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Influence of secondary, micronutrients and biofertilizer in combination with primary nutrients on grain and straw yield of scented rice (*Oryza sativa* L.)

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Abstract
An experiment on scented rice was conducted at pot culture house of the Department of Soil Science and Agricultural Chemistry, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, during Kharif season of 2020. The doses of experiment were 75% NPK, 75% NPK+S_{30}, 75% NPK+S_{30}+Zn_5, 100% NPK, 100% NPK+S_{30}, 100% NPK+S_{30}+Zn_5, 125% NPK, 125% NPK+S_{30} and 125% NPK+S_{30}+Zn_5+Azotobacter. The result showed that the grain yield ranged from 25.0 to 45.0 q ha^{-1} and straw yield from 35.0 to 68.0 q ha^{-1}. The N content in grains varied from 1.40 to 1.49%, P from 0.34 to 0.39%, K from 0.35 to 0.45%, S from 0.19 to 0.25% and zinc from 13.00 to 18.00 ppm. The N content in rice straw varied from 0.20 to 0.28%, P from 0.16 to 0.24%, K from 1.22 to 1.30%, S from 0.10 to 0.15% and zinc from 26.00 to 40.00 ppm. The treatment T_{10} (125% NPK+S_{30}+Zn_5+Azotobacter) gave the best result in terms of grain and straw yield.

Keywords: Primary nutrients, sulphur, zinc, azotobacter, grain and straw yield

Introduction
Rice is the staple food crop for the majority of the world's population. It is the world's second-largest crop by area and production after wheat. India is the world's second largest rice producer, trailing only China. It is critical to our national food security and provides a source of income for most of our rural population. Rice was cultivated on around 44 million hectares of land in India (www.statistics.com). Total production of rice during 2020-2021 is estimated as at record 121.46 million tonnes (www.google.co.in). The basmati variety is widely regarded as the most fragrant, longest, and slender variety of rice.

In the worldwide market, these are rated as the best in terms of quality and command a much greater price than high quality non-aromatic rice. Uttar Pradesh, which borders West Bengal, is the country's largest rice-growing state. Uttar Pradesh produced 15.52 million tonnes of rice in 2020 (www.google.co.in).

The state of Uttarakand is known for its scented rice varieties. These kinds evolved in Uttaranchal and Uttar Pradesh's Himalayan Tarai (Khush, 2000) [7]. In India, the Basmati rice group is the most popular. It is widely used in Asia, Europe (Buttery *et al.* 1988) [3], the United States, and non-traditional rice-growing regions such as Australia. India is a major exporter of high-quality Basmati rice to the United States and Europe and gulf countries.

Buttery *et al.* (1983) [2] identified "2-acetyl-1-pyrroline" as the aromatic rice's major volatile component. Aromatic rice is popular in Asia and commands a higher premium in some marketplaces due to its scent. Aromatic rice is popular in the Middle East as well. Rice without a distinct scent, they believe, is akin to food without salt. Rice removes major and minor nutrients from the soil due to its high grain output, while absence of other nutrients reduces grain yield. Because input prices, particularly of inorganic fertilisers, are rising, we must maximise grain output, optimise nutrient use efficiency, and reduce production costs. The efficiency of nutrient utilisation may be improved by the combined use of organic and inorganic fertilizers.

Therefore, it is of great practical importance to study the combined effects of NPKZnS and Azotobacter on grain and straw yield of scented rice *Oryza sativa* L. in the present days of increasing costs of chemical fertilizers.

The experiment was conducted in pot culture in the controlled conditions.

Materials and Methods

Materials used

For the year 2020, a field experiment was done in Pot Culture House of the Department of SSAC study the effect of N, P, K, S, Zn and Biofertilizer on Grain and Straw yield of scented rice. The variety taken was Sugandha-5 (PB-1509). The experiment was conducted in completely randomized block design replicated thrice. The treatments were as follows:

T_1: Control
T_2: 75% NPK
T_3: 75% NPK + S_{30}
T_4: 75% NPK + S_{30} + Zn_5
T_5: 100% NPK
T_6: 100% NPK + S_{30}
T_7: 100% NPK + S_{30} + Zn_5
T_8: 125% NPK
T_9: 125% NPK + S_{30}
T_{10}: 125% NPK + S_{30} + Zn_5 +Azotobacter
*N – Nitrogen *P - Phosphorus
*K – Potassium *S - Sulphur
*Zn- Zinc

Table 1: Physio-chemical properties of experimental field

Sl. No.	Particulars	Values
1.	Sand (%)	43
2.	Silt (%)	33
3.	Clay (%)	23
4.	Textural classes	Sandy loam
5.	pH	7.85
6.	Electrical conductivity (dSm^{-1})	0.90
7.	Organic carbon (%)	0.45
8.	CEC (C mol (P^+) Kg^{-1})	13.10
9.	Available nitrogen (kg ha^{-1})	180.20
10.	Available phosphorus (kg ha^{-1})	11.10
11.	Available potassium (kg ha^{-1})	170.02
12.	Available sulphur (kg ha^{-1})	12.82
13.	Available zinc (ppm)	0.46
14.	Bulk density (M gm^{-3})	1.38
15.	Porosity (%)	44.2
16.	P.D. (M gm^{-3})	2.40

Source of fertilizers

Nitrogen - Urea and DAP
Phosphorus - Diammonium Phosphate
Azotobacter - 200 gm dissolved in 10 litre water and dip the roots of rice nursery
Potassium - Potassium Chloride
Sulphur - Elemental Sulphur @ 40kg ha^{-1}
Zinc - Zinc Oxide @ 6.0 kg ha^{-1}

Method of Analysis:

For mechanical separation International pipette method was adopted as described by Piper (1966) [12]. pH determination was done by digital pH meter using 1:2.5 soil: water suspension. EC was determined in 1:2.5 soil water suspension with the help of conductivity meter (Jackson, 1967) [6]. Organic carbon was determined by Walkley and Black's rapid titration method. (Jackson, 1967) [6]. Available nitrogen was determined by Alkaline permanganate method as described by Subbiah and Asija (1956) [17]. Available phosphorus was extracted with 0.5M $NaHCO_3$ (Olsen *et al*., 1954) [11] and the extract of P was determined calorimetrically using vanadomolybdate yellow colour method (Jackson, 1967) [6]. Available sulphur was determined by turbidimetric method (Chesnin and Yien, 1950) [5] after extraction with 0.15% $CaCl_2$. Available Zinc was estimated by atomic absorption spectrophotometer using DTPA extractant (Lindsay and Norwell, 1978) [8]. For analysis of grain and straw, samples were first dried in air, then in Oven at 70°C for 8 hours. Nitrogen in prepared samples were determined by Kjeldal's method as described by Jackson (1967) [6]. Phosphorus was determined calorimetrically (Chapman and Pratt, 1961) [4] in a di acid extract according to Jackson (1967) [6]. Potassium was determined by flame photometric method (Pratt, 1965) [13]. in sodium acetate and acetic acid buffer as outlined by Jackson (1967) [6]. Sulphur was determined by turbidimetric method as described by Chesnin and Yien (1950) [5]. Zinc was determined by atomic adsorption spectrophotometer described by Lindsay and Norwell (1978) [8].

Statistical analysis

Data obtained from the experiment were statistically analysed through analysis of variance technique for comparing the effects of the treatments. The significance of various effects was tested at a 5% level of probability.

Results and Discussion

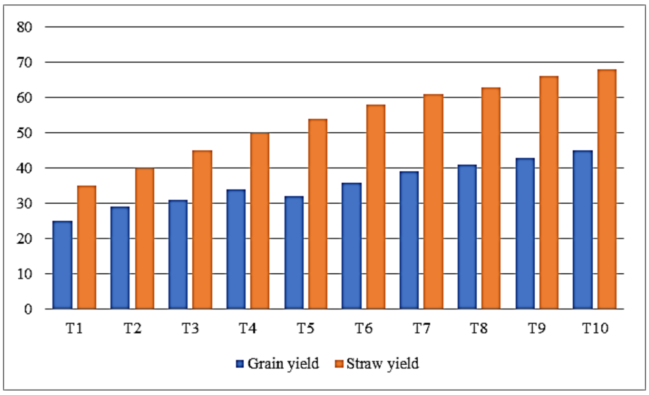

Fig 1: Effect of different treatments on grain and straw yield of scented rice (q ha^{-1})

Results of the pot experiment to study the "Influence of Secondary, Micronutrients in combination with Primary nutrients on Grain and Straw yield of Scented rice (*Oryza sativa* L.)" are presented and discussed briefly. The results pertaining to the experiment are given below in a detailed manner.

Grain yield

The grain yield varied from 25.0 to 45.0 q ha^{-1}, The treatment T_{10} (125% NPK+S_{30}+Zn_5+Azotobacter) gave the highest grain yield followed by T_9 (125% NPK+S_{30}). The results of current study enacted the role of zinc in scented rice crop to increase the yield. The result of present investigation clearly showed that all the treatments gave significantly higher yield in comparison to control. The soils of experimental field were low in nitrogen, phosphorus and medium in potassium. The zinc and sulphur content were also low. The addition of any nutrient in soil gave positive effect on crop yield. Many other scientists reported the results on conformity with the results of present study (Murali and Setty, 2000; Ali *et al*., 2004 and Tripathi *et al*., 2011) [9, 1, 18].

Straw yield

Straw yield varied from 40.0 to 68.0 q ha^{-1} in present study. The treatment T_{10} (125% NPK+S_{30}+Zn_5+Azotobacter) gave the maximum straw yield. Like grain, all the treatments gave significantly higher straw yield than control. The straw yield of scented rice increases with increasing level of nutrients. Increase in straw yield due to addition of N, P, K, S and Zn containing fertilizers has been reported by several workers like Sriramachandrasekharan *et al.* (1996); Verma *et al.* (2004) and Muthukumararaja *et al.* (2010) [16, 20, 10]. The results of present investigation were agreement with these workers.

Table 2: Effect of different treatments on grain and straw yield of scented rice (q ha^{-1})

S. No.	Treatments	Grain yield	Straw yield
1	T_1	25	35
2	T_2	29	40
3	T_3	31	45
4	T_4	34	50
5	T_5	32	54
6	T_6	36	58
7	T_7	39	61
8	T_8	41	63
9	T_9	43	66
10	T_{10}	45	68
SE(d)		0.134	0.540
CD @ 5%		0.288	1.161

Summary and Conclusion

The soil of experimental plot was low in organic carbon, available nitrogen and available phosphorus but medium in case of available potassium; the pH and EC of soil was in normal range. The soil was sandy loam with 43.33% sand, 33.33% silt and 23.33% clay. The observations were recorded on soil samples before transplanting of rice crop. The grain and straw yield were recorded at crop maturity.

The grain yield varied from 25.5 to 45.0 q ha^{-1}. The grain yield in scented rice increased sequentially with each increase in nutrient levels. The treatment effects were significantly over the control. The addition of sulphur and zinc gave significantly higher yield than N, P, K alone. The treatment combination T_{10} (125% NPK +S_{30} +Zn_5+ Azotobacter) was the best treatment in terms of grain yield.

The straw yield ranged from 35.0 to 68.0 q ha^{-1}. Like grain yield, the straw yield in scented rice increased sequentially with each increase in nutrient levels. The treatment T_{10} (125% NPK+S_{30}+Zn_5+Azotobacter) once again gave the highest yield of straw.

The treatment combination T_{10} (125% NPK + S_{30} + Zn_5 + Azotobacter) gave the best result in terms of grain and straw yield of scented rice.

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