Seston and Nitrogen Effects on Yield and N, P Uptake of Rice (*Oryza sativa* L. cv. Hassawi)

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Abstract

In a pot experiment conducted during the summer seasons March-June of 1999 and 2000 the effects of seston (100 and 200 g/pot) and different nitrogen levels (0, 50, 100 and 150 kg N/ha) on yield. Yield components and nutrient uptake of Hassawi rice (*Oryza sativa*) were studied. Yield, yield components and uptake of N and P significantly increased with seston application and with each successive increment of nitrogen. Grain yield increased significantly from 10.5 t/ha without seston to 14.3 t/ha with 200 g/pot seston. Grain yield was the highest under 150 kg N/ha and was significantly superior to both 0 and 50 kg N/ha treatments in both the seasons, but was on a par with the 100 kg N/ha in the second season.

Introduction

Hassawi rice (*Oryza sativa* L.) is generally grown in Al-Hassa from February – March to June-July. During this period, the crop is irrigated by flood irrigation and even though the yield is quite low. Since irrigation water in Saudi Arabia is scarce (Al-Amoud and Mohammad, 1995), it may be beneficial to adopt certain soil-moisture conservation practices like the use of seston (Blue green Algae biomass accumulated in water reservoirs). The role of blue-green algae (BGA) is supplying N to rice field is well documented. In addition, they also bring about, directly or indirectly, a number of changes in the physical, chemical and biological properties of the soil and soil-water interface in rice fields (Mandal et al., 1999). BGA liberate extracellular organic compounds and photosynthetic O_2 during their growth and on decomposing of different organic acid in soil (Rogers and Ladha, 1992). All changes brought about by BGA in soil may ultimately influenced plant-available nutrients. Also optimum levels of fertilizer nutrient, particularly nitrogen plays an important role in boosting the yields (Mandal et al., 1999). In the present investigation an attempt was made to study the effect of seston and levels of nitrogen on the yield and yield attributes of Hassawi rice.

Material and Methods

A pot experiment was conducted in a green house at the Agricultural and Veterinary Training and Research Station, King Faisal University in Al-Hassa, Saudi Arabia during the summer seasons (March to June) of 1999 and 2000. Hassawi rice was grown in plastic pots (100 cm in diameter) filled with soil composed of fine sand (61.8%,) coarse sand (9.6%), silt (25.2%), clay (4.5%) and organic carbon (0.49%) with a pH of 7.2. Twenty-five seeds of Hassawi rice were sown per pot, later thinned to 15 per pot.

12 treatment combinations involving 3 seston treatments (0, 100 and 200 g/pot) and 4 levels of nitrogen (0, 50, 100 and 150 kg N/ha) replicated 4 times in split plot design were used. Nitrogen rates as the main plots and seston levels as subplots.

A basal dose of phosphorus and potassium were applied at 75 kg P_2O_5 /ha and 50 kg K_2O/ha in the form of triple superphosphate (48% P_2O_5) and murate of potash respectively. Nitrogen was applied in the form of urea (46% N) as per treatment in two equal splits, one before sowing and the other at the tillering stage. Seeds of Hassawi rice were sown on 18 March 1999 and 3 March 2000. Seston collected from the shore of the Arabian Gulf was applied according to the treatments just after sowing over the soil surface. The crop was harvested on 25 June and 20 June in 1999 and 2000 respectively.

At harvest number of grains/spike, number of filled grains/ spike, grain and straw yields were determined on samples of 10 plants/pots immediately after harvest 3 plants/pot were randomly sampled, oven dried at 80°C for 24 hours and ground to pass a 20 mm-mesh screen to estimate nitrogen and phosphorus uptake. Total nitrogen was determined on composite plant samples by the Kjeldahl distillation method (Bremner, 1965). For phosphorus determination, the plant material was digested with nitric, sulphuric and perchloric acid mixture. Phosphorus concentration in the extract was determined by Vanadomolybodo-phosphoric yellow color method (Jackson, 1968). Analysis of variance was performed to determine the statistical significance of the effect of treatments according to the procedure outline by Steel and Torrie (1988).

Results and Discussion

Grain yield

The grain yield was significantly higher under 200-g seston/pot than the 100-g seston/pot and the control in both seasons (Table 1). During 1999, this treatment recorded lower grain yield than that during 2000.

Table (1)
Grain and straw yields of summer rice as affected by nitrogen and seston application.

Treatment	Grain yield (t/ha)			Straw yield (t/ha)		
	1999	2000	mean	1999	2000	Mean
Seston rate (g/pot)						
0	8.5	12.4	10.5	22.2	24.6	23.4
100	12.4	12.6	12.5	25.8	28.4	27.1
200	13.0	15.6	14.3	29.3	31.7	30.5
LSD (0.05)*	2.64	1.70	1.24	2.49	3.56	2.58
Nitrogen (kg/ha)						
0	10.3	11.2	10.2	23.7	25.7	24.4
50	11.2	13.2	12.2	26.6	28.4	27.5
100	12.4	13.9	13.1	26.7	28.7	27.7
150	13.2	14.9	14.1	28.0	28.9	28.4
LSD (0.05)*	0.71	0.82	0.68	n.s.	1.04	1.84

n.s. = Not significant
* Calculated From Raw Data.

However, the 100-g seston/pot application recorded more grain yields than the control during both seasons. During 1999, the application of 200-g seston/pot was not significantly different from that of the 100-g seston/pot, both being superior to the control. But during 2000, the 200-g seston/pot application was found superior to both 100-g seston/pot and the control and the latter two were not significantly different. The pooled data of the two seasons also revealed that grain yields were significantly higher under the 200-g seston/pot than under the 100-g seston/pot. The beneficial effect of seston may be attributed to better conservation of soil moisture, which might have helped in improving the growth and yield of crop. This substantiates the findings of Alla-El-Din and Shalan, 1989 and Santra, 1993.

The maximum grain yield was obtained with 150 kg N/ha (Table 1), which was significantly superior than that of 100 kg N/ha. The lowest yield was found under the control. A similar trend was also observed when the data were pooled. However, 50 kg N/ha was found on a par with 100-kg N/ha. Both were being significantly superior to the control in both seasons.

Kumar and Verma (1981) found that upland, rice rsponded up to 150 kg N/ha, whereas Singh *et al.* (1983) observed gradual increase in the yield of upland rice up to 80 kg N/ha.

Straw yield

The straw yield was the highest under the 200-g seston/pot treatment in both seasons (Table 1). This was not significantly different from the 100-g seston/pot in 2000. The combined analysis shows that the straw yield was significantly higher under the 200 than the 100-g/pot treatments, which in turn was again significantly higher than the control. Higher straw yields with seston application, particularly when 200-g seston/pot was applied, might be because of better soil-moisture and fertility conditions that helped in better vegetative growth of the rice. This conforms the findings of Pravdivaya *et al.,* 1988 and Temple *et al.,* 1989.

The effect of nitrogen levels was not significant in 1999, whereas in 2000 all the levels produced significantly higher straw yields over the control. In 1999, the crop perhaps could not utilized most of the applied nitrogen for dry-matter production. But in the second year, under optimum soil-moisture conditions, increased nitrogen levels resulted in more utilization of nitrogen by the crop for dry-matter production. The pooled data revealed that all the 3 levels of nitrogen (50, 100 and 150 kg N/ha) gave significantly higher straw yields than the control. Although, they were at par among themselves.

Grains/spike

The 200-g seston/pot (Table 2) produced significantly higher number of grains/spike than the 100-g seston /pot and the control. The combined analysis of the two seasons indicated that the 200-g seston/pot and no seston, the latter two treatments being at par. The beneficial effect of the addition of the seston may again be attributed to better soil-moisture condition during the spike initiation stage. Nitrogen at 100 and 150 kg/ha recorded similar number of grains/spike in 1999 and 2000. These two levels produced significantly higher number of grains/spike than 50 kg N/ha level. However in 2000. 100 and 50 kg N/ha levels were at par. Again in that year. 50 kg N/ha level could not improve the number or grains/spike over the 0 kg N/ha level, although in 1999, there were significant differences between these two levels of nitrogen.

Table (2)
Grain and filled grains/spike of summer rice as affected by nitrogen and seston application.

Treatment	Grain/spike			Filled grain/spike		
	1999	2000	mean	1999	2000	Mean
Seston rate (g/pot)						
0	80.4	84.3	82.4	69.8	70.6	70.2
100	81.3	85.2	83.3	72.1	73.4	72.4
200	91.1	92.8	92.0	76.8	78.3	77.6
LSD (0.05)*	3.08	1.67	2.44	1.53	3.66	2.49
Nitrogen (kg/ha)						
0	78.2	83.7	81.0	65.8	68.5	67.2
50	83.9	87.1	85.5	71.7	72.3	72.0
100	91.3	92.5	91.9	75.9	76.7	76.3
150	92.8	93.2	93.0	77.4	78.9	78.2
LSD (0.05)*	2.73	3.65	3.05	3.21	3.42	3.12

* Calculated From Raw Data.

The pooled data of two years reveal that the highest number of grains/spike was obtained with 150 kg N/ha which was not significantly different from the 100 kg N/ha but it was significantly superior to the 50 kg N/ha and the 0 kg N/ha treatment. This was obviously because of better crop nutrition in the presence of nitrogen.

Filled grains/spike

The maximum filled grains/spike was produced with the 200 g/pot treatment, followed by the 100 g/pot and no seston in both seasons. However, these under 100 g/pot and no seston were at par in 2000. Similar trend was also observed when the data were pooled (Table 2).

Increase number of filled grains/spike was recorded as the nitrogen levels increased in both seasons. In 1999, 150 and 100 kg N/ha were at par and significantly superior to the other two levels of nitrogen. Moreover, 50 kg N/ha gave more filled grains/spike than the control. Also in 2000, both 150 and 100 kg N/ha were at par and were superior to 50 and 0 kg N/ha treatments.

The 150-kg N/ha treatment produced the highest number of filled grains and was at par with 100 kg N/ha when the data were pooled, and they were significantly differed from 50 kg N/ha.

Nitrogen uptake

Nitrogen uptake increased significantly with seston application and with the increase in the rate of applied nitrogen (Table 3). The increase in nitrogen uptake with sestoning average 46.7% (with 100 g/pot) and 94.7% (with 200 g/pot) in 1999 and 22.1% and 42.6% in 2000. These results are in line with those reported by Zhou and Kleinhofs (1996), Mandal *et al*. (1999) and Thind and Rowell (1999). Similarly, as the rate of fertilizer nitrogen increased from 50 to 150 kg N/ha, average nitrogen uptake by Hassawi rice increased by 19.4% in 1999 and by 45.8 in 2000.

Table (3)

Nitrogen and phosphorus uptake (kg/ha) of summer rice as affected by nitrogen and seston application.

Treatment	Nitrogen			phosphorus		
	1999	2000	mean	1999	2000	Mean
Seston rate (g/pot)						
0	30.4	44.8	37.6	6.7	7.3	7.0
100	44.6	54.7	44.7	7.0	13.5	10.3
200	59.2	63.9	61.6	9.7	16.0	12.9
LSD (0.05)*	3.64	4.27	3.83	1.03	1.64	1.21
Nitrogen (kg/ha)						
0	49.5	65.1	57.3	7.5	10.8	9.2
50	60.9	69.8	65.4	9.7	13.4	11.6
100	67.8	75.6	71.7	10.7	15.5	13.1
150	72.7	101.8	87.3	11.9	18.4	15.2
LSD (0.05)*	2.95	3.04	2.69	0.76	0.82	0.73

* Calculated From Raw Data.

Phosphorus uptake increased significantly with seston application and nitrogen application (Table 3). Like nitrogen uptake, phosphorus uptake increase was substantial. Menon *et al.* (1998) and Rama-Krishnayya *et al.* (1998) reported similar findings. Enhanced growth as well as grain yield and higher nutrient uptake with sestoning maybe attributed to its favorable effect on the edaphic environment.

These results have indicated that sestoning of rice holds a great promise to increase crop yields and to economize fertilizer nitrogen in Hassawi rice production.

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تأثير الطحالب والنيتروجين على إنتاج ومكونات الإنتاج وامتصاص النيتروجين والفسفور في الأرز الحساوي

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الملخص:

أجريت تجربة أصص خلال موسم صيف ١٩٩٩ – ٢٠٠٠م (شهر مارس – يونيو) ، حيث درس تأثير الطحالب الزرقاء المخضرة ومعدلات النيتروجين على إنتاج ، مكونات الإنتاج، وامتصاص النيتروجين والفسفور في محصول الأرز الحساوي (Oryza sativa). أعطى النيتروجين والفسفور زيادة معنوية مع إضافة الطحالب ومع كل زيادة بسيطة للنيتروجين على الإنتاج، مكونات الإنتاج والامتصاص الغذائي للمحصول، كان هناك زيادة في المحصول ومكوناته عند إضافة ٢٠ جم/الأص من الطحالب. زادت معنوياً إنتاجية الحبوب من ١٠,٥ طن/هكتار (بدون أسمدة) إلى ١٤,٣ طن/هكتار (بإضافة ٢٠ جم طحالب/أص). أدت إضافة ١٥٠ كجم نيتروجين/هكتار إلى زيادة معنوية في كمية الحبوب خلال الموسمين مقارنة بالمعاملتين صفر و٥٠ كجم نيتروجين/هكتار، بينما لم تختلف المعاملة ١٥٠ كجم نيتروجين/هكتار معنوياً عن المعاملة ١٠٠ كجم نيتروجين/ هكتار خلال موسم ٢٠٠٠م في إنتاجية الحبوب.