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International Journal of Agricultural and Applied Sciences, June 2020, 1(1): 42-45
https://www.agetds.com/ijaas
ISSN: 2582-8053
https://doi.org/10.52804/ijaas2020.119

Research Article

Elucidating the effect of super oxide dismutase and photosynthetic rate of rice crop variety Pant Dhan 4

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(Received: 30/04/2020**; Revised:** 15/05/2020**; Accepted:** 01/06/2020**)**

ABSTRACT
A field experiment was carried out during *Kharif* season of 2010 and 2011 to study the effect of different nutrients treatments on the productivity of rice. Application of NPK with FYM and Zn proved to be superior in recording the highest Photosynthetic rate and Super Oxide Dismutase. Although fertilizers are important for enhancing rice production but excess use of fertilizer cause deterioration of soil quality which ultimately affect crop productivity so it is required to investigate the physiological aspects of rice plant under integrated nutrients. When imbalanced fertilizers doses are given to the rice-wheat cropping system, they showed a considerable decline in crop productivity and soil fertility.
Keywords*: Rice, NPK, FYM, Photosynthetic rate and Super Oxide Dismutase.*

INTRODUCTION
In India, rice occupies an area of 44 million hectare with an average production of 90 million tones with productivity of 2.0 tons per hectare. Demand for rice is growing every year and it is estimated that in 2025 the requirement would be 140 million tons. India has to raise its rice productivity by 3 per cent per annum to meet future food requirements (Thiyagarajan and Selvaraju, 2001). Although in India the area is decreased by 43.97 million hectare but the production elevated to100 million tones (FAO, 2012). Ninety percent of total world's rice is grown and consumed in south and Southeast Asia, where the normal consumption of rice ranges 300-800gm per day per person (Virk and Barry, 2009). After green revolution consumption of chemical fertilizers namely nitrogen (N), phosphorus (P) and potash (K) is also increased. Faulty use of fertilizers is one of the reasons for problems of soil salinity and alkalinity in agricultural regions of India. There is a proposed level of fertilizer for each crop and soil, which is known as the optimum level (Kundu and Vashist, 1991).Use of fertilizer beyond the optimum level creates imbalance which may causes environmental problems. Green revolution has brought serious ecological problems. Farmers are increasingly complaining of depleting fertility of soils, soil salinity and alkalinity and problems of ground water pollution this could be due to inefficient use of fertilizers (Sharma, 1993).

The application of essential plant nutrients particularly macro and micronutrients in optimum quantity and right proportion through correct methods and time of application is the key to increased and sustained crop production. As the requirement of fertilizer use varies from state to state and area and area therefore it is important to recognize fertilizer use behavior and role of factor influencing fertilizer consumption at state as well as national level (Jaga and Patel, 2012). Increased use of chemical fertilizers elevated the rice production and biomass. In the recent years, crop productivity has stagnated or decreased in spite of consumption of increased rate of chemical fertilizers (Apon *et al.*, 2018). Application of fertilizer support growth and development of rice as NPK are the macro nutrient required by the plant. Micronutrient like zinc helps the plant to protect from disease. Organic fertilizer improved the vegetative growth. Use of organic and inorganic fertilizer gave a significant effect on plant height and leaf area index. This result assisted by (Uwah *et al.* 2014). The wider leaves will support the arrest of more sunlight better photosynthesis. The more sunlight is absorbed, the more photosynthate generated (Duy *et al.* 2004). Photosynthesis is very crucial in the process of growth and development of plants. Photosynthesis plays a key role in the vegetative growth as well as generative phase in flowering, seed filling and postharvest quality (Pangaribuan, *et al.* 2018). Enzymes are very important to the existence of life itself. Enzymes are utilized by the plant for multi-component defense system and are implied in defense reactions of plants against pathogens and different types of stress factors. Various physiological and biochemical

processes such as cell growth and expansion (Lin and Kao, 1999), differentiation and development, auxin catabolism (Mansouri *et al.*, 1999), lignifications (Sitbon *et al.*, 1999), as well as abiotic and biotic stress responses are performed by Peroxidases (Medina *et al.*, 1999).

MATERIALS AND METHODS

The investigation was done during *Kharif* season of 2012 at Norman E. Borlaug Crop Research Centre of G.B. Pant University of Agriculture & Technology, Pantnagar (U.S. Nagar), Uttarakhand, India. The study was performed on rice crop variety Pant Dhan 4 which was provided with different fertilizer combinations of N, P, K, Zn, FYM namely. Treatment combination constitute of T_1(control), $T_2(N_{120})$, $T_3(N_{120} + P_{40})$, $T_4(P_{40} + K_{40})$,$T_5(N_{120} + K_{40})$, T_6 $(N_{120} + P_{40} + K_{40})$, T_7 $(N_{120} + P_{40} + K_{40}$ + Znf),$T_8(N_{120} + P_{40} + K_{40}$ + FYM), T_9 $(N_{180} + P_{80} + K_{40}$ + Znf + FYM), T_{10} $(N_{180} + P_{80}$ + K + Znf + FYM), $T_{11}(N_{150} + P_{40} + K_{40})$, T_{12} $(N_{180} + P_{80} + K_{40}$ + Znf), T_{13} $(N_{180} + P_{80}$ + Znf), $T_{14}\{N_{120} + P_{40} + K_{40}$ (DAP)}.

Half of the nitrogen (1/4 in 150 and 180 Kg N ha^{-1} treatments) and total quantities of Phosphorous and Potash were applied just before transplanting on drained puddle surface and incorporated into top 15 cm. soil manually with the help of spade. The remaining quantity of nitrogen was top dressed in two equal installments in T_1 to T_9 at active tillering and 5-7 days before panicle initiation stage. In T_{10} to T_{12} nitrogen was top dressed at active tillering, 5-7 days before panicle initiation and at flowering stages. The FYM (5 t ha^{-1} on dry weight basis) was applied and incorporated as per the treatment one month before transplanting. The foliar zinc was sprayed 10 to 20 days after transplanting both the year. Two days after transplanting Machete 50 EC (Butachlor at 1.5 Kg ha^{-1}) was sprayed in the field and later one manual weeding was done to keep experiment weed free. For each replication three plants were randomly selected for observations. Observations were recorded on per plot basis. The method of recording observations on various traits is given below.

Photosynthetic rate

Photosynthesis (µmol CO_2 m^{-2} s^{-1}), was determined with the help of portable CO_2 gas analyzer (CID Inc. USA). It was measured in an open system in which instrument takes reference CO_2 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 11 cm^2. Other system set up values used were those which are already present in the memory of instruments. The time of measurement was kept constant. Photosynthetic rate and stomatal conductance were assessed on intact leaves. All observations were taken in full sun light and data were taken in triplicates for each plant to get the mean value.

SOD activity

Total SOD activity was determined by measuring its ability to inhibit the photochemical reduction of Nitrobluetetrazoliumchloride (NBT), as described by (Giannopolitis and Ries, 1977).

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 ofpH 7.0). Filter through muslin cloth and centrifuge at 16,000 rpm for 15 min and supernatant was used as enzyme extract.
2. Potassium phosphate buffer: Buffer was prepared by dissolving 1.644 g KH_2PO_4 (acid solution) in 100 ml distilled water and 1.008 g K_2HPO_4(base solution) in 100 ml distilled water. Then, a buffer solution was prepared by the mixing of these two solutions. The buffer solution was maintained to pH 7.0 by the help of above mentioned acid and base solutions.
3. Take 1.5 ml reaction mixture contain:-

   50 mM phosphate buffer (pH 7.8)

   0.1 µM EDTA

   13 mM methionine

   75 µM NBT

   2 µM riboflavin

In the tubes take 1.5 ml reaction mixture with 50 µl enzyme extract. Tubes are shaken well and illuminated with two 20 watt fluorescent tubes. The reaction was let to proceed for 15 min. after which the tubes were covered with a black cloth and the lights were switched off. The reaction mixture was allowed to record at absorbance of 560 nm. One unit of SOD activity (U) was defined as the amount of enzyme required to cause 50% inhibition reduction of nitrobluetetrazolium chloride (NBT), as described by **(**Giannopolitis and Ries, 1977).

RESULT AND DISCUSSEN

Photosynthetic rate

Photosynthetic rate was recorded at flowering stage during the planting year 2012 data presented on Table 1.Showed that N_{180} P_{80} +Znf(10.43) were found 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_{180} P_{80} K+Znf+FYM, N_{180} P_{80} K+Znf, N_{180} P_{80} +Znf and NPK (DAP) was recorded significantly different from control while rest of the treatment was found non significantly different from control. N_{180} P_{80} +Znf were observed maximum photosynthetic rate which was significantly different from all the treatment

exceptN$_{180}$ P$_{80}$ K+Znf+FYM, N$_{180}$ P$_{80}$ K+Znf and 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 CO2 concentration of350 µL L-1 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 (Hirshawa *et al.*, 2010).

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

S.No.	Treatments	Photosynthetic rate	SOD activity in U/gm
T_1	Control	7.73±0.30	476.26±0.001
T_2	N	7.70±0.18	494.97±0.001
T_3	NP	8.38±0.13	505.26±0.097
T_4	PK	9.23±0.22	511.81±0.0011
T_5	NK	8.78±0.39	512.75±0.001
T_6	NPK	8.80±0.36	528.65±0.089
T_7	NPK+Zn	8.38±0.33	540.82±0.85
T_8	NPK+FYM	8.45±0.13	524.91±0.001
T_9	NPK+Znf+FYM	8.83±0.14	521.17±0.001
T_{10}	N$_{180}$ P$_{80}$ K+Znf+FYM	9.50±0.91	566.08±0.097
T_{11}	N$_{150}$ PK	8.83±0.11	544.91±0.0011
T_{12}	N$_{180}$ P$_{80}$ K+Znf	9.93±0.73	571.70±0.001
T_{13}	N$_{180}$ P$_{80}$ +Znf	10.43±0.53	539.88±0.089
T_{14}	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. N$_{180}$ P$_{80}$ K+Znf(571.70 U/gm)showed maximum value of SOD activity whereas the least value of SOD activity was recorded by the control (476.26 U/gm).

Statistical analysis of the data on SOD activity during 2012 NPK, NPK+Zn, NPK+FYM, NPK+Znf+FYM,N$_{180}$ P$_{80}$ K+Znf+FYM, N$_{180}$ P$_{80}$ K+Znf, N$_{180}$ P$_{80}$ +Znf andNPK(DAP)was foundsignificantly different from control whileN, NP, PK, NK,and N$_{150}$ PKwas found non significantly different from control. N$_{180}$ P$_{80}$ +Znf was observed maximum SOD activity which was significantly different from all the treatments except NP,PK, NK, NPK, NPK+Zn, NPK+FYM, NPK+Znf+FYM, N$_{180}$ P$_{80}$ K+Znf+FYM, N$_{180}$ P$_{80}$ K+Znf and NPK (DAP) is showing minimum value of SOD activity.

The data presented showed that the increment in SOD activity was 16.69% and decreased 7.77% in comparison to control. N$_{180}$ P$_{80}$ 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_2 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$_{180}$ P$_{80}$ 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, whereas when any one of the nutrient is missing it negatively affect the physiology of rice plant. NPK+Znf+FYM, was showed non-significant difference with N$_{180}$ P$_{80}$ K+Znf+FYM which reveal the fact that NPK+Znf+FYM can also be used to reduce soil pollution.

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