Original Research Article

Evaluation of different doses and ~~mode~~ modes of application of ferrous ammonium ~~sulphate~~ sulfate for maximizing rice production

ABSTRACT

The field experiment on rice was carried out during the *Kharif* season 2021 at Agricultural Engineering Research Farm, JNKVV, Jabalpur (M.P.) to evaluate the effect of ferrous ammonium sulphate (FASt) on rice production. Eight treatments were applied, namely RDF- Recommended dose of fertilizer (N:P:K) (120:60:40), RDF + FASt at 15 kg/ha for soil application, RDF + FASt at 25 kg/ha for soil application, RDF + FASt at 35 kg/ha for soil application, RDF + 2 Spray of FASt 0.25% at 25 and 45 DAT, RDF + 2 Spray of FASt 0.50% at 25 and 45 DAT, RDF + 1 Spray of FASt 0.25% at 25 DAT, RDF + 1 Spray of FASt 0.50% at 25 DAT. The studies revealed that applying FASt to transplanted rice significantly increased grain yield over the control. All the growth parameters and yield attributes were found highest in the treatment soil application of ferrous ammonium sulphate (FASt) at 35 kg/ha with a recommended dose of fertilizer (RDF) and more effective comparatively foliar application of FASt at 0.25% and 0.50%. It recorded a maximum grain yield (5188 kg/ha) with a higher harvest index (38.85).

Keywords: *Ferrous ammonium ~~sulphate~~sulfate, Foliar application, ~~Recommended~~recommended dose of fertilizer, Transplanted rice*

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1. INTRODUCTION

Rice (*Oryza sativa* L.) plays a major role in diet, economy, employment, culture and history. Almost 90% of the world's rice is produced and consumed in Asia. It provides the consumer with 50-80% daily calorie intake [1]. It accounts for about 42% of the country's total food grain production and 55% of cereal production. In India, rice contributes 45% to the total food grain production and is grown in an area of 44.1 million ha with a production of 106.64 million tonnes and productivity of 2.42 t/ha [2].

In Madhya Pradesh, it occupies an area of 2.29 ha with a production of 4.23 MT and productivity of 1847 kg/ha [3].

Most Indian soils are deficient in S, Zn, M, Cu, B, Fe and Mo. Rice crops under the Rice-Wheat cropping system (RWCS) struggle with iron and zinc deficiency. Iron chlorosis is most severe when the coarse-textured soils are brought into wider rice cultivation for the first time. Sometimes severe chlorosis due to Fe deficiency can lead to complete failure of the rice crop [4]. It happens even though the total iron content in soils is ~~extraordinary~~ extraordinarily high. However, the amount of plant-usable iron is relatively low to moderate and depends on soil properties, cropping patterns and environmental conditions.

The deficiency of ~~sulphur~~ sulfur is rising ~~speedy~~ speedily in regions wherein constantly sulphur-free fertilizers like DAP and urea are being used. When S becomes limiting, adding N does not change ~~plants~~ plants' yield or protein level. Sulphur is needed early in the growth and development of rice plants. If it is limiting during the early growth period followed by tillering, finally, the yield will be reduced [5].

One such product, which is the multi-nutrient fertilizer ferrous ammonium sulphate ($(NH4)_2 Fe(SO_4)_2.6H_2O$), claims to increase rice productivity. It is a crystalline water-soluble solid containing iron, nitrogen, and sulphur. It is used mainly in soils where iron is deficient, and the soil is neutral to alkaline. It eliminates iron chlorosis by enhancing chlorophyll synthesis and helps conditioning alkaline soils to allow the uptake of immobilized soluble micronutrient salts [6]. Hence, a study was undertaken to test ferrous ammonium sulphate's effect on rice growth and yield along with a recommended dose of fertilizer.

2. MATERIALS AND METHODS

The experiment was conducted at Agricultural Engineering Research Farm, JNKVV, Jabalpur (M.P.), during the *Kharif* season of 2021. All the treatments were arranged in a randomized block design with eight treatments and three replications. Total eight treatments, comprising RDF- Recommended dose of fertilizer (N:P:K) (120:60:40), RDF + FASt at 15 kg/ha for soil application, RDF + FASt at 25 kg/ha for soil application, RDF + FASt at 35 kg/ha for soil application, RDF + 2 Spray of FASt 0.25% at 25 and 45 DAT, RDF + 2 Spray of FASt 0.50% at 25 and 45 DAT, RDF + 1 Spray of FASt 0.25% at 25 DAT, RDF + 1 Spray of FASt 0.50% at 25 DAT. The soil was clay loam in texture, having 0.58% organic carbon, low in available nitrogen (238.14 kg/ha), medium in phosphorus (16.17 kg/ha), rich in

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available potassium (305.12 kg/ha) and neutral in reaction (pH 7.1) with normal electrical conductivity. The gross plot size was 5.0 m × 4.0 m. Dry seeds of the Kranti variety were sown in the bed and covered with FYM. Irrigation was applied to ensure proper germination of seeds in a nursery bed. In all plots, two seedlings per hill were manually transplanted at a planting geometry of 20 cm × 15 cm when they were 25 days old. Urea, single super phosphate, and muriate of potash were used to apply the recommended doses of plant nutrients at 120:60:40 NPK kg/ha, respectively. Data recorded during the study period were analyzed statistically using the F–test. The significant differences between treatment means were compared with the least significant at a 5% level of probability.

3. RESULTS AND DISCUSSION

3.1 Growth parameters

The present results show the effect of different doses and modes of application of FASt on plant height, tillers per hill, dry weight per hill, and leaf area index (**Table 1**). Significant differences were noticed among the treatments regarding plant height at 60 DAT. The treatment, which consisted of soil application of FASt at 35 kg/ha with RDF, registered the highest plant height (105.5 cm); however, it was found at par with treatment, which received RDF with 2 foliar applications of FASt at 0.50% at 25 and 45 DAT. While control plot, which received only RDF, recorded the lowest plant height (82.1 cm) among all the treatments. Similar results were reported by [7].

Significant variation was found among different treatments in the case of number of tillers per hill due to different levels of FASt at 60 DAT. The minimum number of tillers (7.9/hill) occurred under controlled plot due to the non-availability of micronutrient, where only RDF was given. However, soil application of FASt at 15 kg/ha with RDF treatment marginally increases the number of tillers. The treatment, which received soil application of FASt at 35 kg/ha with RDF bears maximum tillers (10.4/hill) and proved significantly superior over all the treatments. This might be due to improved metabolic activity with micronutrients that enhanced the floral primordia development in many tillers. [8] also made similar observations.

FASt nutrition significantly influenced the dry matter production of rice at 60 DAT. The controlled plot received only RDF, producing the least amount of dry matter (42.8 g/hill). However, the soil application of FASt at 35 kg/ha with RDF produced the maximum amount of dry matter production (54.8 g/hill), and it was outperformed among all the treatments, and it was at par with the foliar application of 2 sprays of 0.50% FASt at 25 and 45 DAT along with the RDF. The enhanced

availability of nutrients, especially iron, might have led to a better accumulation of photosynthates in the form of dry matter. Our results closely conform to those of [9].

The leaf area index (LAI) at 60 DAT was significantly influenced by different treatments. The treatment, which consisted of soil application of FASt at 35 kg/ha with RDF, recorded the maximum LAI (4.02) and outperformed all the treatments. However, it was found at par with treatment which received RDF with 2 foliar applications of FASt at 0.50% at 25 and 45 DAT. While control plots recorded a minimum LAI (3.72), supplemented with RDF only. Our results confirm the findings of [10].

Table 1. Effect of different doses and mode of application of FASt on growth parameters of rice at 60 DAT

Treatments	Plant height (cm)	Tillers/hill	dry weight/hill (g)	Leaf area index
RDF- Recommended dose of fertilizer	82.1	7.9	42.8	3.72
RDF + FASt @ 15kg/ha for soil application	86.8	8.6	43.7	3.82
RDF + FASt @ 25kg/ha for soil application	95.4	9.7	48.8	3.89
RDF + FASt @ 35kg/ha for soil application	105.5	10.4	54.8	4.02
RDF + 2 Spray of FASt 0.25% at 25 and 45 DAT	100.8	9.2	47.6	3.91
RDF + 2 Spray of FASt 0.50% at 25 and 45 DAT	103.3	9.4	50.2	3.94
RDF + 1 Spray of FASt 0.25% at 25 DAT	99.8	8.6	43.5	3.83
RDF + 1 Spray of FASt 0.50% at 25 DAT	100.2	8.8	45.4	3.87
CD (P=0.05)	4.34	0.42	5.51	0.05

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3.2 Yield attributes and grain yield

Effective tillers per hill, grains per panicle, grain yield, and harvest index were affected by different doses and modes of application of ferrous ammonium sulphate (**Table 2**). The number of effective tillers per hill was found to increase significantly with an increase in the levels of FASt. Treatment having RDF application only recorded a minimum number of effective tillers (7.0/hill), which were increased in plots getting either soil or foliar application of FASt. However, soil application of FASt at 35kg/ha with RDF recorded maximum effective tillers (10.1/hill). It proved significantly superior over all the doses of FASt because FASt increases plants nutrient uptake capacity and makes them macronutrients available through the chelation process. Similar results were noted by [11].

The number of grains per panicle was significantly affected by different levels of FASt. The highest number of grains per panicle was noticed in soil application of FASt at 35 kg/ha with RDF treatment (178), followed by RDF + 2 Spray of FASt 0.50% at 25 and 45 DAT. These might be due to better translocation of accumulated photosynthates to the sink because iron help in the photosynthesis process. However, the lowest number of grains per panicle was found in the controlled plot, which is applied with RDF only (141). These results might be due to better translocation of accumulated photosynthates to the sink because iron help in the photosynthesis process. These results follow the findings of [12].

There was a positive response in attaining increased grain yield of rice with different FASt graded levels. Maximum grain yield (5188 kg/ha) was recorded under soil application of FASt at 35kg/ha with RDF and proved significantly superior over the rest of the treatments. Moreover, the soil application of 25 kg FASt with RDF and 2 sprays of 0.50% of FASt at 25 and 45 DAT with RDF proved statistically equally good for grain yield. It may be due to better improvement in growth and yield parameters through adequate availability of primary and micronutrients in soil, which favorably influenced physiological processes and the build-up of photosynthates. While the lowest grain yield (3269 kg/ha) was recorded in treatment, which consisted of RDF only. This result was conformity with those of [13].

The harvest index of rice was significantly influenced by micronutrient management practices to a considerable extent. The lowest harvest index was recorded at a controlled plot consisting of RDF only (33.33%), and the highest harvest index associated with soil application of FASt at 35 kg/ha with RDF (38.85%) indicated the optimum vegetative growth and better source-sink relationship [14].

Table 2. Effect of different doses and mode of application of FASt on yield attributes and yield of rice

Treatments	Effective tillers/hill	Grains/panicle	Grain yield (kg/ha)	Harvest index
RDF- Recommended dose of fertilizer	7.0	141	3269	33.33
RDF + FASt @ 15kg/ha for soil application	8.4	152	4381	38.01
RDF + FASt @ 25kg/ha for soil application	8.8	164	4632	38.66
RDF + FASt @ 35kg/ha for soil application	10.1	178	5188	38.85
RDF + 2 Spray of FASt 0.25% at 25 and 45 DAT	8.6	163	4451	38.04
RDF + 2 Spray of FASt 0.50% at 25 and	8.8	165	4620	38.54

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RDF + 1 Spray of FASt 0.25% at 25 DAT	8.3	154	4322	37.88
RDF + 1 Spray of FASt 0.50% at 25 DAT	8.5	158	4390	37.68
CD (P=0.05)	0.23	6.53	254.04	-

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The optimal dose and time of ferrous ammonium sulfate fertilization for the cultivation of rice and other crops in the tropics can vary widely according to weather conditions [15,16,17]; and soil [18,19]. Based on research and field tests carried out more than ten years ago, the appropriate fertilization strategies were established for conventional rice plantings currently used in countries with a tropical climate, as well as in other crops such as corn [20] ~~(Olivares et al. 2018)~~, tomato [21], ~~(Olivares et al. 2020)~~; potato [22] ~~(Olivares and Hernández, 2019)~~, Onion [23] ~~(Olivares et al. 2018)~~ and bananas [24, 25, 26].

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4. CONCLUSION

It was concluded that soil application of ferrous ammonium ~~sulphate~~ sulfate (FASt) at 35 kg/ha with a recommended dose of fertilizer (RDF) was found suitable for enhancing the growth and grain yield of rice with a higher value of harvest index.

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