

Effect of frequency of zinc application on yield of rice (*Oryza sativa*) and wheat (*Triticum aestivum*) in rice-wheat sequence

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ABSTRACT

Effect of Zn application frequency was studied in rice (*Oryza sativa* L.)-wheat (*Triticum aestivum* L. emend. Fiori & Paol.) cropping system in a field experiment conducted during 1989-92 at Kaul. The Zn @ 5 kg/ha when applied to rice every year proved most economical and resulted in higher yields of both rice and wheat.

Key words : Zn, Rice-wheat system, Frequency, Net returns

In rice-wheat growing soils of north-western India the deficiency of Zn was found to the extent of 45-65% (Takkar *et al.*, 1989). Zinc limits crop production under deficiency conditions and responses to its application will leave residual effect for subsequent crops. Most of the earlier studies were conducted to determine the Zn needs of individual crops and information is lacking on its management for specific soil cropping system. To evaluate the direct, residual and cumulative effects of applied Zn on rice-wheat rotation, a field experiment was conducted for 3 years (1989-92) at Rice Research Station, Kaul (Kaithal), Haryana.

MATERIALS AND METHODS

A field experiment was conducted for 3 years (1989-92) with 14 treatments as shown

in Table 1 to evaluate the optimum Zn level and periodicity of Zn application for maximum response in rice-wheat cropping system. The experiment was conducted with 4 replications in randomized block design. The experimental soil was clay loam in texture having pH 8.3, EC 0.13 ds/m, organic carbon 0.32%, DTPA extractable Zn 0.85 ppm; available P and K were 25 and 480 kg/ha respectively. N and P₂O₅ were applied @ 150 and 60 kg/ha to each crop, respectively. High yielding varieties of rice 'HKR 120' and wheat 'HD 2329' were grown in succession by adopting standard agronomic practices. Thirty-five days old seedlings of rice were transplanted at a spacing of 15 × 15 cm in the first week of July and the crop was harvested in the third week of October. All phosphorus, Zn and one-third nitrogen were applied

before transplanting and remaining nitrogen was applied in 2 equal splits after 21 and 42 days of transplanting. Wheat was sown in the second week of November (10-15 November each year) in lines (22 cm spacing from line to line) and was harvested in the last week of April. In wheat all phosphorus, Zn and half N were applied before sowing and remaining nitrogen was applied 5 days after first irrigation, i.e. 28 days after sowing. Grain and straw yields of both the crops were recorded. Prices of wheat and rice grains were Rs 250 and 270/q respectively. Wheat straw was sold @ Rs 25/q and paddy straw was burnt. Zn was purchased @ Rs 50/ kg.

RESULTS AND DISCUSSION

Rice

The grain yield of rice increased significantly with Zn application when compared with control in all the study years. The direct response was 12.6 (16.9%), 14.3 (19.1%) and 16.1 (21.6%) q/ha at 5, 10 and 20 kg Zn/ha level in the first season, respectively. The residual effect at these levels on second crop of rice was 3.9 (5.5%), 6.9 (9.8%) and 10.0 (14.8%) q/ha and it further decreased to 2.0 (3.6%), 3.1 (5.5%) and 4.3 (7.6%) q/ha in the fifth crop respectively. Highest grain and straw yields of rice were obtained by applying 5 kg Zn/ha to alternate crop of rice. The yields, however were on par with cumulative application of Zn to both rice and wheat crops. The per cent response decreased when Zn was applied to each crop and @ 10 kg/ha to alternate crops. These results are in accordance with the findings of Katyal and Agarwal (1982), who also reported the residual effect of Zn on subsequent crops.

Increase in grain yield with Zn application has also been reported by Nambiar (1992), and Agarwal and Bhan (1997) in rice-wheat cropping system. Rice exhibited more response to applied Zn as compared to wheat. Straw yield also exhibited the same trend.

Wheat

Wheat grain yield (Table 1) also increased significantly with Zn application when compared with control in all the study years. The residual effect of Zn on second crop of rotation was 6.5 (13.7%), 6.4 (13.5%) and 8.4 (17.8%) q/ha at 5, 10 and 20 kg Zn/ha respectively when compared with control. When Zn was applied @ 5 kg/ha to both crops the increase in grain yield was 7.3 (15.4%) q/ha over the control. At higher levels the yield decreased. The residual effect on 4th crop (1990-91) was 1.9 (4.1%), 3.1 (6.6%) and 4.0 (8.6%) q/ha at 5, 10 and 20 kg Zn/ha respectively and it decreased further in 1991-92 at 5 kg Zn level it only. At 10 and 20 kg Zn levels, it increased slightly but this increase was non-significant. Highest grain and straw yields of wheat were obtained by applying 5 kg Zn/ha to alternate crops of rice. When Zn was applied to both the crops, the yield decreased when compared with the treatments, where Zn was applied to rice only. Grain yield also increased significantly over control when Zn was applied to 4th, 5th and 6th crops of rotation @ 5 and 10 kg/ha. Agarwal and Bhan (1997) also reported favourable direct and residual effect of Zn on wheat yield. The increase in yield due to Zn application to soil could possible be due to the enhanced synthesis of carbohydrates and proteins.

Table 1. Effect of Zn application frequency on economics and yields (q/ha) of rice and wheat in rice-wheat sequence

Treatment (Zn kg/ha)	Rice						Wheat						Net profit Rs (000 ha/yr)	Cost benefit ratio
	Grain			Straw			Grain			Straw				
	1989	1990	1991	1989	1990	1991	1989	1990	1991	1989	1990	1991		
Control	74.7	70.4	56.6	83.7	97.0	65.3	47.3	46.6	45.2	60.2	70.5	73.9	31.5	—
<i>Applied to rice in the first year only</i>														
5	87.3	74.3	58.6	89.2	103.9	68.3	53.8	48.5	46.8	69.0	73.4	75.9	34.0	30.4
10	89.0	77.3	59.7	90.4	107.9	70.1	53.7	49.7	48.9	70.1	74.6	77.9	34.7	19.6
20	90.8	80.8	60.9	94.7	111.8	72.8	55.7	50.6	49.7	70.1	76.5	81.1	35.5	12.1
<i>Applied to rice and wheat every year</i>														
5	87.3	83.0	63.7	89.2	119.0	73.0	54.6	52.6	52.4	73.2	76.2	83.5	35.8	8.6
10	89.0	83.5	63.4	90.4	121.0	72.8	53.1	51.5	50.9	68.9	75.4	80.9	35.1	3.6
<i>Applied to rice every year</i>														
5	87.3	81.3	64.3	89.2	113.0	73.1	53.8	52.1	52.7	69.0	76.7	83.7	35.8	17.6
10	89.0	82.5	64.4	90.4	117.5	72.9	53.7	53.3	52.4	70.1	77.8	83.4	35.9	8.8
<i>Applied to first crop of rice and fourth crop of wheat</i>														
5	87.3	74.3	60.6	89.2	97.0	69.6	53.8	50.8	48.4	69.0	75.1	78.5	34.4	17.6
20	89.0	77.3	62.5	90.4	103.9	71.1	53.7	51.7	49.8	70.1	77.1	81.0	35.1	10.9
<i>Applied to first and fifth crops of rice</i>														
5	87.3	74.3	61.6	89.2	97.0	69.8	53.8	48.5	49.6	69.0	73.4	80.4	34.4	17.9
10	89.6	77.3	64.6	90.4	103.9	72.8	53.7	49.7	51.3	70.1	74.6	83.0	35.2	11.2
<i>Applied to first crop of rice and sixth crop of wheat</i>														
5	87.3	74.3	58.6	89.2	92.6	68.3	53.8	48.5	49.9	69.0	73.4	80.3	34.2	16.5
10	89.0	77.3	59.7	90.4	103.9	70.1	53.7	49.7	51.7	70.1	74.6	84.4	34.8	10.2
CD(P = 0.05)	4.2	2.3	2.6	5.6	11.8	3.6	3.5	1.7	1.1	4.2	NS	2.0		

Straw yield also exhibited the same trend.

Gross and net returns

Gross and net returns (Table 1) were more when Zn was applied @ 10 kg/ha to rice every year closely followed by the treatment where it was applied @ 5 kg/ha to both crops. Net profit due to Zn application was Rs 2,529, Rs 3,270 and Rs 4,040/ha/year at 5, 10 and 20 kg/ha levels respectively when it was applied in the first year (1989) only. With cumulative application to each crop @ 5 kg/ha the net profit was Rs 4,301/ha/year and it decreased to Rs 3,616/ha/year at 10 kg level. Maximum net profit was Rs 4,409/ha/year when Zn was applied @ 10 kg/ha to rice closely followed by the treatment, where it was applied @ 5 kg/ha to rice only (Rs 4,390/ha/year). Net profit decreased with other frequencies of application. Agarwal and Bhan (1997) also reported similar results in rice-wheat cropping sequence. Benefit : cost ratio was more (30.4) when Zn was applied @ 5 kg/ha in 1989 only and it decreased to 19.6 and 21.1 at 10 and 20 kg Zn/ha

(single application). With cumulative applications the ratios at 5 and 10 kg Zn/ha were 8.6 and 3.6 respectively. With alternative application of Zn to rice @ 5 and 10 kg/ha, the ratios were 17.6 and 8.8 respectively. The ratio decreased with increased cost of cultivation. It is thus clear that 5 kg Zn/ha is most profitable when applied alternately in rice crop in rice-wheat cropping system.

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