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Effect of chitosan (Plant Growth Enhancer) on yield and economics of transplanted rice

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Abstract
A field experiment was conducted at Krishi Nagar Farm, Department of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during *kharif* season 2018, on effect of chitosan (plant growth enhancer) on yield and economics of transplanted rice. The field experiment was laid out in randomized block design with thrice replication. The experimental results revealed that maximum grain yield (4471 kg ha^{-1}), straw yield (7702 kg ha^{-1}), gross monetary returns (93649 Rs. ha^{-1}), net Monetary returns (56068 Rs. ha^{-1}) and benefit-cost ratio (2.49) were recorded under application of 100% RDF + 1% Chitosan at 20, 40 and 60 DAT over the rest treatments.

Keywords: chitosan, rice yield and economics

Introduction
Rice (*Oryza sativa* L.) plant belonging to the family of *Poaceae* (*Gramineae*). It is the most important staple food in Asia, providing average 32% of total calorie uptake (Kumhar *et al*., 2018 and Kumhar *et al*., 2016) [6, 7]. Globally rice is grown in over 160 mha producing about 478 MT of grains annually (Anonymous, 2016) [2]. In India rice grown nearly 43.19 mha area with the production of 109.70 MT and triggering productivity of 2550 kg ha^{-1}. (Anonymous, 2017) [3]. Rice production has pivotal role in our national economy. There is always a growing demand for rice in India due to burgeoning population.

The role of plant growth regulators (promoters, retardants and inhibitors) in various physiological and biological processes in plants is well known which enables a rapid change in phenotype of the plant. Plant growth regulators play a vital roles in coordination of many growth and behavioral processes in rice, which regulate the amount, type and direction of plant growth (Rajendra and Jones Jonathan 2009; Anjum *et al.,* 2011) [10]. Similarly, Choi *et al.,* (2010) [4] stated that application of PGR increased paddy yield. Whereas, Singh *et al*., (2019b) [13] reported that application of Forchlorfenuron increased yield of transplanted rice.

Chitosan is a natural biopolymer modified from chitin, which is the main structural component of squid pens, cell walls of some fungi and shrimp and crab shells. Chitin and chitosan are copolymers found together in nature. They are inherent to have specific properties of being environmentally friendly and easily degradable. Chitosan has strong effects on agriculture such as acting as the carbon source for microbes in the soil, accelerating of transformation the process of organic matter into inorganic matter and assisting the root system of plants to absorb more nutrient from the soil. Chitosan is absorbed to the root after being decomposed by bacteria in the soil. Plant growth regulators modify growth and development in various ways under different growth conditions. GA_3 is responsible for stimulating the production of mRNA molecules in the cells, which in turn improves the chances of fast growth (Richards *et al*., 2001; Olszewki and Gubler, 2002) [11, 8].

Materials and methods
A field experiment was conducted during the *Kharif* season of the year 2018 at Krishi Nagar Farm, Department of Agronomy, J.N.K.V.V., Jabalpur (MP). The experiment was done with randomized block design with thrice replications.

The experiment comprised of eight treatments: T_1 = 100% RDF (Recommended dose of fertilizes), T_2 = 100% RDF + Chitosan 1% at 15, 30, 45 and 60 DAT (Days after transplanted), T_3 = 100% RDF + Chitosan 1% at 20, 40 and 60 DAT, T_4 = 75% RDF + Chitosan 1% at 15, 30, 45 and 60 DAT, T_5 = 100% RDF + Chitosan 1% at 15, 30, 45 and 60 DAT without fungicide and Insecticide, T_6 = 100% RDF + Chitosan 0.5% at 15, 30, 45 and 60 DAT, T_7 = 100% RDF + Chitosan s0.33% at 15, 30, 45 and 60 DAT and T_8 = 100% RDF + Cow-urine 5% and Vermiwash 10% at 15, 30, 45 and 60 DAT.

The soil of the experimental area was sandy clay loam in texture, neutral in soil reaction (pH 6.7), medium in organic carbon content (0.60 %), normal in electrical conductivity (0.30 dS m^{-1}), medium in available N (281.43 kg ha^{-1}), available P (20.35 kg ha^{-1}) and medium in available K (272.12 kg ha^{-1}).

The rice variety '*Kranti'* was used for transplanted of 21 days old seedlings (two seedling hill^{-1}) with 20 x 20 cm crop geometry. Recommended nutrient dose of 120:60:40 N, P_20_5, K_20 kg ha^{-1} were applied uniformly through urea, single super phosphate and muriate of potash, respectively. Out of this, half of N and entire dose of P_20_5 and K_20 were applied at the time of transplanting and the remaining quantity of N was applied in two equal splits, one at tillering and another at panicle initiation stage. A package and practices were adopted as recommended by JNKVV, Jabalpur.

Results and Discussion
Effect of chitosan on yield of rice
The data of *kharif* season 2018 pertaining to yield (kg ha^{-1}) and economics as influenced by different treatments is presented in Table 1.

Application of 100% RDF + 1% Chitosan at 20, 40 and 60 DAT brought marked increase in the grain and straw yield of rice over

100% RDF plots during the year of experimentation. Significant increase in grain yield was noted as compared to 100% RDF. Among the chitosan treatments, highest grain and straw yield were recorded under application of 100% RDF + 1% Chitosan at 20, 40 and 60 DAT (4471 and 7702 kg ha^{-1}) followed by application of 100% RDF + 1% Chitosan at 15, 30, 45 and 60 DAT (4370 and 7684 kg ha^{-1}). The grain and straw yield were lowest under application of 100% RDF (3362 and 6710 kg ha^{-1}). Singh *et al.*, (2019b) [13] reported an increased significantly grain and straw yield of transplanted rice with application of forchlorfenuron @ 3640 g ha^{-1}. The finding is also similar with Pandey *et al.*, (2001) [9], whom reported that IAA @ 50 ppm produced significantly maximum grain yield $hill^{-1}$, 1000-grain weight and yield kg ha^{-1}.

Effect of chitosan on economics of rice

Data given in Table 1 indicated that effectiveness of any production system is ultimately evaluated on the basis of its economics. Economic analysis is the basic consideration in determining that which treatment gives the highest return. All chitosan treatments gave higher net benefit over 100% RDF. Economic analysis promised that maximum gross monetary return (Rs. 93649 ha^{-1}), net return of (Rs. 56068 ha^{-1}) and B: C ratio (2.49) were obtained from application of 100% RDF + 1% Chitosan at 20, 40 and 60 DAT. The lowest gross monetary return (Rs. 32181 ha^{-1}) and net return (Rs. 40077 ha^{-1}) were observed with 100% RDF (without chitosan spray). Singh *et al.*, (2019a) [12] revealed that the application of Forchlorfenuron @ 3640 g ha^{-1} gave the best effects as compared to all other treatments and to achieve highest grain and straw yield of rice with maximum economic return.

Table 1: Effect of chitosan on grain, straw yield and economics of rice

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
T_1 - 100 % RDF	3362	6710	32181	72258	40077	2.25
T_2 - 100 % RDF + 1 % Chitosan at 15, 30, 45 and 60 DAT	4370	7684	39381	91847	52466	2.33
T_3 - 100 % RDF + 1 % Chitosan at 20, 40 and 60 DAT	4471	7702	37581	93649	56068	2.49
T_4 - 75 % RDF + 1 % Chitosan at 15, 30, 45 and 60 DAT	3917	7109	38271	82760	44489	2.16
T_5 - 100 % RDF + 1 % Chitosan at 15, 30, 45 and 60 DAT without fungicide and insecticide	4236	7569	39309	89260	49951	2.27
T_6 - 100 % RDF + 0.5 % Chitosan at 15, 30, 45 and 60 DAT	4027	7215	36581	84906	48325	2.32
T_7 - 100 % RDF + 0.33 % Chitosan at 15, 30, 45 and 60 DAT	3978	7139	35629	83886	48257	2.35
T_8 - 100 % RDF + Cow-urine 5% and Vermiwash 10% at 15, 30, 45 and 60 DAT	3588	6921	36881	76635	39754	2.08
SEm±	65	56	--	--	--	--
CD(P=0.05)	197	171	--	--	--	--

Conclusion

On the basis of findings of present experimental, it can be concluded that application of 100% RDF + 1% Chitosan at 20, 40 and 60 DAT found more remunerative followed by application of 100% RDF + 1% Chitosan at 15, 30, 45 and 60 DAT as both received higher values of NMR (Rs 56068 and 52466 ha^{-1}).

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