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# Effect of plant based nano-sized gypsum on growth parameters and yield of wheat (*Triticum aestivum* L.)

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**Abstract**
A field experiment was conducted during rabi season 2016-2017 in wheat crop at N. E. Borlaug Crop Research Centre, G. B. P. U. A & T, Pantnagar to study the effect of plant based nano-sized gypsum on growth parameters and yield of wheat. The surface soil (0-15 cm) of the experimental field was silty clay loam in texture, medium in organic carbon (0.72), low in available N (218.59 kg/ha), medium in available P (12.53 kg/ha) and medium in available K (149.56 kg/ha) with neutral soil reaction (pH 7.3). The study revealed that Parthenium based nano-sized gypsum along with 75% RDF gives promising results.

**Keywords:** Nanotechnology, nanofertilizer, nano-sized gypsum, gypsum

## Introduction
Wheat (*Triticum aestivum*), being the most staple crop worldwide holds great significance in food security. To meet the food requirement of huge population we need to enhance the food grain production accordingly. Fertilizers are the major determinant of agricultural production due to which they have gained importance in research. Prolonged use of fertilizers containing primary macronutrient viz. nitrogen, phosphorus and potassium has led to secondary macronutrients and micronutrients deficiencies in soil which affects both crop yield and human nutiriton. Nanotechnology promises to solve the problem of low nutrient use efficiency. Nanoparticles posses special properties like smaller size, high specific surface area, high surface energy and high solubility. Owing to the unique properties, nanoparticles have capability to enhance the uptake of water and nutrients. These unique properties can be exploited beneficially for improving the nutrient use efficiency (Naderi and Danesh-Sharaki, 2013) [1]. Nano-particles have less diameter than cells's pore diamerter, so it can easily cross the barrier and make entry into the plant cell (Navarro et al., 2008) [2]. Gypsum is a naturally occurring mineral containing Ca (29.2%) and S (18.6%) (Reddy and Reddy, 2010) [3]. Benefit of gypsum in agriculture include reclamation of alkaline soil, source of nutrient for Ca and S and compensates the negative effects of subsoil acidity (Dick et al., 2006) [4]. Application of gypsum in Ca deficient soil is known to improve root growth, thus reducing water stress (Farina and Channon, 1988) [5]. Calcium is known for its ability to enhance cell division, membrane stability, osmoregulation and cell structural integrity. Gypsum is known to increase yield and enhance quality of peanut and concentration of calcium in peanut seeds as it acts as a source of calcium (Summer and Lorrimore, 2006) [6]. Sulphur benefits the plant by better nitrogen utilization in plant, synthesis of amino acids *viz.* cystine, cysteine and methionine, synthesis of protein and fat etc. Hence, gypsum application seems to be promising in improving yield and quality of wheat. Also, it helps to reduce the risk of Ca and S deficiency in soil. Nano-sized gypsum is supposed to have high specific surface area, high surface energy, reactivity, mobility and solubility (Verma, 2015) [7]. In this experiment attempt has been made to see the effect of plant based nano-sized gypsum.

## Materials and methods
Field experiment was conducted during rabi season 2016-2017 in wheat crop at N. E. Borlaug Crop Research Centre, G. B. P. U. A & T, Pantnagar, U. S. Nagar, Uttarakhand. The

experimental site is located at foothills of Himalayas at an altitude of 243.84 m above mean sea level, 29°N latitude and 79°E longitudes. It lies under Tarai region. Climate of Pantnagar is humid, sub-tropical having hot and dry summer and extreme cold winter. During the crop period, the total rainfall was 11 mm in 5 rainy days. The soil of the experimental site is silty clay loam in texture and slightly alkaline in reaction. The soil was high in organic matter, low in available nitrogen (218.59 kg/ha), and medium in available phosphorus (12.53 kg/ha) and potassium (149.56 kg/ha). The experiment consisted of 8 treatments which were laid out in Randomised Block Design (RBD) with three replications. Plot size was 2m×2m, variety used was DPW 621-50 and seeds were sown at spacing of 20 cm at the rate of 100 kg/ha.

Seeds were treated with nano-sized gypsum @ 100ppm. Full doses of phosphorus and potassium and half dose of nitrogen were applied as basal dose. Remaining nitrogen was given in three split doses at 25, 45 and 65 days after sowing. At 25 DAS soil application of urea along with 300ppm of nano-sized gypsum was done. At 45 DAS sole application of urea and at 65 DAS foliar application of urea

Observations recorded were emergence count and emergence percentage at 10 days after sowing, tillers/m$^2$ at 45, 90DAS and at maturity and others *viz.* plant height, dry matter accumulation at 30, 60 and 90 days after sowing.

## Results and discussions

### Emergence count

Emergence count was recorded highest with 75% RDF plus nano-sized gypsum which was at par with 75% RDF plus neem based nano-sized gysum and 75% RDF plus parthenium based nano-sized gypsum and significantly higher over rest of the treatments. Improvement in emergence in neem and parthenium based nano-sized gypsum might be due to their better formulation and stability. The low specific surface area and high surface energy of the nano-sized gypsum particles rapidly enters through cell wall and cell membrane and during the process they increase the pore size of cell wall and cell membrane considerably.

**Table 1:** Effect of plant based nano-sized gypsum on emergence count

| Treatments | Emergence/m$^2$ |
|---|---|
| Control | 244 |
| RDF* | 254 |
| 75% RDF + Gypsum | 251 |
| 75% RDF + NG* | 289 |
| 75% RDF + NBNG* | 280 |
| 75% RDF +PBNG* | 276 |
| 75% RDF + VBNG* | 273 |
| 75% RDF + DBNG* | 262 |
| SEm± | 4 |
| C.D (at 5%) | 14 |
| C. V (%) | 3.07 |

### Plant height (cm)

The data pertaining to plant height was obtained at 30, 60 and 90 DAS. Plant height at 30DAS did not differ significantly. Plant height at 60 and 90 DAS, was recorded maximum with 75% RDF plus nano-sized gypsum which was at par with other plant based nano-sized gypsum formulations applied with 75% RDF and was significantly higher over control, and 75% RDF plus gypsum.

### Tillers/m$^2$

At 45 DAS, maximum number of tillers/m$^2$ obtained with 75% RDF plus nano-sized gypsum which was at par with 100% RDF and other plant based nano-sized gypsum formulations and was significantly higher over control and 75% RDF plus gypsum. At 90 DAS, maximum number of tillers/m$^2$ was obtained with 75% RDF plus nano-sized gypsum which was at par with 100% RDF and 75% RDF plus dhaincha based nano-sized gypsum. At maturity, the number of tillers/m$^2$ was maximum with75% RDF plus nano-sized gypsum which was at par with other treatments except control, 75% RDF plus gypsum and 75% RDF plus dhaincha based nano-sized gypsum. Maximum tillers mortality was recorded in 75% RDF plus dhaincha based nano-sized gypsum, while minimum tiller mortality was observed in neem based nano-sized gypsum.

Improvement in tillers/m$^2$ in neem and parthenium based nano-sized gypsum might be due to their lower mean particle size and better stability in spray solution. Presence of azadirachtin in neem leaves and presence of parthenin in parthenium acts as a reducing agent and thus reduces the mean particle size during the preparation of nano-sized particles. Moreover they provide better stability of the nano-sized particles by making a biological coating over the nano-sized particles, thus avoiding their re-agrregation in the spray solution. Due to superior quality of these two plant based nano-sized gypsum particles i.e., neem and parthenium based nano-sized gypsum, they enhanced tillering.

### Dry matter accumulation (g)

At 30 DAS, highest dry matter accumulation was obtained with 100% RDF which was at par with neem based nano-sized gypsum, parthenium based nano-sized gypsum and nano-sized gypsum along with 75% RDF. At 60 DAS, 100% RDF showed highest dry matter accumulation which was at par with 75% RDF plus nano-sized gypsum and significantly higher over the other treatments. At 90 DAS, 75% RDF plus nano-sized gypsum recorded highest dry matter accumulation which was found statistically at par with 100% RDF and significantly higher over the other treatments.

**Table 2:** Effect of plant based nano-sized gypsum on plant height, number of tillers and dry matter accumulation

| Treatments | Plant height (cm) | | | Tillers/m$^2$ | | | Dry matter Accumulation (g/m$^2$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | 45 DAS | 90 DAS | maturity | 30 DAS | 60 DAS | 90 DAS |
| Control | 19.89 | 39.05 | 65.51 | 280 | 290 | 233 | 38.67 | 126 | 752.33 |
| RDF | 25.47 | 53.68 | 82.73 | 434 | 406 | 376 | 63.67 | 235 | 1012.33 |
| 75% RDF + Gypsum | 21.03 | 43.22 | 68.96 | 336 | 357 | 332 | 41.67 | 137.67 | 774.67 |
| 75% RDF + NG | 24.21 | 49.27 | 86.13 | 447 | 417 | 394 | 61.00 | 232.67 | 1017.33 |
| 75% RDF + NBNG | 22.58 | 49.15 | 80.95 | 414 | 397 | 369 | 58.00 | 194.33 | 838.00 |
| 75% RDF + PBNG | 22.30 | 51.13 | 82.45 | 430 | 409 | 381 | 61.67 | 203.00 | 848.67 |
| 75% RDF + VBNG | 22.47 | 49.43 | 81.77 | 412 | 394 | 362 | 46.67 | 192 | 843.67 |
| 75% RDF + DBNG | 21.85 | 49.07 | 80.34 | 430 | 404 | 341 | 45.00 | 175 | 827.00 |
| SEm± | 1.25 | 2.71 | 2.96 | 12 | 5 | 11 | 3.17 | 5.22 | 15.57 |
| C.D (at 5%) | NS | 8.28 | 9.07 | 37 | 16 | 35 | 9.71 | 15.99 | 47.69 |
| C. V (%) | 9.62 | 9.76 | 6.52 | 5.30 | 2.35 | 5.69 | 10.55 | 4.836 | 3.12 |

### Grain yield

Grain yield differ significantly with different treatments. Maximum grain yield was observed with 100% RDF which was statistically at par with 75% RDF plus nano-sized gypsum and 75% RDF plus parthenium based nano-sized gypsum. there was no significant difference among the plant based nano-sized gypsum formulations when used along with 75% RDF. It shows that with the application of parthenium based nano-sized gypsum around 25% RDF can be saved without any significant yield penalty. Hence, instead of 100% RDF 75% RDF along with parthenium based nano-sized gypsum may be recommended as it will save 25% of N, P and K and will also add calcium and sulphur to the soil thus reducing the chance of calcium and sulphur deficiencies in the soil in a long run.

### Straw yield

Maximum straw yield was recorded with 100% RDF which was at par with nano-sized gypsum and significantly higher over the rest of the treatments. Straw yield obtained with plant based gypsum formulations were however, higher over control and bulk gypsum which shows their better uptake compared to bulk gypsum, except dhaincha based nano-sized gypsum.

### Biological yield

The highest biological yield (9.85 t/ha) was recorded with 100% RDF which was at par with 75% RDF plus nano-sized gypsum and significantly higher over the other treatments. Within plant based nano-sized gypsum formulations maximum biological yield was recorded with parthenium based nano-sized gypum and minimum with dhaincha based nano-sized gypsum however all the plant based formulations were higher than control.

**Table 3:** Effect of plant based nano-sized gypsum on grain yield, straw yield, biological yield and harvest index

| Treatments | Grain yield (t/ha) | Straw yield (t/ha) | Biological yield (t/ha) | Harvest index (%) |
|---|---|---|---|---|
| Control | 2.87 | 4.05 | 6.91 | 41.5 |
| RDF | 4.07 | 5.78 | 9.85 | 41.2 |
| 75% RDF + Gypsum | 3.50 | 4.84 | 8.37 | 42.3 |
| 75% RDF + NG | 4.00 | 5.73 | 9.73 | 41.1 |
| 75% RDF + NBNG | 3.67 | 5.13 | 8.36 | 41.9 |
| 75% RDF + PBNG | 3.73 | 4.92 | 8.80 | 42.3 |
| 75% RDF + VBNG | 3.47 | 4.90 | 8.66 | 40.9 |
| 75% RDF + DBNG | 3.33 | 4.73 | 8.07 | 41.5 |
| SEm± | 0.13 | 0.17 | 0.26 | 1.1 |
| C.D (at 5%) | 0.39 | 0.53 | 0.78 | NS |
| C. V (%) | 6.09 | 5.98 | 5.15 | 4.6 |

### Conclusion

On the basis of the study it can be concluded that nano-sized gypsum has a great potential in improving emergence, plant growth and yield of wheat. Parthenium based nano-sized gypsum gave promising results which were at par with 100% RDF and thus it can save upto 25% of the RDF without any yield penalty.

*RDF: recommended dose of fertilizer, *NG: nano gypsum, *NBNG: neem based nano gypsum, *PBNG: parthenium based nano gypsum, * VBNG: vegetable peel based nano gypsum, * DBNG: dhaincha based nano gypsum.

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