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## Clarifying the relationship between the rice crop variety Pant Dhan 4's photosynthetic rate and superoxide dismutase

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### ABSTRACT

During the 2010 and 2011 Kharif seasons, a field experiment was conducted to examine the impact of various nutrition treatments on rice yield. The maximum photosynthetic rate and superoxide dismutase were recorded when NPK was applied with FYM and zinc. Investigating the physiological characteristics of rice plants under integrated nutrients is necessary because, although fertilizers are crucial for increasing rice production, excessive fertilizer usage degrades soil quality, which in turn affects crop output. Crop yield and soil fertility significantly decreased when the rice-wheat cropping system received uneven fertilizer dosages.

**Keywords:** NPK, FYM, photosynthetic rate, rice, and superoxide dismutase.

### INTRODUCTION

With an annual output of 90 million tons and a productivity of 2.0 tons per hectare, rice covers 44 million hectares in India. The demand for rice is expected to increase annually, reaching 140 million tons by 2025. To satisfy future food needs, India must increase its rice yield by 3% annually (Thiyagarajan and Selvaraju, 2001). Even though India's acreage has shrunk by 43.97 million hectares, output has increased to 100 million tons (FAO, 2012). South and Southeast Asia produce and eat 90% of the world's rice, with an average daily intake of 300–800 grams per person (Virk and Barry, 2009). The use of chemical fertilizers, namely potash (K), phosphorus (P), and nitrogen (N), has also expanded since the green revolution. One of the causes of soil salinity and alkalinity issues in India's agricultural areas is improper fertilizer application. The ideal amount of fertilizer is suggested for every crop and soil type (Kundu and Vashist, 1991). Overuse of fertilizer results in an imbalance that might lead to environmental issues. Serious ecological issues have been brought about by the green revolution. Farmers are complaining more and more about declining soil fertility, soil salinity and alkalinity, and issues with ground water contamination, which may be caused by ineffective fertilizer usage (Sharma, 1993). The secret to improved and maintained crop production is the delivery of vital plant nutrients, especially macro and micronutrients, in the ideal amount and proportion using the proper techniques and timing of application. It is crucial to understand fertilizer use behavior and the function of factors affecting fertilizer consumption at the local and national levels since the requirements for fertilizer usage vary from state to state and region to area (Jaga and Patel, 2012). Rice yield and biomass increased when chemical fertilizers were used more often. Despite increasing use of chemical fertilizers, agricultural yield has stagnated or declined in recent years (Apon et al., 2018). Since NPK is the macronutrient that rice needs, fertilizer application promotes rice growth and development. Zinc is one micronutrient that aids in the plant's defense against illness. The vegetative development was enhanced by organic fertilizer. Plant height and leaf area index were significantly impacted by the use of both organic and inorganic fertilizers. This outcome was made possible by (Uwah et al. 2014). Wider leaves will facilitate improved photosynthesis by absorbing more sunlight. Photosynthate is produced in proportion to the amount of sunlight received (Duy et al. 2004). For plants to grow and develop, photosynthesis is essential. According to Pangaribuan et al. (2018), photosynthesis is essential for both vegetative development and the generative phase of flowering, seed filling, and postharvest quality. The survival of life itself depends heavily on enzymes. Plants use enzymes in their multi-component defensive mechanism, which is suggested in their defense responses to many stressors and pathogens. Peroxidases carry out a number of physiological and biochemical processes, including cell growth and expansion (Lin and Kao, 1999), differentiation and development, auxin catabolism (Mansouri et al., 1999), lignifications (Sitbon et al., 1999), and abiotic and biotic stress responses (Medina et al., 1999).

### MATERIALS AND METHODS

The study was conducted at the Norman E. Borlaug Crop Research Center of G.B. Pant University of Agriculture & Technology in Pantnagar (U.S. Nagar), Uttarakhand, India, during the 2012 Kharif season. The rice crop variety Pant Dhan 4, which was given several fertilizer combinations of N, P, K, Zn, and FYM, was the subject of the research. To determine the mean value, each plant's T1 (control) and T2 (N120) treatment combinations were obtained in triplicate.

### **SOD activity**

According to Giannopolitis and Ries (1977), total SOD activity was assessed by evaluating its capacity to prevent the photochemical reduction of nitrobluetetrazolium chloride (NBT).

### **Reagents**

1. Enzyme extract: Leaf sample of 0.2 g was homogenized in mortar & pestle with 4ml of ice cold extraction buffer (100mM phosphate buffer of pH 7.0). Filter through muslin cloth and centrifuge at 16,000 rpm for 15 min and supernatant was used as enzyme extract.
3. Potassium phosphate buffer: Buffer was prepared by dissolving 1.644 g  $\text{KH}_2\text{PO}_4$  (acid solution)  $T_3(N_{120} + P_{40})$ ,  $T_4(P_{40} + K_{40})$ ,  $T_5(N_{120} + K_{40})$ ,  $T_6(N_{120} \text{ solution})$  in 100 ml distilled water and 1.008 g K HPO (base solution)  $T_7(N_{120} + P_{40} + K_{40})$ ,  $T_8(N_{120} + P_{40} + K_{40} + \text{Znf})$ ,  $T_9(N_{180} + P_{80} + K_{40} + \text{Znf} + \text{FYM})$ ,  $T_{10}(N_{180} + P_{80} + K_{40} + \text{Znf} + \text{FYM})$ ,  $T_{11}(N_{150} + P_{40} + K_{40})$ ,  $T_{12}(N_{180} + P_{80} + K_{40} + \text{Znf})$ ,  $T_{13}(N_{180} + P_{80} + \text{Znf})$ ,  $T_{14}(N_{120} + P_{40} + K_{40} (\text{DAP}))$ .

Half of the nitrogen (1/4 in 150 and 180 Kg N  $\text{ha}^{-1}$  treatments) the total amounts of potash and phosphorus were manually mixed into the top 15 cm of soil with a shovel just before transplanting on the drained puddle surface. In T1 to T9, the remaining nitrogen was top-dressed in two equal installments during active tillering and five to seven days before to the panicle start stage. Nitrogen was top-dressed during active tillering, five to seven days before to panicle initiation, and throughout blooming phases in T10 to T12. One month before to transplanting, the FYM (5 t  $\text{ha}^{-1}$  on dry weight basis) was applied and integrated in accordance with the protocol. Ten to twenty days after transplanting both years, the foliar zinc was applied. To maintain the experiment weed-free, Machete 50 EC (Butachlor at 1.5 kg  $\text{ha}^{-1}$ ) was sprayed on the field two days after transplanting, followed by one hand weeding. Three plants were chosen at random for observation for each replication. Each plot was used to record observations. The photosynthetic rate of photosynthesis ( $\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$ ) was measured using a portable  $\text{CO}_2$  gas analyzer (CID Inc. water), as shown below. These two solutions were then combined to create a buffer solution. The aforementioned acid and base solutions helped to keep the buffer solution at pH 7.0.

4. Take 1.5 ml reaction mixture contain:-50 mM phosphate buffer (pH 7.8)

0.1  $\mu$ M EDTA

13 mM methionine 75  $\mu$ M NBT

2  $\mu$ M riboflavin

Put 50  $\mu$ l of the enzyme extract and 1.5 ml of the reaction mixture in the tubes. Two 20-watt fluorescent bulbs are used to light the tubes, which are thoroughly shaken. The tubes were covered with a dark cloth and the lights were turned off after the reaction was allowed to continue for fifteen minutes. At 560 nm absorbance, the reaction mixture was allowed to record. According to Giannopolitis and Ries (1977), one unit of SOD activity (U) is the quantity of enzyme needed to reduce nitrobluetetrazolium chloride (NBT) by 50%.

## RESULT AND DISCUSSEN

### Photosynthetic rate

Photosynthetic rate was recorded at flowering stage during the planting year 2012 data presented on USA). It was measured in an open system in which Table 1. Showed that NP<sub>180</sub> + Zn<sub>f</sub>(10.43) were found instrument takes reference CO<sub>2</sub> from atmosphere. The air flow rate, response time and added interval time were 0.4 LPM, 15 S and 20 s, respectively. The area of window of leaf chamber (broad rectangular) was maximum value of photosynthetic rate however least value of photosynthetic rate was recorded by the control (7.73). Statistical analysis of the data on photosynthetic rate during 2012 at PK, N P<sub>80</sub> 11 cm<sup>2</sup>. Other system set up values used were those which are already present in the memory of K+Zn<sub>f</sub>+FYM, NP<sub>80</sub> + Zn<sub>f</sub>, N

<sup>180</sup>P + Zn<sub>f</sub> and instruments. The time of measurement was kept constant. Photosynthetic rate and stomatal (DAP) was recorded significantly different from control while rest of the treatment was found conductance were assessed on intact leaves. All non significantly different from control. NP<sub>180</sub> + Zn<sub>f</sub>

servations were taken in full sun light and data were observed maximum photosynthetic rate which was significantly different from all the treatment

except NP<sub>180</sub> + Zn<sub>f</sub>+FYM, N<sub>180</sub> + Zn<sub>f</sub> and The data presented showed that the increment in NPK (DAP). Control showed minimum value of photosynthetic rate.

Data presented showed that increment in photosynthetic rate was 25.90% for 2012 in comparison to control. Deficiencies of N, P or K decreased the photosynthetic rate, yield components and paddy yields. Photosynthetic rate at an ambient CO<sub>2</sub> concentration of 350  $\mu$ L L<sup>-1</sup> increased with increases in leaf nitrogen content in all varieties examined. There was a close linear correlation between leaf nitrogen content and the photosynthetic rate for each individual cultivar (Hirshaw *et al.*, 2010).

**Table 1. Effect of different nutrients on photosynthetic rate and SOD activity of rice variety Pant Dhan 4 in kharif 2012.**

| S.No            | Treatments                                              | Photosynthetic rate | SOD activity in U/gm |
|-----------------|---------------------------------------------------------|---------------------|----------------------|
| T <sub>1</sub>  | Control                                                 | 7.73 $\pm$ 0.30     | 476.26 $\pm$ 0.001   |
| T <sub>2</sub>  | N                                                       | 7.70 $\pm$ 0.18     | 494.97 $\pm$ 0.001   |
| T <sub>3</sub>  | NP                                                      | 8.38 $\pm$ 0.13     | 505.26 $\pm$ 0.097   |
| T <sub>4</sub>  | PK                                                      | 9.23 $\pm$ 0.22     | 511.81 $\pm$ 0.001   |
| T <sub>5</sub>  | NK                                                      | 8.78 $\pm$ 0.39     | 512.75 $\pm$ 0.001   |
| T <sub>6</sub>  | NPK                                                     | 8.80 $\pm$ 0.36     | 528.65 $\pm$ 0.089   |
| T <sub>7</sub>  | NPK+Zn                                                  | 8.38 $\pm$ 0.33     | 540.82 $\pm$ 0.85    |
| T <sub>8</sub>  | NPK+FYM                                                 | 8.45 $\pm$ 0.13     | 524.91 $\pm$ 0.001   |
| T <sub>9</sub>  | NPK+Zn <sub>f</sub> +FYM                                | 8.83 $\pm$ 0.14     | 521.17 $\pm$ 0.001   |
| T <sub>10</sub> | N <sub>180</sub> P <sub>80</sub> K+Zn <sub>f</sub> +FYM | 9.50 $\pm$ 0.91     | 566.08 $\pm$ 0.097   |
| T <sub>11</sub> | N <sub>150</sub> PK                                     | 8.83 $\pm$ 0.11     | 544.91 $\pm$ 0.001   |
| T <sub>12</sub> | N <sub>180</sub> P <sub>80</sub> K+Zn <sub>f</sub>      | 9.93 $\pm$ 0.73     | 571.70 $\pm$ 0.001   |

|                 |                                       |            |              |
|-----------------|---------------------------------------|------------|--------------|
| T <sub>13</sub> | N <sub>180</sub> P <sub>80</sub> +Znf | 10.43±0.53 | 539.88±0.089 |
| T <sub>14</sub> | NPK (DAP)                             | 10.30±0.43 | 561.40±0.085 |
|                 | S.Em.±                                | 0.41       | 12.91        |
|                 | CD at 5%                              | 1.18       | 36.93        |

#### Super Oxide Dismutase activity

SOD activity was recorded at flowering stage during the planting year 2012 data presented on Table 1. SOD activity was 16.69% and decreased 7.77% in comparison to control. N<sub>180</sub> P<sub>80</sub> K+Znf was showed

the maximum value of SOD which reveals the fact that integrated supply of nutrient is important for the increment of SOD activity. SOD is one of the protective enzyme active oxygen scavenging enzyme system while clear biological oxygen free radicals in vivo within senescent leaves of plants, the soluble protein which is mainly RuBisCO play a role in plant metabolic activity, which serves as a key enzyme of the photosynthesis contributed to plant fixed CO<sub>2</sub> before leaf senescence. The results obtained the effect of organic fertilizers along with chemical fertilizer with organic fertilizers and recommended dose of NPK on leaf super oxide dismutase (SOD) activity in rice is increased. Half dose of CPMR+ RDF, CPMR organic fertilizer and RDF show results at equal with each other out of all the treatment and better than CM(Cow Manure), CMR(Cow Manure Rice Straw husk), PM(Poultry Manure) and PMR (Poultry Manure, Rice Straw and Husk) in both the years and even in pooled means (Siavoshi and Laware 2013). From the above results it may be concluded that N<sub>180</sub> P<sub>80</sub> K+Znf+FYM was observed as the best treatment for all the parameter as Zn is an essential micronutrient and FYM helps in slow release of nitrogen, increase water holding capacity of soil it also works as soil conditioner. The physiology of the rice plant is negatively impacted when any one of the nutrients is absent. The non-significant difference between NPK+Znf+FYM and N<sub>180</sub> P<sub>80</sub> K+Znf+FYM indicates that NPK+Znf+FYM may also be utilized to lessen soil pollution.

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- maximal SOD activity, which differed substantially from every treatment except for NP, PK, NK, NPK+Zn, NPK+FYM, NPK+Znf+FYM, N
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