير المحاصيل الشتوية السابقة والتسميد الحيوى على نمو ومحصول الأرز تحت مستويات مختلفة من التسميد النتروجينى

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أقيمت تجربتان حقليتان فى مزرعة محطة البحوث الزراعية بتاج العز خلال موسمى ٢٠٠٠ ، ٢٠٠١ لدراسة تأثير المحاصيل الشتوية السابقة (برسيم مصرى ـ قمح) وثلاث معدلات من التسميد الحيوى (السريالين) استخدم خلطا مع البذرة كلقاح (صفر ، ٣٠٠ ، ٦٠٠ جرام/فدان) على نمو ومحصول الأرز تحت مستويات مختلفة من التسميد الآزوتى (٣٠ ، ٤٥ ، ٦٠ كجم نيتروجين/فدان).

وتتلخص أهم النتائج المتحصل عليها فيما يلى:

١ـ كان للمحاصيل الشتوية السابقة تأثير معنوى على طول النبات ومساحة ورقة العلم وعدد الداليات/م^{٢} وعدد الحبوب فى الدالية ووزن ألف حبة وكذلك محصول الحبوب والقش /فدان خلال موسمى النمو فى نفس الوقت تجد أن صفة وزن الدالية كانت معنوية فى السنة الأولى فقط حيث أشارت النتائج المتحصل عليها تفوق محصول الأرز المنزرع عقب البرسيم معنويا على الأرز المنزرع عقب القمح.

٢ـ أشارت النتائج إلى وجود زيادة معنوية فى جميع الصفات المدروسة للنباتات المعاملة بالسماد الحيوى (السريالين) كلقاح للبذرة عند معدلات ٣٠٠ إلى ٦٠٠ جرام/فدان حيث أوضحت النتائج تفوق النباتات المعاملة عند ٦٠٠ جرام/فدان بالمقارنة بالمعاملة عند ٣٠٠ جرام فى المحصول ومكوناته وصفات النمو فى كلا موسمى الزراعة.

٣ـ أدت زيادة معدل السماد النيتروجينى حتى ٦٠ كجم نيتروجين /فدان إلى زيادة معنوية فى جميع الصفات تحت الدراسة وذلك خلال موسمى النمو.

٤ـ أظهرت نتائج التفاعل بين عوامل الدراسة أن عدد الداليات/م^{٢} ووزن الدالية بالجرام ومحصول الحبوب بالطن/فدان أعطت أعلى قيمة لمتوسطتها عندما زرعت نباتات الأرز عقب البرسيم وسمدت بالسماد النيتروجينى بمعدل ٤٥ كجم/فدان خلال موسمى الزراعة ٢٠٠٠ ، ٢٠٠١. كما أوضحت نتائج التفاعل أن وزن الدالية بالجرام ومحصول الحبوب بالطن للفدان وصلت أعلى قيمة لها عندما زرعت حبوب الأرز الملقحة بالسريالين بمعدل ٦٠٠ جرام/فدان عقب البرسيم خلال موسمى الزراعة. أيضا أشارت النتائج وجود تفاعل معنوى على صفة مساحة ورقة العلم حيث أعطت أعلى قيمة لها عندما لقحت حبوب الأرز بالسريالين بمعدل ٦٠٠ جرام/فدان وسمدت بمستوى ٦٠ كجم/فدان فى حين أن صفتى وزن الدالية بالجرام ووزن الألف حبة بالجرام أعطت أعلى قيم عندما لقحت حبوب الأرز بالسريالين بمعدل ٦٠٠ جرام للفدان وسمدت بالسماد النيتروجينى بمعدل ٤٥ كجم/فدان.

٥ـ أظهر التفاعل بين عوامل الدراسة معنوية على محصول الأرز ومكوناته كما يلى:

- عدد الداليات/م^{٢} ووزن الدالية بالجرام ومحصول الحبوب بالطن للفدان أعطت جميعها أعلى قيم لمتوسطاتها عندما زرع الأرز عقب البرسيم وسمد بمعدل ٤٥ كجم/فدان خلال موسمى الزراعة.
- وزن الدالية بالجرام ومحصول الحبوب بالطن/فدان وصلت أعلى قيمة لها عندما زرعت حبوب الأرز الملقحة بالسريالين بمعدل ٦٠٠ جرام/فدان والمنزرعة عقب محصول البرسيم خلال موسمى الزراعة.
- مساحة ورقة العلم ومحصول القش بالطن/فدان أعطت أعلى قيمة لها عندما لقحت حبوب الأرز بالسريالين بمعدل ٦٠٠ جرام/فدان وسمدت بـ ٦٠ كجم نيتروجين/فدان خلال موسمى النمو فى حين أن صفات وزن الدالية بالجرام ووزن ألف حبة بالجرام ووزن محصول الحبوب بالطن للفدان أعطت أعلى قيم لمتوسطاتها عندما زرعت حبوب الأرز الملقحة بالسريالين بمعدل ٦٠٠ جرام/فدان والمسمدة بمعدل ٤٥ كجم نيتروجين/فدان خلال موسمى ٢٠٠٠ ، ٢٠٠١.
- وأخيرا محصول الحبوب بالطن/فدان أعطى أعلى قيمة لمحصول الحبوب فى الأرز عندما زرعت حبوب الأرز الملقحة بالسريالين بمعدل ٦٠٠ جرام/فدان والمنزرعة عقب محصول البرسيم والمسمدة بمعدل ٤٥ كجم نيتروجين/فدان.

وعموما يعتبر التفاعل الثلاثى هو عبارة عن أفضل المعاملات التى يمكن أن يوصى بها لزيادة إنتاجية محصول الأرز سخا ١٠١ تحت ظروف منطقة تاج العز بمحافظة الدقهلية.

Table (1): Means of plant height (cm), flag leaf area (cm^2), number of panicles/m^2, number of grains/panicle, panicle weight (g), 1000-grain weight (g), grain yield (t/fad) and straw yield (t/fad) as affected by the preceding crops, nitrogen levels and bio-N-fertilizer (cyriallen) in both seasons.

Characters	Plant height (cm)		Flag leaf area (cm^2)		No. of panicles/m^2		No. of seeds /panicle		Panicle weight (g)		1000-grain weight (g)		Grain yield (t/fad		Straw yield (t/fad)	
Seasons **Treatments**	**2000**	**2001**	**2000**	**2001**	**2000**	**2001**	**2000**	**2001**	**2000**	**2001**	**2000**	**2001**	**2000**	**2001**	**2000**	**2001**
Preceding crops:																
Berseem	91.3	98.5	25.9	26.3	364.6	377.9	102.2	106.6	2.8	3.0	29.4	30.2	4.274	4.618	4.737	4.863
Wheat	84.4	91.7	23.8	24.6	331.3	360.0	93.9	97.9	2.6	2.7	28.2	28.2	3.776	4.161	4.625	4.795
F- test	**	*	*	*	*	*	*	*	*	NS	*	**	*	**	**	**
Nitrogen levels (kg N/fad):																
30	82.0	89.3	23.1	23.8	309.6	335.7	84.0	89.5	2.5	2.7	24.6	26.9	3.616	3.716	4.487	4.508
45	89.2	95.9	25.6	25.8	361.9	385.0	100.9	103.1	2.8	2.9	30.3	30.8	4.214	4.659	4.649	4.835
60	92.4	101.4	25.9	27.4	372.3	386.3	109.3	114.1	2.8	3.0	31.0	31.3	4.246	4.795	4.907	5.069
F- test	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
LSD at 5%	1.3	1.4	0.4	0.4	19.3	8.5	3.5	2.3	0.15	0.09	0.8	0.7	0.073	0.045	0.042	0.023
at 1%	1.9	2.0	0.6	0.6	28.1	12.3	5.1	3.3	0.21	0.14	1.1	1.0	0.106	0.066	0.061	0.034
Cyriallen (g/fad):																
0	80.4	88.8	21.3	23.2	321.6	349.9	77.1	87.0	2.4	2.6	26.3	26.4	3.655	3.994	4.586	4.674
300	88.3	95.2	25.4	25.6	357.3	375.4	101.3	103.1	2.8	3.0	29.2	30.6	4.134	4.505	4.678	4.808
600	94.8	99.3	27.0	27.1	364.9	381.6	115.7	116.7	2.9	3.1	29.9	31.6	4.287	4.671	4.779	4.930
F- test	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
LSD at 5%	2.0	0.9	0.3	0.3	21.4	7.2	5.0	3.7	0.06	0.07	0.46	0.59	0.041	0.066	0.065	0.049
at 1%	2.7	1.3	0.4	0.4	28.9	9.8	6.8	5.0	0.09	0.09	0.62	0.81	0.061	0.089	0.088	0.066
Interaction effects:																
P x N	**	NS	NS	NS	**	**	NS	*	*	**	NS	**	**	**	NS	NS
P x C	NS	NS	NS	NS	NS	NS	NS	**	*	**	NS	NS	**	**	NS	NS
N x C	NS	NS	**	*	NS	*	NS	NS	**	*	*	**	**	**	**	**
P x N x C	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**	**	NS	NS

Table (2): Means of number of panicles/m^2, panicle weight (g) and grain yield (t/fad) as affected by the interaction between preceding crops and nitrogen levels in both seasons.

Characters	No. of panicles/m^2				Panicle weight (g)				Grain yield (t/fad)			
Seasons	2000		2001		2000		2001		2000		2001	
Preceding crops	Berseem	Wheat	Berseem	Wheat	Berseem	Wheat	Berseem	Wheat	Berseem	Wheat	Berseem	Wheat
N-levels (kg/fad):												
30	329.8	289.4	338.5	332.8	2.6	2.1	2.8	2.5	3.518	3.354	3.941	3.806
45	395.4	328.3	404.2	365.8	3.1	2.4	3.2	2.7	4.623	3.806	4.887	4.235
60	388.4	356.2	391.1	381.4	3.0	2.6	3.0	2.9	4.422	4.390	4.789	4.641
F- test	**		**		*		**		**		**	
LSD at 5%	27.3		12.0		0.2		0.1		0.103		0.100	
at 1%	39.7		17.4		---		0.2		0.150		0.146	

Table (3): Means of panicle weight (g) and grain yield (t/fad) as affected by the interaction between preceding crops and cyriallen rates in both seasons.

Characters	Panicle weight (g)				Grain yield (t/fad)			
Seasons	2000		2001		2000		2001	
Preceding crops	Berseem	Wheat	Berseem	Wheat	Berseem	Wheat	Berseem	Wheat
Cyriallen (g/fad):								
0	2.4	2.1	2.7	2.2	3.883	3.428	4.181	3.806
300	3.0	2.4	3.0	2.8	4.456	3.813	4.785	4.224
600	3.1	2.6	3.1	2.9	4.489	4.089	4.889	4.452
F- test	*		**		**		**	
LSD at 5%	0.069		0.093		0.052		0.093	
at 1%	---		0.126		0.071		0.127	

Table (4): Means of flag leaf area (cm^2), panicle weight (g) and 1000-grain weight (g) as affected by the interaction between nitrogen levels and cyriallen rates in both seasons.

Characters	Flag leaf area (cm^2)						Panicle weight (g)						1000-grain yield (g)					
Seasons	2000			2001			2000			2001			2000			2001		
Cyriallen rates	0	300	600	0	300	600	0	300	600	0	300	600	0	300	600	0	300	600
N-levels (kg/fad):																		
30	20.3	21.2	22.4	21.9	23.7	25.7	1.95	2.30	2.60	2.17	2.60	2.70	23.4	27.2	27.9	24.1	29.2	29.3
45	23.0	24.4	27.0	23.2	25.9	27.7	2.40	2.95	3.08	2.67	3.07	3.15	24.5	31.3	31.8	27.5	32.9	32.1
60	24.9	27.2	28.4	24.6	27.6	29.0	2.60	3.08	3.06	2.88	3.18	3.00	25.9	32.5	31.4	29.3	33.9	30.9
F- test	**			*			**			*			*			**		
LSD at 5%	0.5			0.5			0.12			0.11			0.8			1.03		
at 1%	0.7			---			0.16			---			---			1.40		

Table (5): Means of grain and straw yields (t/fad) as affected by the interaction between nitrogen levels and cyriallen rates in both seasons.

Characters	**Grain yield (t/fad**						**Straw yield (t/fad**					
Seasons	**2000**			**2001**			**2000**			**2001**		
Cyriallen rates	0	300	600	0	300	600	0	300	600	0	300	600
N-levels (kg/fad):												
30	3.282	3.763	3.914	3.299	4.207	4.491	4.245	4.609	4.723	4.402	4.757	4.864
45	3.601	4.238	4.585	3.761	4.803	5.027	4.486	4.645	4.905	4.562	4.838	5.080
60	3.958	4.451	4.373	4.105	4.949	4.942	4.552	4.694	5.092	4.615	4.911	5.260
F- test	**			**			**			**		
LSD at 5%	0.064			0.114			0.111			0.084		
at 1%	0.087			0.155			0.152			0.114		