The Pharma Innovation Journal 2021; 10(10): 2635-2640

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(10): 2635-2640

www.thepharmajournal.com
Received: 06-08-2021
Accepted: 18-09-2021

Vivek Kumar
Department of Soil Science and Agricultural Chemistry, C. S. Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

Sushil Dimree
Department of Soil Science and Agricultural Chemistry, C. S. Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

RK Pathak
Department of Soil Science and Agricultural Chemistry, C. S. Azad University of agriculture and technology, Kanpur, Uttar Pradesh, India

US Tiwari
Department of Soil Science and Agricultural Chemistry, C. S. Azad University of agriculture and Technology, Kanpur, Uttar Pradesh, India

SD Dubey
Department of Soil Science and Agricultural Chemistry, C. S. Azad University of agriculture and Technology, Kanpur, Uttar Pradesh, India

Corresponding Author:
Vivek Kumar
Department of Soil Science and Agricultural Chemistry, C. S. Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

Effect of different levels of sulphur and zinc on growth parameters and yield of hybrid rice (*Oryza sativa* L.) in central alluvial tract of Uttar Pradesh

Vivek Kumar, Sushil Dimree, RK Pathak, US Tiwari and SD Dubey

Abstract
A field experiment was conducted at student's instructional farm Chandra Shekhar Azad University of Agriculture & Technology, Kanpur during *Kharif* season of 2019 and 2020. The experiment was carried out in Factorial Randomized Block Design (RBD) having three replications and sixteen treatments T_1 (control), T_2 (Zn_0+S_{15}), T_3 (Zn_0+S_{30}), T_4 (Zn_0+S_{45}), T_5 ($Zn_{2.5}$+S_0), T_6 ($Zn_{2.5}$+S_{15}), T_7 ($Zn_{2.5}$+S_{30}), T_8 ($Zn_{2.5}$+S_{45}), T_9 (Zn_5+S_0), T_{10} (Zn_5+S_{15}), T_{11} (Zn_5+S_{30}), T_{12} (Zn_5+S_{45}), T_{13} ($Zn_{7.5}$+S_0), T_{14} ($Zn_{7.5}$+S_{15}), T_{15} ($Zn_{7.5}$+S_{30}) and T_{16} ($Zn_{7.5}$+S_{45}) for hybrid rice. The result showed that highest grain yield (62.95 and 65.50 q ha^{-1}) and straw yield ((90.25 and 93.85 q ha)) with 100% RDF + soil application of S@30kg and Zn@5 kg ha^{-1} which was found higher to the magnitude of 44.87 and 53.58 per cent and of 20.41 and 27.95 per cent during both the years over the yield of their control. The result also indicated that maximum plant height (84.35 and 87.77 cm), number of tillers $hill^{-1}$ (10.49 and 11.15), number of hills m^{-2}(50.25 and 51.35), number of tillers m^{-2} (502.50 and 564.80) and number of effective tillers m^{-2} (467.50 and 529.80) recorded with soil application of 100% RDF + S@30kg and Zn@5 kg ha^{-1} which was found higher during both the years over control. The results revealed that the treatments with soil combination of 100% RDF + S@30kg and Zn@5 kg ha^{-1} significantly influenced the growth and yield of hybrid rice during both the years of experimentation.

Keywords: Experiment**,** factorial randomized block design, replication, treatment, yield and growth parameters

1. Introduction
Rice (*Oryza sativa* L.) is one of the most important staple foods for nearly half of the world's population, most of them living in developing countries. Rice occupies about 11% of world's agricultural land and ranks second in terms of cultivated area (Tumrani *et al*. 2015) [12]. Rice is the second most widely consumed cereal in the world next to wheat. India ranks first in respect of area 437.80 lakh ha. and second in production 118.40 million tonne ha^{-1}. It is higher by 8.67 million tonnes than the five years' average production of 109.76 million tonnes and obtained 2705 kg yield per hectare during 2019-2020. (Ministry of Agriculture & Farmers Welfare 2020-21). Rice is grown in tropical and sub-tropical areas and occupies an area of 40 million ha^{-1} to 43 million ha^{-1} in the country, only 42 per cent of which is grown under irrigated condition. Rice provide food for more than 70% of the population and source of livelihood for 120-155 million rural house holders and also a back bone of Indian Agriculture. India alone produce nearly one fourth of the rice globally. Rice is one of the chief grains and dominant crop of the country. Moreover, this country has the largest area under rice cultivation, as it is one of the principal food crops. Rice is a high energy or high calorie cereal crop. Rice protein, though small in amount, is of high nutritional value. Chaudhary and Tran, (2001) [2]. Sulphur involve in chlorophyll production, protein synthesis and plant function and structure. It forms an important constituent of straw and plant stalks. Sulphur application increased the microbial biomass carbon and arylsulphatase activity. It is a building block for protein and a key ingredient in the formation of chlorophyll Duke and Reisenaue, (1986) [5]. Zinc is essential for the transformation of carbohydrates and regulates consumption of sugars. The function of zinc in plants is as a metal activator of enzymes. Deficiency of zinc in lowland rice occurs in near neutral to alkaline soils, particularly in calcareous soils. Zinc deficiencies are widely spread throughout the world, especially in the rice lands of Asia and deficiencies occur in neutral and calcareous soils Tisdale *et al*., (1997) [11].

2. Materials and Methods

2.1 Experimental Site and Location

The experiment was conducted at Students' Instructional Farm, Department of Agronomy Chandra Shekhar Azad University of Agriculture & Technology, Kanpur and it was in the alluvial tract of Indo - Gangetic plains in central part of Uttar Pradesh between 25 ^{0}26' to 26 ^{0}58' North latitude and 79 ^{0}31' to 80 ^{0}34' East longitude at an elevation of 125.9 m above mean sea level. The region falls under agro-climatic zone (Central Plain Zone) of Uttar Pradesh.

Treatment combination and symbols

Sr. No.	Treatment Symbol	Treatment combination
1.	T_1	Control ($Zn_0 + S_0$)
2.	T_2	$Zn_0 + S_{15}$
3.	T_3	$Zn_0 + S_{30}$
4.	T_4	$Zn_0 + S_{45}$
5.	T_5	$Zn_{2.5} + S_0$
6.	T_6	$Zn_{2.5} + S_{15}$
7.	T_7	$Zn_{2.5} + S_{30}$
8.	T_8	$Zn_{2.5} + S_{45}$
9.	T_9	$Zn_5 + S_0$
10.	T^{10}	$Zn_5 + S_{15}$
11	T_{11}	$Zn_5 + S_{30}$
12	T_{12}	$Zn_5 + S_{45}$
13	T_{13}	$Zn_{7.5} + S_0$
14.	T_{14}	$Zn_{7.5} + S_{15}$
15.	T_{15}	$Zn_{7.5} + S_{30}$
16.	T_{16}	$Zn_{7.5} + S_{45}$

Note: RDF of NPK was given @ 150: 75: 60 kg ha^{-1} in all the plots except control whereas Sulphur and Zinc was applied in all the plots of hybrid rice as per treatment @ 0, 15, 30, 45 kg ha^{-1} and 0, 2.5, 5.0, 7.5 kg ha^{-1}, respectively.

2.2 Field preparation

The experimental field was ploughed once with soil turning plough. In first week of June, irrigation was applied and at proper soil moisture, field was ploughed with tractor drawn disc harrow followed by planking. Layout was made by marking of plots.

2.3 Transplanting

The nursery was given a light irrigation before uprooting the seedlings at 25 days of sowing. Transplanting was done by manual labours using two seedlings per at the spacing of 20 10 cm on 15 July 2019 and 17 July 2020.

2.4 Application of Fertilizer

The Urea, di-ammonium phosphate, muriate of potash, elemental sulfur and zinc oxide were used as source of N, P, K, S and Zn. In paddy, half dose of N, full doses of P_2O_5, K_2O, S and Zn were applied as basal and remaining amount of nitrogen was top dressed in equal two splits. RDF of N:P:K (@ 150:75:60) will be applied in all the treatments except control by Urea, DAP and MOP, respectively while different doses of Sulphur (0, 15,30 45 kg/ha) and Zinc (0, 2.5, 5.0, 7.5 kg/ha) given by elemental sulphur and zinc oxide as per treatment composition.

2.5 Cultural operations

In order to protect, the crop from adverse effects of weeds and to pulverize the soil, the weeding operations were performed by manual labors with the help of *khurpi* during both the years of experimentation in the crops.

3. Results

3.1 Effect of Sulphur and zinc on grain yield (q ha^{-1}) of hybrid rice

The data with regard to grain yield (q ha^{-1}) have been summarized in table no 1.

3.1.1 Effect of Sulphur

It is obvious that the application of sulphur at different levels significantly influenced the grain yield of hybrid rice over control (S_0). The significant and maximum grain yield 60.78 and 63.37 q ha^{-1} was recorded with the application of sulphur @ 30 kg ha^{-1} however, it was closely followed by the treatment where sulphur was applied @ 45 kg ha^{-1} during first and second years, respectively. It was further noticed that the application of sulphur at that level increased the yield to the magnitude of 12.68 and 13.91% over control during first and second years of experimentation.

3.1.2 Effect of Zinc

The data of grain yield in relation to effect of zinc has been summarized in table and fig. It was found that the application of zinc had considerable influence on the grain yield over control. Maximum grain yield 60.91 and 63.55 q ha was recorded with the application of Zn @ 5.0 kg ha^{-1} which was found at par with the treatment where zinc was given @ 7.5 kg ha^{-1} but significantly superior over control during first and second years, respectively. It was further observed that the application of zinc increased the grain yield to the tune of 13.07 and 14.48% during first and second years of investigation.

3.1.3 Effect of Sulphur and Zinc

A cursory look of data clearly revealed that the application of both sulphur and zinc had significant impact on grain yield. The highest grain yield (62.95 and 65.50q ha^{-1}) was recorded with soil application of sulphur and zinc @ 30 and 5.0 kg ha^{-1} during first and second years, respectively. It was increased to the magnitude of 44.87 and 53.58 per cent in comparison to control during first and second year.

Table 1: Effect of Sulphur on grain yield of hybrid rice during 2019 and 2020

Factors	2019					2020				
	S_0	S_{15}	S_{30}	S_{45}	Mean	S_0	S_{15}	S_{30}	S_{45}	Mean
Zn_0	43.45	56.25	58.33	57.45	53.87	42.65	58.65	60.95	59.80	55.51
$Zn_{2.5}$	56.19	57.89	59.95	58.25	58.07	58.65	60.35	62.63	60.97	60.65
$Zn_{5.0}$	58.65	60.40	62.95	61.65	60.91	61.45	62.95	65.50	64.29	63.55
$Zn_{7.5}$	57.45	59.75	61.90	60.35	59.86	59.75	62.25	64.40	63.25	62.41
Mean	53.94	58.57	60.78	59.42	58.18	55.63	61.05	63.37	62.07	60.52

	2019		2020	
Factors	S.E.(m)	C.D. (at 5%)	S.E.(m)	C.D. (at 5%)
S	0.586	1.69	0.52	1.49
Zn	0.586	1.69	0.52	1.49
S x Zn	1.17	3.38	1.03	2.98

3.2 Effect of treatments on straw yield (q ha^{-1}) of hybrid Rice

The data with regard to straw yield (q ha^{-1}) have been summarized in table no 2.

3.2.1 Effect of Sulphur

It is indicated that the application of sulphur significantly increased the straw yield than control. The maximum straw yield (87.46 and 90.91 q ha) was recorded with the treatment where sulphur was applied @ 30 kg ha^{-1} however, it was at par with the treatment where sulphur was given @ 45 kg ha^{-1} during first and second years, respectively. It was increased in the order of 8.44 and 9.91 per cent during first and second years, respectively.

3.2.2 Effect of Zinc

The data pertaining to straw yield depicted in table and fig clearly revealed that the application of zinc considerably improved the straw yield of hybrid rice. The maximum mean value of straw yield (87.57 and 91.14 q ha) was registered with the application of zinc @ 5.0 kg ha^{-1} which was significantly superior over control of zinc but showed at par similarity with the treatment where zinc was given @ 7.5 kg ha^{-1}. Straw yield was increased to an order of 8.58 and 10.37 per cent over control during first and second year of experimentation.

3.2.3 Effect of Sulphur and Zinc

The data of straw yield as given in table and fig clearly showed that there were non-significant interaction effect of different combinations of sulphur and zinc on straw yield. The maximum straw yield (90.25 and 93.85 q ha) was recorded in the treatment where sulphur and zinc given @ 30 and 5 kg ha^{-1} which improved the straw yield to an order of 20.41 and 27.95 per cent over control during first and second years, respectively.

Table 2: Effect of treatments on straw yield of hybrid Rice during 2019 and 2020

Factors	2019					2020				
	S_0	S_{15}	S_{30}	S_{45}	Mean	S_0	S_{15}	S_{30}	S_{45}	Mean
Zn_0	74.95	80.75	84.55	82.35	80.65	73.35	83.98	87.35	85.60	82.57
$Zn_{2.5}$	80.55	83.10	86.15	84.40	83.55	83.95	86.62	89.82	87.45	86.96
$Zn_{5.0}$	84.75	86.58	90.25	88.70	87.57	87.95	90.40	93.85	92.35	91.14
$Zn_{7.5}$	82.35	86.45	88.90	87.35	86.26	85.60	89.25	92.60	90.75	89.55
Mean	80.65	84.22	87.46	85.70	84.51	82.71	87.56	90.91	89.04	87.56

	2019		2020	
Factors	S.E.(m)	C.D. (at 5%)	S.E.(m)	C.D. (at 5%)
S	0.797	2.30	0.727	2.10
Zn	0.797	2.30	0.727	2.10
S x Zn	1.60	N.S.	1.45	N.S.

3.3 Effect of sulfur and zinc on Plant Height (cm)

The data with regard to Plant Height (cm) have been summarized in table no 3.

3.3.1 Effect of Sulphur

It was noted that the application of sulfur at different levels significantly increased the plant height of hybrid rice over control during both the years. The maximum plant height (81.45 and 84.92 cm) was recorded with the application of sulfur @ 30 kg ha^{-1} followed by the treatments where sulfur was given @ 45 kg ha^{-1} but significantly better over control during first and second years, respectively.

3.3.2 Effect of zinc

The application of zinc at different levels significantly increased the plant height during both the years of experimentation. The maximum plant height (81.55 and 85.15 cm) was recorded with the application of zinc @ 5.0 kg ha^{-1} during first and second years, respectively. Whereas, the minimum plant height was noted over its control.

3.3.3 Effect of Sulphur and zinc

Appraisal of data clearly revealed that the application of sulphur and zinc did not significantly influence the height of plants in during first and second year. The maximum mean value (84.35 and 87.77 cm) regarding plant height was recorded with the treatment where sulphur and zinc was applied @ 30 and 5 kg ha^{-1} during first and second years of experimentation.

Table 3: Effect of sulfur and zinc on Plant Height (cm)

Factors	2019					2020				
	S_0	S_{15}	S_{30}	S_{45}	Mean	S_0	S_{15}	S_{30}	S_{45}	Mean
Zn_0	67.6	75.38	78.16	76.98	74.53	66.53	78.59	81.67	80.13	76.73
$Zn_{2.5}$	75.29	77.57	80.33	78.06	77.81	78.59	80.86	83.92	81.7	81.27
$Zn_{5.0}$	78.29	80.94	84.35	82.61	81.55	82.34	84.35	87.77	86.15	85.15
$Zn_{7.5}$	76.98	80.07	82.95	80.87	80.22	80.06	83.41	86.3	84.76	83.63
Mean	74.54	78.49	81.45	79.63	78.53	76.88	81.80	84.92	83.19	81.70

	2019		2020	
Factors	S.E.(m)	C.D. (at 5%)	S.E.(m)	C.D. (at 5%)
S	0.586	1.692	0.516	1.491
Zn	0.586	1.692	0.516	1.491
S x Zn	1.172	N.S.	1.032	N.S.

3.4 Effect of sulfur and zinc on No. of tillers hill^{-1}

The data with regard to number of tillers hill^{-1} have been summarized in table 4.

3.4.1 Effect of Sulphur

It was observed that the application of sulfur at different levels significantly increased the tillers hill^{-1} of hybrid rice over control during both the years. The maximum number of tillers hill^{-1} (9.53 and 10.39) were recorded with the application of sulfur @ 30 kg ha^{-1} followed by the treatments where sulfur was given @ 7.5 kg ha^{-1} but significantly better over control during first and second years, respectively.

3.4.2 Effect of zinc

It is obvious from the data that the application of zinc at different levels significantly increased the number of tillers hill^{-1} during both the years of experimentation. The maximum number of tillers hill^{-1} (9.51 and 10.38) were recorded with the application of zinc @ 5.0 kg ha^{-1} during first and second years, respectively. Whereas, the minimum number of tillers hill^{-1} was noted over its control.

3.4.3 Effect of Sulphur and zinc

A cursory glance of data clearly revealed that the application of sulphur and zinc did not significantly influence the number of tillers hill^{-1} in during first and second year. The maximum mean value (10.49 and 11.15) of number of tillers hill^{-1} was recorded with the treatment where sulphur and zinc was applied @ 30 and 5 kg ha^{-1} during first and second years of experimentation.

Table 4: Effect of sulfur and zinc on no of tillers hill^{-1}

Factors	2019					2020				
	S_0	S_{15}	S_{30}	S_{45}	Mean	S_0	S_{15}	S_{30}	S_{45}	Mean
Zn_0	6.45	7.35	8.29	7.85	7.49	5.95	8.15	9.15	8.68	7.98
$Zn_{2.5}$	7.27	8.15	9.45	8.33	8.30	8.1	9.05	10.41	9.2	9.19
$Zn_{5.0}$	8.49	9.35	10.49	9.72	9.51	9.37	10.3	11.15	10.7	10.38
$Zn_{7.5}$	7.8	8.88	9.89	9.25	8.96	8.63	9.78	10.86	10.18	9.86
Mean	7.50	8.43	9.53	8.79	8.56	8.01	9.32	10.39	9.69	9.35

	2019		2020	
Factors	S.E.(m)	C.D. (at 5%)	S.E.(m)	C.D. (at 5%)
S	0.177	0.511	0.145	0.420
Zn	0.177	0.511	0.145	0.420
S x Zn	0.354	N.S.	0.291	N.S.

3.5 Effect of treatments on number of hills meter^{-2}

The perusal of data in relation with number of hills meter^{-2} have been depicted in table 5.

3.5.1 Effect of Sulphur

It was found that the application of sulfur at different levels significantly increased the number of hills meter^{-2} of hybrid rice over control during both the years. The maximum number of hills meter^{-2} (49.38 and 50.30) were recorded with the application of sulfur @ 30 kg ha^{-1} followed by the treatments where sulfur was given @ 45 kg ha^{-1} but significantly superior over control during first and second years, respectively.

3.5.2 Effect of zinc

It is clear from the data that the application of zinc at different levels significantly increased the number of number of hills meter^{-2} during both the years of experimentation. The maximum number of hills meter^{-2} (49.15 and 50.15) were recorded with the application of zinc @ 5.0 kg ha^{-1} during first and second years, respectively. Whereas, the minimum number of hills meter^{-2} was noted over its control.

3.5.3 Effect of Sulphur and zinc

A cursory glance of data clearly revealed that the application of sulphur and zinc did not bring significant influence on the number of hills meter^{-2} in during first and second year. The maximum mean value (50.25 and 51.35) of number of hills meter^{-2} was recorded with the treatment where sulphur and zinc was applied @ 30 and 5 kg ha^{-1} during first and second years of experimentation.

Table 5: Effect of treatments on number of hills meter^{-2}

Factors	2019					2020				
	S_0	S_{15}	S_{30}	S_{45}	Mean	S_0	S_{15}	S_{30}	S_{45}	Mean
Zn_0	44.45	46.38	48.15	47.45	46.61	43.1	47.55	49.25	48.5	47.10
$Zn_{2.5}$	46.15	47.85	49.55	48.35	47.98	47.25	48.95	49.95	49.10	48.81
$Zn_{5.0}$	48.45	49.15	50.25	49.95	49.45	49.15	49.95	51.35	50.15	50.15
$Zn_{7.5}$	47.15	48.75	49.55	49.05	48.63	48.25	49.24	50.65	49.85	49.50
Mean	46.55	48.03	49.38	48.70	48.16	46.94	48.92	50.30	49.40	48.89

	2019		2020	
Factors	S.E.(m)	C.D. (at 5%)	S.E.(m)	C.D. (at 5%)
S	0.380	1.097	0.447	1.292
Zn	0.380	1.097	0.447	1.292
S x Zn	0.759	N.S.	0.894	N.S.

3.6 Effect of treatments on number of tillers meter^{-2}

The data with regard to number of tillers meter^{-2} have been summarized in table 6.

3.6.1 Effect of Sulphur

It was observed that the application of sulfur at different levels significantly increased the number of tillers meter^{-2} of hybrid rice over control during both the years. The maximum number of tillers meter^{-2} (448.35 and 503.38) were recorded with the application of sulfur @ 30 kg ha^{-1} followed by the treatments where sulfur was given @ 45 kg ha^{-1} but significantly better over control during first and second years, respectively.

3.6.2 Effect of zinc

It clearly indicated that the application of zinc at different levels significantly increased the number of tillers meter^{-2} during both the years of experimentation. The maximum number of tillers meter^{-2} (444.49 and 502.03) were recorded with the application of zinc @ 5.0 kg ha^{-1} during first and second years, respectively. Whereas, the minimum number of tillers meter^{-2} were noted over its control.

3.6.3 Effect of Sulphur and zinc

An appraisal of data clearly revealed that the application of sulphur and zinc brought significant influence on the number of tillers meter^{-2} during first and second year. The maximum mean value (502.50 and 564.80) of number of tillers meter^{-2} was recorded with the treatment where sulphur and zinc was applied @ 30 and 5 kg ha^{-1} during first and second years of experimentation.

Table 6: Effect of treatments on number of tillers meter^{-2}

Factors	2019					2020				
	S_0	S_{15}	S_{30}	S_{45}	Mean	S_0	S_{15}	S_{30}	S_{45}	Mean
Zn_0	266.7	340.80	399.10	372.40	344.75	252.20	380.40	443.20	388.00	365.95
$Zn_{2.5}$	335.5	389.90	445.90	386.80	389.53	378.00	440.50	499.00	441.90	439.85
$Zn_{5.0}$	387.6	442.35	502.50	445.50	444.49	442.30	499.50	564.80	501.50	502.03
$Zn_{7.5}$	330.1	390.00	445.90	441.40	401.85	386.000	443.20	506.50	498.50	458.55
Mean	329.98	390.76	448.35	411.53	395.15	364.63	440.90	503.38	457.48	441.59

	2019		2020	
Factors	S.E.(m)	C.D. (at 5%)	S.E.(m)	C.D. (at 5%)
S	2.526	7.29	2.162	6.247
Zn	2.526	7.29	2.162	6.247
S x Zn	5.051	14.594	4.324	12.493

3.7 Effect of treatments on number of effective tillers meter^{-2}: The data with regard to number of effective tillers meter^{-2} have been summarized in table 7.

3.7.1 Effect of Sulphur

It was observed that the application of sulfur at different levels significantly increased the number of effective tillers meter^{-2} of hybrid rice over control during both the years. The maximum number of effective tillers meter^{-2} (413.35 and 468.38) were recorded with the application of sulfur @ 30 kg ha^{-1} followed by the treatments where sulfur was given @ 45 kg ha^{-1} but significantly better over control during first and second years, respectively.

3.7.2 Effect of zinc

It is clear from the data that the application of zinc at different levels significantly increased the number of effective tillers meter^{-2} during both the years of experimentation. The maximum number of effective tillers meter^{-2} (409.47 and 467.25) were recorded with the application of zinc @ 5.0 kg ha^{-1} during first and second years, respectively. Whereas, the minimum number of effective tillers meter^{-2} was noted over its control.

3.7.3 Effect of Sulphur and zinc

A cursory glance of data clearly revealed that the application of sulphur and zinc brought significant influence on the number of effective tillers meter^{-2} in during first and second year. The maximum mean value (467.50 and 529.80) of number of effective tillers meter^{-2} were recorded with the treatment where sulphur and zinc was applied @ 30 and 5 kg ha^{-1} during first and second years of experimentation.

Table 7: Effect of treatments on number of effective tillers meter^{-2}

Factors	2019					2020				
	S_0	S_{15}	S_{30}	S_{45}	Mean	S_0	S_{15}	S_{30}	S_{45}	Mean
Zn_0	231.70	305.80	364.10	337.40	309.75	217.20	345.40	408.20	353.00	330.95
$Zn_{2.5}$	300.50	354.90	410.90	351.80	354.53	343.00	405.50	464.00	406.90	404.85
$Zn_{5.0}$	352.60	407.30	467.50	410.50	409.47	407.30	464.50	529.80	466.50	467.25
$Zn_{7.5}$	295.10	355.00	410.90	406.40	366.85	351.00	408.20	471.50	463.50	423.55
Mean	294.98	355.75	413.35	376.53	360.15	329.63	405.90	468.38	422.48	406.59

	2019		2020	
Factors	**S.E.(m)**	**C.D. (at 5%)**	**S.E.(m)**	**C.D. (at 5%)**
S	1.806	5.218	1.448	4.184
Zn	1.806	5.218	1.448	4.184
S x Zn	3.612	10.436	2.896	8.368

4. Discussion

Application of sulfur and zinc at different doses and their interaction also influenced the yield was found significant. It was observed that the combined application of sulfur and zinc further enhanced the grain and straw yield of hybrid rice. The highest grain (62.95 and 65.50 q ha^{-1}) and straw yield (90.25 and 93.85 q ha^{-1}) was recorded with combined application of sulfur and zinc @ 30 and 5.0 kg ha^{-1} during first and second years, respectively. Darade and Bankar (2009) [3] reported that soil application of $ZnSO_4$ @ 25 kg ha^{-1} produced significantly higher yield attributes and yield of rice. These results are in close conformity with the findings Islam *et al.* (1997) [6] and Saha *et al.* (2013). Data pertaining to growth parameters mainly plant height (cm), number of tiller hill^{-1}, number of hill m^{-2}, number of tiller m^{-2}, number of effective tiller m^{-2} clearly revealed that the application of sulfur and zinc at different levels increased these attributes significantly over its control. It was observed that the application of sulfur @ 30 kg ha^{-1} showed its superiority on increase in growth characters over its control. Whereas, the application of sulfur @ 45 kg ha was found as second best treatment in terms of all growth parameters. While, in case of levels of zinc, the application of zinc @ 5.0 kg ha^{-1} responded better in relation to growth parameters. Furthermore, the application of zinc @ 7.5 kg ha^{-1} was found as second best treatment in terms of these parameters. The increase in growth parameters might be to favorable effect of sulfur and zinc along with RDF of NPK throughout the growth period in adequate amounts and their synergistic effect in improving growth. Ram *et al.* (2014) [9] recorded that increase in metabolic activities in plant with sulfur application is the cause of enhanced growth parameters The results are in close conformity with the findings of worker (Arif *et al*. 2012; Rahman *et al.* 2008, Dash *et al*. 2015 and Tejnuava *et al*. 2014) [7, 8, 4, 10].

5. Conclusion

As a results from the two years of experimentation (2019 and 2020), it may be inferred that in hybrid rice, the application of 100% RDF + soil application of S@30kg and Zn@5 kg ha^{-1} followed by 100% + soil application of S@30kg and Zn@7.5 kg ha^{-1} may be more effective for growth parameters and yield of hybrid rice. Treatment T_{11} (Zn_5+S_{30} kg ha-1) showed highest improvement of growth parameters and yield of hybrid rice during both the years.

6. References

1. Anonymous. Ministry of Agriculture and Farmers Welfare, Government of India 2020-21.
2. Chaudhary RC, Tran DV, editors. (eds.). Specialty rices of the world a prologue in Specialty Rice of the World: Breeding, Production, and Marketing (Rome; New Delhi: FAO; Oxford & IBH Publishing Co. Pvt. Ltd.), 2001, 3-14.
3. Darade AB, Bankar KB. Yield attributes and yield of hybrid rice as affixed by placement of urea, DAP briquettes and zinc levels. Agriculture Update 2009;9(3, 4):226-228.
4. Dash AK, Singh HK, Mahakud T, Pradhan KC, Jena D. Interaction effect of nitrogen, phosphorus, potassium with sulphur, boron and zinc on yield and nutrient uptake by rice under rice-rice cropping system in inceptisol of coastal Odisha. *International Research* Journal of Agricultural Science and Soil Science 2015;5(1):14-21.
5. Duke SH, Reisenaue HM. Roles and requirements of sulphur in plant nutrition. In: Tabatabai, M. A. (ed.), Sulphur in Agriculture., American Society of Agronomy, Madison, Wisconsin, USA 1986, 124-168.
6. Islam MR, Risat TM, Jahiruddin M. Direct and residual effects of S, Zn and B on yield, nutrient uptake in a rice-mustard cropping system J Indian Soc. Soil Sci 1997;45(1):126-129.
7. Muhammad Arif, Muhammad Asif Sehzad. Boron Zinc and Microtone effects on growth, chlorophyll, contents and yield attributes of rice (*Oryza sativa* L) African Journal of Biotechnology 2012;11(48):10851-10858.
8. Rahman MT, Jahiruddin M, Humauan MR, Alam MJ, Khan AA.Effect of Sulphur and Zinc on Growth, Yield and Nutrient Uptake of Boro Rice (cv. BRRI Dhan 29). J Soil. Nature 2008;2(3):10-15
9. Ram B, Singh SK, Latarae AM, Kumar O. Effect of Sulphur, Zinc, and Boraon application on growth and yield of hybrid rice. Journal of Soil Science 2014;62(2):184-188.
10. Tajnuva A, Khan Ashraf-Uz-Zaman, Md, Abdul Halim Md, Abdur Razzaque Sheikh Shawkat Zamil. Effect of Sulphur and Boron on Yield and Nutrients Content of BRRI dhan30. International Journal of Business, Social and Scientific Research 2014;2(2):153-168.
11. Tisdale LS, Nelson LW, Beaton DJ, Havlin LJ. Soil Fertility and Fertilizers. Prentice Hall of India. 5th edn. 1997, 319-346
12. Tumrani SA, Pathan PA, Suleman BM. Economic contribution of rice production and food security in Indonesia. Asia Pacific Res. J 2015;33:63-74.