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Summary

Two field experiments were performed during 2010 and 2011 seasons at the Experimental Farm of Rice Research and Training Center (RRTC), Sakha, Kafrelshiekh, Egypt. The experiments were performed to study the effect of different combinations of mineral nitrogen fertilizer and farmyard manure on growth characters, yield and its components of Sakha 105 rice cultivar; physical quality and chemical quality of rice grains and rice straw as well as soil nitrogen available and soil organic matter percentage. The preceding crop was Egyptian clover in both seasons. Randomized complete block design (RCBD) was used with four replicates in the two seasons. The studied characters were:

Growth character:

Plant height and leaf area index (LAI).

Yield and its attributes:

Panicle length, panicle weight, number of panicles/m^2, number of grains/panicle, filled grains percentage, 1000 grains weight and gain yield (t/ha).

Physical quality (milling characters):

Hulling, milling and head rice percentage.

Chemical quality (nutrition quality):

- Macronutrients: nitrogen, phosphorus and potassium (%) as well as protein content (%)
- Heavy metals: iron, zinc and manganese as essential metals as well as cadmium and lead as non-essential elements.

Summary

Soil characters:

Soil nitrogen available and soil organic matter (%).

The following is a summary of the most important results during both seasons under study:

A- Growth characters:

Data showed that rice plant height was increased with increasing mineral nitrogen levels up to 69 kg N/fed. without significant differences with 46 kg N/fed. FYM application led to clear increment just at the rate of 9 t/fed. Also combined application of N+ FYM showed maximum heights at the treatment of 69 kg N/fed.+ 9 t FYM/fed. during both seasons.

Data indicated that LAI was significantly increased as mineral N level increased up to 69 kg N/fed. Application of FYM at rate of 9 t/fed. clearly increased LAI. Maximum LAI was obtained with different combinations. LAI was increased up to PI stage then decreased at harvest

B- Yield and its attributes:

- Application of mineral N at rate of 69 kg N/fed. produced the greatest number of panicles/m^2 in comparison with other N levels. Individual application of FYM had no significant effect on panicles number/m^2 at the two rates. Combined use of N and FYM produced maximum number of panicles/m^2 at 69 kg N/fed. + 9 t FYM/fed.
- Gradual significant increment was observed with increasing mineral N level from 23 up to 69 kg N/fed. FYM application had less effect than mineral N but it was significant in comparison with control treatment. Application of N plus FYM gave maximum panicle weight by treatment of 69 kg N/fed. + 9 t FYM/fed.

- The greatest values of panicle length were found when rice plants fertilized by 69 kg N/fed. + 7.5 or 9 t FYM/fed. or by 46 kg N/fed.+ 9 t FYM/fed. Individual application of N or FYM increased panicle length with significant differences over control.
- Data revealed that application of N combined with FYM had better effect than adding each separately. Application of 46 or 69 kg N/fed. + 9 t FYM/fed. and 69 kg N/fed.+ 7.5 t FYM/fed. gave the greatest number of grains per panicle. Mineral nitrogen surpassed FYM in regard to number of grains per panicle.
- Filling grain percentage didn't significantly differ among the treatments under study. The greatest percentage was obtained with 69 kg N/fed. + 7.5 or 9 t FYM/fed.
- There were no significant differences in regard to thousand grains weight since control treatment gave the greatest values and decreased with application of N or FYM alone or in combination.
- Mineral nitrogen greatly affected rice grain yield since increased up to 69 kg N/fed. FYM also increased grain yield with significant difference just in 2011 season. Combinations of mineral and FYM led to maximizing grain yield at the treatment of 9 kg N/fed. + 9 t FYM/fed. without significant difference with treatment of 69 kg N/fed.+ 7.5 t FYM/fed. in 2010 season.

C- Quality characters:

C-1 Physical quality (milling characters):

- Mineral N increased hulling percent up to 69 kg N/fed. Also applying FYM resulted in higher hull percent with the rate of 7.5 t/fed. and increased with the rate 9 t/fed. in comparison with control. Maximum percent was recorded with 69 kg N/fed. + 7.5 t FYM/fed. treatment.

- Mineral N up to 46 kg N/fed. led to higher milling percent, then decreased at the level of 69 kg N/fed. FYM application also led to an increase in milling percent. Maximum percent was recorded when N and FYM combined.
- Both of mineral N or FYM increased head rice percent. Greatest value was given by combined application and reached maximum at the treatment of 69 kg N/fed. + 9 t FYM/fed.

C-2- Chemical quality (nutrition quality):

1- Nitrogen concentration (%):

- Nitrogen concentration in rough grains was increased with increasing N level up to 69 kg/fed. without clear difference between this level and 46 kg/fed. FYM application produced an increase in N concentration and no significant differences between FYM rateswere detected. While joint application of N and FYM surpassed in regard to N concentration with the treatment of 46 kg N/fed. + 7.5 t FYM/fed. in both seasons.
- Maximum nitrogen concentrations in brown rice were obtained by 46 kg N/fed. + 7.5 t FYM/fed. in both seasons and decreased with 69 kg N/fed. + 7.5 or 9 t FYM/fed. Control treatment produced the lowest concentrations of N.
- Milled rice contained maximum N concentrations with treatment of 46 kg N/fed. + 7.5 t FYM/fed. and treatment, 46 kg N/fed. + 9 t FYM/fed. FYM increased N content without significant differences in comparison to control in both season.
- Chemical analysis of rice straw showed that lowest concentrations were obtained by control treatment. Greatest values were obtained by the combination 46 kg N/fed. + 7.5 t FYM/fed. Mineral nitrogen surpassed FYM rates in both seasons in regard to N concentration in straw.

2- Protein content (%):

Data about protein content in rough grains as well as brown and milled rice and straw referred to that lowest protein content was noticed with unfertilized plots. Maximum protein was recorded in treatment of 46 kg N/fed. + 7.5 t FYM/fed.

3- Phosphorus concentration (%):

- Results indicated that were no clear differences among the treatments under study in the first season. But in the second, phosphorus concentration increased with raising N level up to 69 kg/fed. as well as with increasing FYM up to 9 t/fed. Greatest P concentration was recorded at mixing 23 kg N/fed. + 9 t FYM/fed. in both seasons.
- In regard to P concentration in brown rice, highest values were recorded in the combination of 23 kg N/fed. + 9 t FYM/fed. in comparison to adding mineral N or FYM alone.
- Data revealed that P concentration in milled rice was significant in 2010 season only. The treatment of 23 kg N/fed. + 9 t FYM/fed. followed by 23 kg N/fed. + 7.5 t FYM/fed. treatment and equal to the treatment of 46 kg N/fed. + 9 t FYM/fed. in the second season.
- Phosphorus concentration in rice straw was decreased with no inputs and increased with N applied alone up to 69 kg N/fed. No significant increase with application of 9 t FYM/fed. over 7.5 t FYM/fed. was detected The concentrations reached a maximum at the treatment of 23 kg N/fed. + 9 t FYM/fed. then decreased with raising amounts of fertilizers.

4- Potassium concentration (%):

- Data cleared that potassium concentration in rough grains was increased with increasing N level up to 46 kg N/fed. after that

decreased with 69 kg N/fed. It was also noted that K concentration was significantly increased with increasing FYM from 7.5 t/fed. up to 9 t/fed. only in the first season. The greatest values were obtained by treatment (46 kg N/fed. + 7.5 t FYM/fed.) in the first season and by treatment (23 kg N/fed. + 9 t FYM/fed.) in the second season.

- Control treatment produced lowest values of K concentration in brown rice, then it increased with raising N level up to 46 kg/fed. and decreased at the level of 69 kg/fed. Both rates of FYM led to a significant increase in K concentration which maximized with the treatments of 23 kg N/fed. + 9 t FYM/fed. and 46 kg N/fed. + 7.5 t FYM/fed.
- It was obvious from data that greatest K concentration was recorded with the treatment (23 kg N/fed. + 9 t FYM/fed.) also with treatment (46 kg N/fed. + 7.5 t FYM/fed.) and decreased with increasing amounts of fertilizers. Application of N alone didn't affect K percent in the milled rice, while FYM application significantly affected K percent.
- Rice straw contained K concentrations more than that found in grains. Mineral nitrogen and FYM rates resulted in more K concentrations over control and maximized with application of 23 kg N/fed. + 9 t FYM/fed., 46 kg N/fed. + 7.5 t FYM/fed. and 69 kg N/fed. + 7.5 t FYM/fed. then decreased with the treatment (69 kg N/fed. + 9 t FYM/fed.).

5- Iron concentration (mg/kg):

- Both nitrogen levels and FYM increased iron concentration in rough grains. Maximum values were recorded with application of 69 kg N/fed. + 9 t FYM/fed. followed by treatment of 69 kg N/fed. + 7.5 t FYM/fed.
- Concentration of iron decreased with hulling process. The values were increased with N levels or FYM and reached maximum in the brown grains at the treatment, 69 kg N/fed. + 9 t FYM/fed.

- Results showed that milled grains had lower concentrations than rough grains or brown rice. Iron concentration was increased with increasing N or FYM alone. The treatment of 69 kg N/fed. + 9 t FYM/fed. produced maximum iron concentrations.
- Data clarified that Fe concentration in rice straw was higher than grains and increased with N application without significant differences between 46 and 69 kg/fed. in the first season. Raising the rate of FYM to 9 t/fed. resulted in clear increment in Fe concentration just in the second season. Greatest values were given by 69 kg N/fed. when combined with 9 t FYM/fed.

6- Zinc concentration (mg/kg):

- Results indicated that zinc concentration in rough grains tended to increase with increasing mineral N level or FYM. Application of N combined with FYM gave best concentration of Zn at 46 kg N/fed. + 7.5 t FYM/fed. after that decreased with the higher amounts of fertilizers.
- There were no significant differences among N level and also between FYM rates. The treatment of 23 kg N/fed. + 7.5 t FYM/fed. followed by 9 t FYM/fed. recorded the greatest Zn concentration in brown rice in the first season and 23 kg N/fed. + 9 t FYM/fed. followed by 23 kg N/fed. + 7.5 t FYM/fed. in the second season, then the values decreased with the higher rates of the fertilizers.
- Results revealed that greatest Zn concentrations were given by 23 kg N /fed. when combined with 9 t FYM/fed. It was noticed that zinc concentration didn't significantly influenced by the treatments under study in both seasons.
- Data cleared that but Zn concentration in rice straw increased with N applied alone without significant differences in the first season. FYM

applied at the rate of 9 t/fed. surpassed N applied alone. Maximum values were recorded with the treatment, 23 kg N/fed. + 9 t FYM/fed. and decreased up to 69 kg N/fed. + 9 t FYM/fed.

7- Manganese concentration (mg/kg):

- Small increases in Mn in rough grains were recorded with raising of N levels up to 69 kg/fed. and also with raising FYM rates .The combination of 69 kg N/fed. + 9 t FYM /fed. recorded highest concentrations in both seasons.
- Mn concentration decreased in brown rice in comparison with rough grains. All N levels led to non-significant increase in Mn concentration. FYM surpassed N levels, while the combined application of them produced greatest values at the treatment (69 kg N/fed. + 9 t FYM/fed.).
- More depression was noted in Mn concentration at the rate of 9 t FYM after milling process. It increased with N level without clear difference but was lower than those given by FYM .Combined application gave the greatest concentrations.
- Result showed that maximum Mn concentrations were recorded with the treatment of 46 kg N/fed. + 9 t FYM/fed. Control treatment gave lowest values in both seasons.

8- Cadmium concentration (mg/kg):

- In regard to rough grains Cd concentration was increased as N level increased. FYM led to decreasing Cd concentration in rough grains. Greatest values were obtained by 69 kg N/fed followed by 69 kg N/fed. + 7.5 t FYM/fed. treatment.

- Significant increase was noted with N level up to 69 kg N/fed since gave maximum Cd concentration in brown rice followed by 69 kg N/fed. combined with 7.5 t FYM/fed.
- Simple depression was noticed in Cd concentration in milled rice in comparison with its concentration in rough and brown grains. N level tended to increasing Cd concentration. FYM application resulted in less values of Cd without clear significant differences. N level of 69 kg N/fed. gave the highest values in both seasons.
- N-level resulted in a significant increase in Cd concentration in rice straw only in the second season. Less Cd concentrations were obtained by FYM applied alone at the two rates and returned to increase when FYM was combined with mineral N.

9- Lead concentration (mg/kg):

Lead concentration in rough grains as well as in brown and milled rice and straw didn't significantly affected by different fertilization treatments under study.

D-soil characters:

Soil nitrogen available (mg/kg):

It was obvious from data that soil available nitrogen was increased with raising mineral N level up to 69 kg N/fed. as well as with raising FYM. Soil available nitrogen the obtained by mineral N was superior to that obtained by FYM applied alone. Combined application of N plus FYM doubled their effects on soil available nitrogen.

Soil organic matter (%):

Data revealed that soil organic matter was decreased with increasing mineral nitrogen, but FYM tended to increase soil organic

matter percent. Treatment of 9 t FYM/fed. surpassed 7.5 t FYM/fed. treatment. Joint application of mineral nitrogen and FYM at the rate of 69 kg N/fed. + 9 t FYM/fed. followed by 46 kg N/fed. + 9 t FYM/fed. led to maximum soil organic matter percentage.

E- Estimation daily intake (EDI):

Protein (g/day/person): Results indicated that greatest daily intakes of protein were recorded by the treatment of 46 kg N/ fed. plus 7.5 t FYM/fed. in both seasons.

Phosphorus (g/day/person): Maximum daily intakes were found with the treatment of 23 kg N/ fed. plus 9 t FYM/fed. in both seasons. This estimation showed that application of FYM at its high rate was better than the lower rate.

Potassium (g/day/person): Treatment of 23 kg N/fed. plus 9 t FYM/fed. resulted in greatest daily intakes in both seasons of study.

Iron (mg/day/person): It can be concluded that consumption of milled rice treated by 69 kg N/ fed. combined with 9 t FYM/fed. will give adult person greatest amount of iron nutrient compare to other fertilization treatments

Zinc (mg/day/person): Values of EDI reached peak when milled rice received 23 kg N/ fed. plus 9 t FYM/fed. This outcome illustrated that this treatment led to milled rice more valuable than other fertilization treatments.

Manganese (mg/day/person): Greatest valuable milled rice was found with application of 69 kg N/ fed. plus 9 t FYM/fed. and 23 kg N/ fed. plus 9 t FYM/fed. in the first and second seasons, respectively. These results

indicated that appropriate fertilizer management of both mineral combined with organic could increase absorption and translocation abilities of Fe, Zn and Mn in grain and improve nutrition quality of rice

Cadmium (mg/day/person): Treatment of 9 t FYM/fed. resulted in the lowest daily intake values in both seasons. While treatment of 69 kg N/fed. resulted in greatest values. This means that consumption of milled rice treated by farmyard manure as an organic fertilizer is better than consumption of milled rice treated by other fertilizations treatments under condition of this study.

Lead (mg/day/person): Application of 69 kg N/fed. plus 7.5 or 9 t FYM/fed. and 23 kg N/fed. in the first and second seasons, respectively resulted in least amounts of lead element that humans can intake.

Conclusion

1- Application of 69 kg N/fed. + 9 t/fed. led to maximum grain yield of Sakha 105 rice cultivar and its components. It's possible to reduce mineral fertilization with simple reduction in grain yield to maintain environment and reduce mineral fertilizers costs by the combination of 46 kg N/fed. + 9 t FYM/fed.

2- Application of 46 kg N/fed. + 9 t FYM/fed. introduced highest concentrations of most nutrients under study, phosphorus, potassium, zinc and manganese except protein, the greatest values were obtained by the combination of 46 kg N/fed. + 7.5 t FYM/fed.

3- Application of 46 kg N/fed. + 9 t FYM/fed. can be suitable for iron element concentrations instead of 69 kg N/fed. + 9 t FYM/fed. to also save costs and maintain environment.

4- FYM applied alone helped to reduce cadmium concentrations in milled rice and lowest values were obtained by application of 9 t FYM/fed.

5- Greatest values of SOM and soil available nitrogen were found with treatment of 46 or 69 kg N/fed. + 9 t FYM/fed.

6- In regard to estimation of daily intakes (EDI) of elements by consumption of milled rice in Egypt, highest intakes were obtained with application of 46 or 69 kg N/fed. + 9 t/fed. Daily intake of protein was best with treatment of 46 kg N/fed. + 7.5 t/fed.

Further studies and research should focus on adding organic fertilizer for rice crop and its conjoint application with mineral nitrogen as well there should be an encouragement to farmers by the government to know its importance in maintaining soil environment and reduce fertilization costs with access to high yield with maximum nutritional value, which contributes in reducing the disease and increase the body's immunity.