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Efficacy assessment of plasma and nanochitosan on yield attributes of wheat *(Triticum aestivum* L.)

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Abstract
A field experiment entitled "Efficacy assessment of Plasma and Nanochitosan on yield attributes of Wheat (*Triticum aestivum* L.)" was conducted with 12 treatments (full dose of fertilizer+ control, full dose of fertilizer+ nanochitosan, full dose of fertilizer+ plasma, 3/4th dose of fertilizer+ control, 3/4th dose of fertilizer+ nanochitosan, 3/4th dose of fertilizer+ plasma, ½ dose of fertilizer+ control, ½ dose of fertilizer+ nanochitosan, ½ dose of fertilizer+ plasma, no fertilizer+ control, no fertilizer+ nanochitosan+ nanochitosan and no fertilizer+ plasma) having 3 replications laid out in split plot design at N.E. Borlaug crop research centre, pantnagar during *rabi* 2017-18. Various yield attributing characteristics such as spike length, spike density/m2, fertile and sterile spikelets/spike, 1000 grain weight, grain yield, straw yield biological yield harvest index and grain: straw ratio have been recorded. Full dose of fertilizer along with nanochitosan was performed better which was statistically at par with 3/4th dose of fertilizer in addition to plasma but significantly higher than the other treatments. Hence, nanochitosan and plasma can be useful to coup up emerging issues related to agriculture.

Keywords: Nanochitosan, plasma, target action, chelating agent, loading efficiency, surface etching, plasma resonance

Introduction
Every day, millions of rural people who depend on agriculture confront technical, economic, social, cultural, and traditional obstacles to improving their livelihoods. To cope with these obstacles, the rural poor draw on indigenous knowledge and innovate through local experimentation and adaptation. Indigenous knowledge alone, however, is not enough to deal with the complex problems facing the agricultural sector. Supporting technological advancements in agriculture puts investors at the exciting intersection of groundbreaking technologies, enormous economic potential, and critical social benefits—reducing poverty, improving nutrition, and protecting water, soil, and human capital all at once.
New technologies such as plasma and nanotechnology are making promise and proved their use in different sectors of society but limited studies were done in agriculture. Plasma denominate substance with a high, unstable energy level that have more or less equal number of positive and negative charged particle or reactive species, created when gas become ionized. When plasma comes into contact with solid materials, the surfaces get excited and change their important properties, such as the surface energy, rate of imbibition etc. Which helps to accelerated physiological processes of plants together with surface etching effect resulted increase permeability towards seed coat, surface modification of seed coat, stimulate seed germination and seedling growth of the plant. It also increases the physiological metabolism of plant such as superoxide dismutase and peroxidase activities, photosynthetic pigments, photosynthetic efficiency and nitrate reductase activity. Such morphological modifications on seed surfaces are safe and inconceivable to have any genetic impact. Therefore, plasma technology may consider as a fast, economic and pollution-free method to improve crop production (Dobrin *et al.,* 2015) [5].
Nanotechnology has proved their worth in agriculture. This is a powerful technology which can have ability to create massive changes in food and agriculture system. Nanofertilizers release the nutrients as on requirement of crop and preventing them from prematurely interaction with soil, water environment and microorganisms and released nutrient directly assemble into the plant system effectively. These unique characteristics can be improved nutrient use efficiency of crop (DeRosa *et al.,* 2010) [4]. Chitosan nanoparticles have good association and loading efficiency values of a model substance which is showing their ability

as a nano carrier for nutrient delivery systems (Aiping *et al.*, 2006) [1] and also act as a slow release fertilizers that are only little bit soluble in water or are slowly broken down by microbial action (Prasad *et al.*, 2009) [8]. Thus, the rate of nutrient liberation from slow release fertilizers is related to their water solubility, microbiological degradation, and chemical hydrolysis and NO_3 --N leaching was decreased by applying slow release fertilizers coated with nano-materials.

Now a days seed treatment seems to be more popular because it improves germination rates, revamp ease of handling and accuracy of planting and cost of seed treatment is viewed as indemnity. Germination and seedling stages are crucial for healthy plant growth. The presence of biotic (diseases) and abiotic stresses (temperature and salt) at these stages can influence the successful establishment of crop. Plasma and Nanotechnology of seeds is come forth platforms to apostrophize these issues. Plasma seed treatments bestow to seed germination enhancement and rises plant productivity. Nanochitosan are easily applied to seed's surface and enter the nano pores of cell wall and cell membrane of the seed, by avoiding direct interaction with soil systems and increases in harvest index, crop index and mobilization index of yield factors, as compared with factor treated with normal non-fertilized and normal fertilized (Aziz *et al.*, 2016).

Material and method

The field experiment was conducted during the *Rabi* season, 2017 at the Norman E. Borlaug crop research centre of G.B. Pant University of Agriculture and Technology, Pantnagar, district Udham Singh Nagar, Uttarakhand representing the *Tarai* region of Uttarakhand. The soil of *Tarai* region (Mollisols) has developed from calcareous medium to moderately coarse textured parent material under the prominent influence of forest vegetation with moderate to well drain conditions. The soil of experimental site was silty clay loam with neutral pH of 7.4 and EC of 0.419 dS/m medium in organic carbon (0.72%), low in available nitrogen (216.25 Kg/ha), but available phosphorus (12.14 Kg/ha) and potassium was in medium range (139.08 Kg/ha). The experiment was laid out in split plot design with three replications. The treatments were included four different doses of fertilizer in main plot and application of seed treatments in subplot. The treatments comprises 4 doses of recommended dose of fertilizers (150:60:40 NPK Kg/ha) viz; Full dose of fertilizer (NI), 3/4 dose of fertilizer (N2), ½ dose of fertilizer (N3) and No dose of fertilizer (N4)in main plot and Control/ No seed treatment (S1), Plasma treatment (S2) and Chitosan nanoparticles (S3) in subplot. Yield attributes like spike length (cm), peduncle length (cm), spike density (per m2), fertile spikelets per spike, sterile spikelets per spike, grains per spike, test weight (g), grain yield (q/ha), straw yield (q/ha), biological yield (q/ ha) and harvest index (%) was recorded and economic analysis of cost of cultivation, gross return, net return and B:C ratio was calculated. The data obtained from various observations was statistically analyzed as per procedure of split plot design by using the standard techniques of Variance (ANOVA) with the help of computer software programme, STPR developed by department of Mathematics and statistics, GBPUA&T Pantnagar. If 'F' test will be found significant at 5% level of significance the critical difference (CD) will be calculated to test the significance of differences between the treatment means.

Plasma seed treatment

The wheat seeds have been treated in a capacitively coupled plasma reactor consists of Stainless Steel (SS) chamber with rotary pump for creating necessary sub-atmospheric vacuum (Fig.2). The plasma treatment of wheat seeds have done using air plasma formed radio frequency supply (13.56 MHz) with treatment time 2, 4, 6, 8 and 15 minutes with fixed 50 watts coupled power and 0.7 mbar pressure. This treatment was done at institute of plasma research, Ahmedabad.

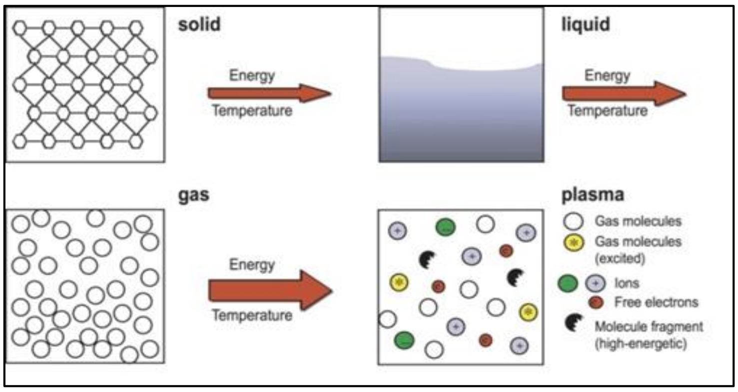

Fig 1: Formation of active molecules (plasma)

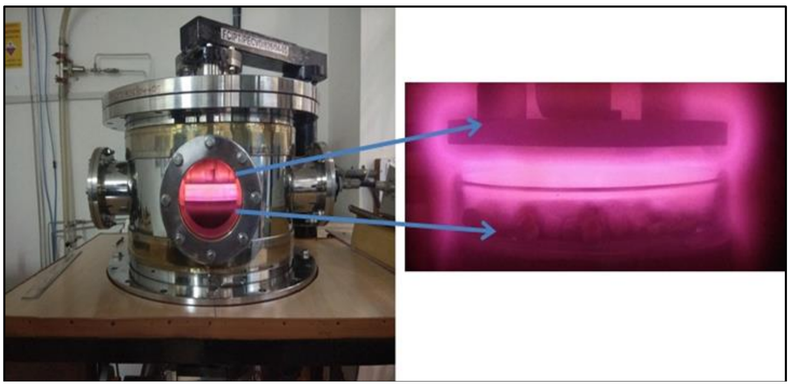

Fig 2: Radio frequency plasma system for wheat seed treatment (in-set shows closer view of plasma)

Nanochitosan purchased from nanoshell, Wilmington (USA), 50ppm of it used for experiment purpose that have $C_6H_{11}NO_4$ (Molecular formula), > 99% Purity, 1.4 Specific gravity, Cost price 1000 Rs/gram and White Appearance. For preparing 50 ppm nanochitosan solution weighed the nanochitosan at 0.050 gram or 50 mg and blended in 1 liter distilled water with the help of magnetic stirrer for 30 minutes, for equal distribution of it into the distilled water. The seeds of wheat were immersed in a sodium hypochloride solution for 2 minutes for surface sterilization of seeds then they were soaked in nanochitosan 50 ppm solution for 3 hours. Treated seeds were shade dry over muslin cloth for 24 hours. This process was done one day before the sowing of wheat seeds.

Result and discussion

Table 1: Effect on the yield attributing indices as influenced by fertilizer doses and seed treatments of wheat

Fertilizer dose (150:60:40 NPK Kg/ha)	Yield attributing indices					
	Spike length (cm)	Spike density/m2	Peduncle length (cm)	Fertile spikelets/ spike	Sterile spikelets/ spike	1000 grain weight (g)
Full dose of fertilizer	11.9	319	15.3	17.2	1.5	45
¾ dose of fertilizer	11.2	317	16.1	16.6	1.6	39
½ dose of fertilizer	10.1	302	16	16.0	1.7	37
No fertilizer	9.5	254	14.4	14.4	1.6	32
SEm±	0.07	11.33	1.71	0.33	0.16	2
C.D. (P=0.05)	0.24	39.98	NS	1.17	NS	5
C. V. (%)	10.9	11.3	6.5	6.1	8.3	7
Seed treatment						
Control	9.5	244.8	14.8	15.1	1.9	36
Plasma	10.9	307.4	16	16.3	1.43	39
Nanochitosan	11.6	344	15.6	16.9	1.45	42
SEm±	0.04	8.97	0.88	0.21	0.09	1.79
C.D. (P=0.05)	0.14	27.14	NS	0.637	0.09	5.6
C.V. (%)	11.54	10.4	13.6	12.5	14.6	8.6
Interaction	S	NS	NS	NS	NS	NS

Yield attributes

Spike length was reported maximum under full dose of fertilizer along with nanochitosan seed treatment @ 50 ppm, which was significantly higher over remaining treatments. It might be due to more response towards satisfactory nutrient, more formation of dry matter which was translocated and efficient partitioning of photosynthates towards sink. These findings can be supported by the results obtained from Mondal *et al.* (2012) [7]. Maximum spike density/m2 was obtained with full dose of fertilizer plus nanochitosan seed treatment and was significantly higher than no fertilizer along with control. Peduncle length did not affected significantly. Fertile spikelets/spike observed maximum at full dose of fertilizer with nanochitosan seed treatment, which was at par with 3/4th and ½ dose of fertilizer along with plasma seed treatment for 6 minutes but significantly higher over no fertilizer plus control. Nanochitosan may enter the nano pores of cell wall and cell membrane of the seed, avoided direct interaction with soil system and produce more number of fertile spikelets. Similar results were also obtained by Boonlertnirum *et al.* (2013). Maximum sterile spikelets/ spike were found under no fertilizer along with control and also significantly higher than remaining treatments due to lodging of them and minimum found in nanochitosan treated seed plus full fertilizer doses.

Table 2: Effect of fertilizer doses and seed treatment methods on grain yield, straw yield, biological yield, harvest index and grain: straw ratio of wheat

Fertilizer doses (150:60:40 NPK Kg/ha)	Grain yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)	Harvest index (%)	Grain : straw ratio
Full dose of fertilizer	52.4	91.4	143.8	36.4	0.57
¾ dose of fertilizer	49.0	86.5	135.5	36.1	0.56
½ dose of fertilizer	42.7	83.2	125.9	33.9	0.51
No fertilizer	30.8	50.3	81.3	37.8	0.61
SEm±	1.4	2.31	2.2	1.10	-
C.D. (P= 0.05)	4.8	8.17	7.8	3.91	-
C. V. (%)	9.6	8.8	5.5	9.1	-
Seed treatments					
Control	39.9	68.7	108.6	38.5	0.58
Plasma	44.7	78.5	123.2	35.9	0.56
Nano Chitosan	46.6	86.4	133.0	34.6	0.53
SEm±	1.03	2.81	2.6	1.46	-
CD (P=0.05)	3.1	8.50	8.0	NS	-
C.V. (%)	8.2	7.0	7.6	13.9	-
Interaction	NS	NS	S	S	

Grain yield, straw yield, biological yield and harvest index

Maximum grain yield was recorded at full dose of fertilizer along with nanochitosan seed treatment which was at par with 3/4th dose of fertilizer applied to plasma treated seeds (6 minutes). The possible results might be due to nanochitosan and plasma improved uptake and translocation of nutrients and increased sink strength. These findings were concurrent with the finding of Cho *et al.* (2008) [3] and Sadhu *et al.*,

(2017) [9]. Straw yield was produced maximum with full dose of fertilizer plus nanochitosan and at par with 3/4th and ½ dose of fertilizer along with plasma treated seeds for 6 minutes. Reason behind that production of more vegetative biomass especially due to nitrogen and potassium. However, nanochitosan and plasma improved nutrient use efficiency. Nanochitosan with sufficient nutrient might increase overall dry matter accumulation of crop that enables for maximum biological yield of wheat. These results were in line with finding of Gornik *et al.* (2008) [6]. Harvest index and grain straw ratio was found maximum with no fertilizer (37.8%) & (0.61), which was at par with full, 3/4th and ½ dose of fertilizer but seed treatment did not influenced significantly.

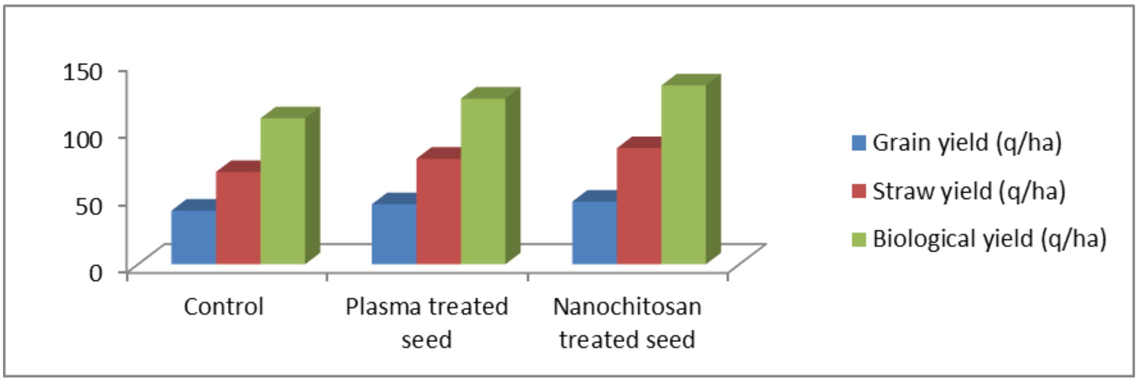

Fig 3: Effect of seed treatments on grain yield, straw yield and biological yield

Table 3: Effect of fertilizer doses and seed treatments on gross return, net return, cost of cultivation and B: C ratio

Fertilizer doses (150:60:40 NPK Kg/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	Cost of cultivation (Rs/ha)	B:C ratio
Full dose of fertilizer	97,893.5	65,150.1	32743.4	2.02
¾ dose of fertilizer	94,557.1	63,324.8	31232.3	2.03
½ dose of fertilizer	83,611.6	53,846.3	29765.3	1.91
No fertilizer	59,079.0	32,720.7	26358.3	1.17
SEm±	2,089.4	2,089.4	-	0.05
C.D. (P= 0.05)	7,370.8	7,370.8	-	0.18
C. V. (%)	7.48	11.6	-	8.3
Seed treatments				
Control	76,887.3	48,445.8	28441.5	1.65
Plasma	85,066.3	54,374.8	30691.5	1.75
Nano Chitosan	89,402.3	58,460.7	30941.6	1.94
SEm±	1,414.9	1,414.9	-	0.03
CD (P=0.05)	4,278.5	4,278.5	-	0.10
C.V. (%)	5.85	9.11	-	6.3
Interaction	NS	NS	-	S

Economic analysis

Maximum gross and net return was reported with full dose of fertilizer in addition to nanochitosan seed treatment, which was statistically at par with 3/4th dose of fertilizer plus plasma treated seeds at 6 minute. 3/4th dose of fertilizer along with nanochitosan seed treatment @ 50 ppm reported maximum B: C ratio, which was statistically at par with full and ½ dose of fertilizer in addition to plasma treated seeds for 6 minutes but significantly higher than remaining treatments.

Conclusion

Grain yield was found maximum in full dose of fertilizer plus nanochitosan which was statistically at par with 3/4th dose of fertilizer along with plasma and B: C ratio was also found maximum with 3/4th dose of fertilizer and in nanochitosan. So, these could be a better for economic and ecological point of view.

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References

1. Aiping Z, Jianhong L, Wenhui Y. Effective loading and controlled release of camptothecin by O-carboxymethylchitosan aggregates. Carbohydr Polym. 2006; 63(1):89-96.
2. Boonlertnirun S, Suvannasara R, Boonlertnirun K. Effects of chitosan application before being subjected to drought on physiological changes and yield potential of rice (*Oryza sativa* L.). J Appl. Sci. Res. 2013; 9(12):6140-6145.
3. Cho M, No H, Prinyawiwatkul W. Chitosan treatments affect growth and selected quality of sunflower sprouts. J Food Sci. 2008; 73(1):70-77.
4. De Rosa MC, Monreal C, Schnitzer M, Walsh R, Sultan Y. Nanotechnology in fertilizers. Nat. Nanotechnol. 2010; 5:91-94.
5. Dobrin D, Magureanu M, Mandache NB, Ionita MD. The effect of non-thermal plasma treatment on wheat germination and early growth. Innovative Food Science and Emerging Technologies, 2015; 29:255-260.
6. Gornik K, Grzesik M, Romanowska-Duda B. The effect of chitosan on rooting of grapevine cuttings and on subsequent plant growth under drought and temperature stress. J Fruit Ornam. Plant Res. 2008; 16:333-343.

7. Mondal M, Malek M, Puteh A, Ismail M, Ashrafuzzaman M, Naher L. Effect of foliar application of chitosan on growth and yield in okra. Aust J Crop Sci. 2012; 6(5):918.
8. Prasad R. Efficient fertilizer use: The key to food security and better environment. Journal of Tropical Agriculture. 2009; 47(1-2):1-17.
9. Sadhu S, Rohit T, Deshmukh RR, Annapure US. Influence of cold plasma on the enzymatic activity in germinating mung beans (Vigna radiate). LWT - Food Sci. & Tech. 2017; 78:97-104.