



## Research Article

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# Effect of Zinc and Silicon on Growth and Yield of Aromatic Rice (*Oryza Sativa*) in North-Western Plains of India

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## Abstract

The present study entitled Effect of Zinc and silicon on growth and yield of aromatic rice in north western plain zone of India was carried out during *kharif* 2018 at Student Instructional Cum-Research Farm, IFTM University, Moradabad, India. The ten treatment combinations (*viz.* T<sub>1</sub> Control, T<sub>2</sub> RDF 120:80:40, T<sub>3</sub> RDF 120:80:40 + Two Zinc spray @ 0.5%, T<sub>4</sub> RDF 120:80:40 + Two Si spray @ 0.2%, T<sub>5</sub> RDF 120:80:40 + Two Si spray @ 0.3%, T<sub>6</sub> NPK 150:80:40, T<sub>7</sub> NPK 150:80:40 + Two Zinc spray @ 0.5%, T<sub>8</sub> NPK 150:80:40 + Two Si spray @ 0.2%, T<sub>9</sub> NPK 150:80:40 + Two Si spray @ 0.3%) were tested under randomized block design with three replications. The results revealed that the application of zinc and silicon significantly influenced the growth and yield of aromatic rice. Plant height, LAI, dry weight, number of tillers, panicle length, number of grains per panicle and 1000-grain weight were recorded maximum with the application of 120:80:40 kg ha<sup>-1</sup> NPK + @ 0.5% Zn spray at 30 and 45 DAT. Grain yield and harvest index also influenced significantly with the application of zinc and silicon and maximum grain yield was recorded with the application of 150:80:40 NPK + two Zn spray 0.5% (65.88 q ha<sup>-1</sup>) followed by treatment 150:80:40 NPK + Two Si spray @ 0.3% (63.46 q ha<sup>-1</sup>) and lowest in T<sub>1</sub> control (30.12 q ha<sup>-1</sup>). Harvest index was recorded non-significant.

## Keywords

Zinc, Silicon, Aromatic rice

## Introduction

Rice (*Oryza sativa* L.) is one of the most important field crops after wheat in the world providing staple food to the millions. It is an indispensable source of calories for almost half of the population with in Asia. More than 90% of the world rice is produced and consumed in Asia, which is a native for 60% of the earth's population. Rice is the first most important crop in India where it is grown in an area of 43.79 million ha<sup>-1</sup> with a total production of 112.91 million tones and an average productivity of 2578 kg ha<sup>-1</sup> [1]. India is first in terms of area (44.5 million ha) and second in production (172.58 million tonnes) [2]. Basmati rice is primarily grown in north-western India and Pakistan. These rice cultivars are preferred for their long and slender kernels, which expand to 3-4 times their original length and remain fluffy on cooking. Paddy soils are usually deficient in organic matter because of high temperature and moisture, which causes rapid decomposition of organic matter [3]. Aromatic rice constitutes a small but special group of rice, which is considered best for aroma, superfine grain and better cooking qualities [4]. There are many known groups of aromatic varieties such as Basmati rice from India and Pakistan and Jasmine rice from Thailand. These groups and varieties differ in the grain length, shape, weight, density and in their cooking and eating quality. Aromatic rice has occupied a prime position in society for aroma,

milling, cooking and eating qualities and has been considered auspicious [5].

In India, zinc is considered as the fourth important yield limiting nutrient after nitrogen, phosphorus and potassium respectively [6]. The critical limit of available zinc in the soil suitable for rice growth is 0.6 mg kg<sup>-1</sup>. Soil application of zinc increased the grain yield and foliar application of zinc increase the grain zinc concentration [7]. When rice was grown in different types of soil, up to 90 percent difference was observed in the grain Zn concentration in the same rice varieties [8]. Silicon is an important micronutrient for healthy and competitive growth of all cereals including rice in Asia [9]. Rice is one of highly sensitive crops to Zn deficiency and Zn limits growth and yield of rice. Zinc deficiency in rice has been widely reported in many rice-growing regions of the world. In India 47

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percent and in MP 60.3 percent of the soils found deficient in Zn [10]. Paddy soil conditions are usually not favorable for the availability of zinc and hence zinc deficiency has been reported countrywide in rice soils [11].

Role of silicon in plant health and growth has been investigated in silicon accumulating crops and it seemed significantly effecting [12]. Research evidences proved that adequate uptake of silicon (Si) can increase the tolerance of agronomic crops especially rice to both abiotic and biotic stress [13]. Effects of silicon on yield are related to the deposition of the element under the leaf epidermis which results a physical mechanism of defense, reduces lodging, increases photosynthesis capacity and decreases transpiration losses [14]. Silicon (Si) is the second most abundant element in the earth's crust and considered as a beneficial element for crop growth, especially for crops under poaceae family. Rice is a typical silicon accumulating plant and it benefits from silicon nutrition. Its supply is essential for healthy growth and economic yield of the rice crop. Silicon interacts favorably with other applied nutrients and improves their agronomic performance and efficiency in terms of yield response. Also, it improves the tolerance of rice plants to abiotic and biotic stresses. Hence, silicon management is essential for increasing and sustaining rice productivity [15]. Accumulation of Si in leaves and tissues in addition to conferring resistance against fungal diseases and insect pests, can improve erectness of leaves, increase yield and alleviate water stress, salinity stress and nutrient deficiency or toxicity stresses as well. Silicon is also considered as an environmentally-friendly element in relation to soils, fertilizers and plant nutrition [13]. In modern agriculture, Si has already been recognized as a functional nutrient for a number of crops, particularly rice and sugarcane, and plays an important role in the growth and development of crops, especially gramineae crops [16,17]. The hulls of poor-quality and milky-white grains (kernels) are generally low in silicon content, which is directly proportional to the silicon concentration in the rice straw [18,19].

## Materials and Methods

Present field experiment was conducted during *kharif* 2018 at Student Instructional Cum-Research Farm, IFTM University, Moradabad, India. The experimental site lies between 28° 21' to 28° 16' North latitude and 78° 4' to 79° East longitude and mean sea level of 193 meters. The soil samples were collected randomly to analyze the physico-chemical properties from different spots on the experimental site at the depth of 0-15 cm before conducting the experiment and a composite soil sample was prepared after proper drying, mixing and sieving. The soil of the experimental site was sandy loam in texture, having 7.8 pH with 0.43 per cent of organic carbon, EC 0.8 and available nitrogen is low (96.75 kg ha<sup>-1</sup>), available phosphorus was medium (22.5 kg ha<sup>-1</sup>) and available potassium was medium (225 kg ha<sup>-1</sup>) and micronutrients were available Sulphur 9.60 ppm, Zn 0.54 ppm, B 0.45 ppm, Fe 4.32 ppm, Mn 5.49 ppm and Cu 0.86 ppm. The experiment consisted of nine treatment combinations viz. (T<sub>1</sub> control, T<sub>2</sub> 120:80:40 RDF, T<sub>3</sub> 120:80:40 RDF + Two Zn spray @ 0.5%, T<sub>4</sub> 120:80:40 + Two Si spray @ 0.2%, T<sub>5</sub> 120:80:40 RDF + Two Si

spray @ 0.3%, T<sub>6</sub> 150:80:40 NPK, T<sub>7</sub> 150:80:40 NPK + Two Zn spray @ 0.5%, T<sub>8</sub> 150:80:40 NPK + Two Si spray @ 0.2% and T<sub>9</sub> 150:80:40 NPK + Two Si spray @ 0.3% which were tested in randomized block design and replicated three times. Foliar application of zinc and silicon were applied at 30 and 45 DAT as per the treatment. The graded levels of NPK were applied through Urea, Single super phosphate and Murate of potash. Half dose of nitrogen and full doses of phosphorus and potassium were applied basally at the time of transplanting. Healthy plant of paddy cultivar *Navya* (IMR 002) were transplanted at 20 cm × 15 cm and at a depth of 2-3 cm on 9<sup>th</sup> July, 2018. Observations on growth and yield attributes were recorded from five selected plants from the net plots. All the data obtained from the experiment were analyzed statistically using the F-test as per the standard statistical procedure [20] and least significant difference (LSD) values (P0.05) were used to determine the significance of difference between treatment means.

## Results and Discussion

### Growth and yield attributes

Plant height was significantly influenced with the application of zinc and silicon with recommended dose of NPK. Tallest plants were recorded with the application of NPK 120:80:40 kg ha<sup>-1</sup> + @ 0.5% Zn spray at 30 and 45 DAT (Table 1) followed by NPK 150:80:40 + Two Zinc spray @ 0.5% and NPK 150:80:40. Shortest plant was observed in control treatment. LAI of aromatic rice was recorded maximum (8.05) with the application of treatment T<sub>7</sub> 150:80:40 NPK + two Zn spray 0.5% at 30 and 45 DAT. Minimum LAI was recorded in control treatment. Dry weight of aromatic rice was influenced significantly with the application of zinc and silicon. Maximum dry weight with was recorded with the application of T<sub>7</sub> 150:80:40 NPK + two Zn spray @ 0.5% at 30 and 45 DAT (51.44 g) and minimum dry weight was recorded in control treatment. It may be due to the application of RDF with zinc or silicon, which increase the availability of nutrients and silicon also increase the water use efficiency of rice and it also increase the chlorophyll content and resulted the maximum production of photosynthates. The present findings were quite similar with those of Shivay, et al., Metwally, and Pooniya, et al. [21-23].

Number of tillers, number of grains panicle<sup>-1</sup>, weight of grain panicle<sup>-1</sup>, and grain sterility percentage was influenced significantly with the application of zinc and silicon with RDF. Maximum number of tillers plant<sup>-1</sup> (11.11) was recorded with the application of T<sub>7</sub> 150:80:40 NPK + two Zn spray @ 0.5% at 30 and 45 DAT (Table 2) while minimum recorded in control plot. Increase in number of tillers by Zn application may be attributed to its role in various Zn induced enzymatic activity and auxin metabolism which control growth of plant. These results are confirmatory with the findings of Ghani, et al. [24]. Highest number of grain panicle<sup>-1</sup> (187.56) was recorded with the application of T<sub>9</sub> 150:80:40 NPK + two Si spray @ 0.3% at 30 and 45 DAT and recorded minimum in control treatment. The efficiency of Si application in increasing the assimilation of carbohydrates in panicles, which leads to increased number of filled grains also reported by Jawahar, et al. [25]. An increasing trend of 1000- seed weight was recorded maximum

**Table 1:** Plant height (cm), leaf area index and dry weight (g) of aromatic rice as influenced by Zinc and Silicon.

Treatments	Plant height (cm) (60DAT)	Leaf are index (60DAT)	Dry weight (g) (60DAT)
T <sub>1</sub> Control	104.22	4.41	30.54
T <sub>2</sub> . RDF 120:80:40	129.56	7.10	37.14
T <sub>3</sub> . RDF 120:80:40 + Two Zinc spray @ 0.5%	133.22	6.74	51.40
T <sub>4</sub> . RDF 120:80:40 + Two Si spray @ 0.2%	127.44	7.20	46.51
T <sub>5</sub> . RDF 120:80:40 + Two Si spray @ 0.3%	128.71	7.53	46.37
T <sub>6</sub> . NPK 150:80:40	129.11	8.29	39.30
T <sub>7</sub> . NPK 150:80:40 + Two Zinc spray @ 0.5%	131.92	8.05	51.44
T <sub>8</sub> . NPK 150:80:40 + Two Si spray @ 0.2%	132.22	8.98	42.33
T <sub>9</sub> . NPK 150:80:40 + Two Si spray @ 0.3%	132.67	6.87	44.86
SE (m ±)	2.18	0.24	2.13
CD at 5%	6.58	0.74	6.46

**Table 2:** Effect of application of Zinc and Silicon on the growth and yield attributes of rice.

Treatment	No. of tillers plant <sup>-1</sup>	No. of effective tillers plant <sup>-1</sup>	Number of grains Panicle <sup>-1</sup>	1000 seed weight (g)	Grain sterility (%)	Weight of grain panicle <sup>-1</sup> (g)
T <sub>1</sub> Control	5.56	3.67	132.11	27.69	22.76	3.44
T <sub>2</sub> . RDF 120:80:40	10.11	7.33	176.22	31.25	18.69	4.29
T <sub>3</sub> . RDF 120:80:40 + Two Zinc spray @ 0.5%/lit	10.78	8.33	183.00	30.87	13.35	4.21
T <sub>4</sub> . RDF 120:80:40 + Two Si spray @ 2 ml/lit	10.00	8.22	179.11	31.41	16.37	4.42
T <sub>5</sub> . RDF 120:80:40 + Two Si spray @ 3 ml/lit	10.11	7.99	180.11	30.70	16.03	4.72
T <sub>6</sub> . NPK 150:80:40	9.22	7.89	181.33	30.71	17.95	4.69
T <sub>7</sub> . NPK 150:80:40 + Two Zinc spray @ 0.5%/lit	11.11	8.56	180.44	32.77	17.29	4.35
T <sub>8</sub> . NPK 150:80:40 + Two Si spray @ 2 ml/lit	8.99	7.99	180.67	31.22	18.12	4.83
T <sub>9</sub> . NPK 150:80:40 + Two Si spray @ 3 ml/lit	10.67	8.34	187.56	30.76	18.36	5.49
SE (m ±)	0.47	0.33	6.05	0.53	1.51	0.21
CD at 5%	1.41	1.02	18.31	1.61	4.59	0.63

**Table 3:** Yield and harvest index of aromatic rice as influenced by Zinc and Silicon.

Treatments	Grain yield (q ha <sup>-1</sup> )	Stover yield (q ha <sup>-1</sup> )	Biological yield (q ha <sup>-1</sup> )	Harvest index (%)
T <sub>1</sub> Control	30.12	42.31	72.44	41.59
T <sub>2</sub> . RDF 120:80:40	52.06	62.28	114.34	45.53
T <sub>3</sub> . RDF 120:80:40 + Two Zinc spray @ 0.5%/lit	59.14	63.87	126.67	46.83
T <sub>4</sub> . RDF 120:80:40 + Two Si spray @ 2 ml/lit	53.04	65.98	119.02	44.59
T <sub>5</sub> . RDF 120:80:40 + Two Si spray @ 3 ml/lit	54.72	68.22	122.96	44.50
T <sub>6</sub> . NPK 150:80:40	62.42	72.67	135.09	46.28
T <sub>7</sub> . NPK 150:80:40 + Two Zinc spray @ 0.5%/lit	65.88	73.28	139.16	47.32
T <sub>8</sub> . NPK 150:80:40 + Two Si spray @ 2 ml/lit	62.86	78.23	141.09	44.53
T <sub>9</sub> . NPK 150:80:40 + Two Si spray @ 3 ml/lit	63.46	75.79	139.23	45.60
SE (m ±)	1.76	2.570	3.978	1.000
CD at 5%	5.308	7.772	11.998	3.024

with the application of T<sub>7</sub> 150:80:40 NPK + two Zn spray 0.5% at 30 and 45 DAT. Grain sterility (%) of aromatic rice was recorded the application maximum with of T<sub>3</sub> 120:80:40 NPK + two Zn spray @ 0.5% at 30 and 45 DAT(22.76%) and minimum

(13.35%) in treatment T<sub>3</sub>. RDF 120:80:40 + Two Zinc spray @ 0.5% at 30 and 45 DAT. Weight of grain panicle<sup>-1</sup> was recorded maximum in T<sub>9</sub> 150:80:40 NPK + two Si spray 0.3% @ at 30 and 45 DAT (5.49 g) followed by T<sub>8</sub>. NPK 150:80:40 + Two Si

spray @ 0.2% at 30 and 45 DAT. Similar observations were also reported earlier by Singh and Shivay, and Salton, et al. [26,27].

## Yield

Grain yield of aromatic rice was significantly influenced with the application of zinc and silicon with NPK (Table 3). The highest grain yield was recorded under treatment T<sub>7</sub> 150:80:40 NPK + two Zn spray 0.5% (65.88 q ha<sup>-1</sup>) followed by treatment T<sub>9</sub> NPK 150:80:40 + Two Si spray @ 0.3% (63.46 q ha<sup>-1</sup>) and lowest in T<sub>1</sub> control (30.12 q ha<sup>-1</sup>). Supply of Zn by foliar sprays might have made adequate availability of Zn which has facilitated the growth of the plant, due to its involvement in many metallic enzyme system, regulatory functions and auxin production [28], increased synthesis and transport of carbohydrates to the sink [29,30]. Straw and biological yield was significantly influenced by the application of treatment T<sub>8</sub> 150:80:40 two Si spray 0.2% (78.23 and 141.09 q ha<sup>-1</sup>). Minimum straw and biological yield were recorded from T<sub>1</sub> control (42.31 and 72.44 q ha<sup>-1</sup>, respectively). Harvest index was recorded non-significant. Similar results were also earlier reported by Ghasal, et al. and Yadav, et al. [31,32].

## Conclusion

On the basis of experimental findings, it can be concluded that application of 150:80:40 kg ha<sup>-1</sup> with two Zn foliar spray at 30 and 45 days after transplanting improved the yield attributes of rice.

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