"Impacts Of N, P, K, S, And Zn On Wheat (*Triticum Aestivum* L.) Yield Outcomes In Uttarakhand's Dehradun District"

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ABSTRACT
During the rabi season of 2018–19, a field experiment was conducted at the research block of Shri Guru Ram Rai University in Dehradun, Uttarakhand, to examine how the yield attributes of wheat (Triticum aestivum L.) in the Dehradun Valley, India, responded to varying dosages of NPK S and Zn under irrigated conditions. In order to do this, a net plot size of 4.0 x 2.7 meters was used to evaluate eight treatments with various dose combinations of NPK, Zn, and S in randomized block design (RBD) with three replications. Dosage of Nitrogen varied under studied treatments. Seven yield parameters were studied and evaluated to know if they are significantly different under each treatment or not. Statistical measures like CD, ANOVA and comparative analysis was conducted to explore responses of yield attributes such as grain and straw yield, grain counts/ spike and weight, biological and harvest index of crop to different treatments (fertilizer dosage combinations).

Keywords: Fertilizer, NPK, Nutrients, Wheat, Treatment, Yield

INTRODUCTION

In developing countries like India, food security is a challenge and concern to satisfy cereal demand from large number of populations. After attaining independence in 1947, India's major concern was production of adequate food grains to fulfill country' s requirements at domestic level. Focusing on this, the green revolution emanated in India which made country in dependent to its crop production mainly wheat. The majority of Indians are guaranteed nutritional security through production and consistent supply, thanks to the country's various and enriched agroecological conditions, especially in the recent past. Wheat (*Triticum aestivum*) is one of the most important cereal crops in India. Wheat not only fulfills a huge demand for food, but also contributes a lot in farm income. At global level, it is the national staple food in forty-three countries. With an annual production of about 731 million tons, wheat holds the title of crop with the largest acreage worldwide, occupying roughly 217 million hectares. (USA, 2018). Its high starch content (60–68%) is accompanied by high protein (8–15%), fat (1.5-2%), sugar (2.3%), cellulose (2–2.5%), and mineral matter (1.5–2%) nutritional qualities. Apart from its nutritional attributes, wheat also contains Vitamin A, B1, B2, Nicotinic acid, and E, which makes it a highly favored grain in the Indian subcontinent. India is currently the world's second-largest producer of wheat (Sharma and Sendhil, 2016). Along with required soil amendments, nutrient-fertilizers are considered as important tool to obtain more crop yield. Generally N fertilizers are considered popular among farmers to grow crop under irrigated conditions in India. For wheat crop, the combined use of NPK plays an important role in its production. Application of NPK in balanced share at proper time has great impact on wheat yield. Plant species, even varieties with in species vary in their behavior to obtain and utilize NPK for grain production (Gilland Rahmat, 1994). However, a balanced nutrient intake is required for optimum crop yield and ideal soil health. As indiscriminate use of inorganic fertilizer leads to deficiency of macro and micronutrients in soil (Swaroop and Ganeshmurthy, 1993).

Keeping required nutrient uptake, and their role in wheat crop production, this study was conducted to analyze the yield responses of wheat (*Triticum aestivum L.)* to different dosages and combinations of NPK, Zn and S in valley region of Uttarakhand, India.

Materials and methods:

Study site and description

During the 2018–19 Rabi season, the experiment was carried out in the research plot of Shri Guru Ram Rai University in Dehradun, Uttarakhand. Situated between latitudes 30˚ 19' N and longitudes 78˚ 04' E is the Dehradun valley. Dun Valley has a humid subtropical climate. Winter temperatures typically vary from 1 to 20˚C, while summer temperatures can reach as high as 44˚C for a few days. Rainfall totals for the year average 2208.9 mm.

The experiment consisting of eight treatment combinations carried out in a randomized block design (RBD) with three replications. The total no of plots were 24. The net plot size was 4.0×2.7m. The treatments (T) carried out to explore yield response of wheat, were comprised of:

T1: Farmers practice (100kg DAP/ha)

T2: T1 + (15kg S+ 2.5kg Zn)/ha= (100kg DAP+15kg S+ 2.5kg Zn)/ha.

T3: Recommended dose of fertilizer (RDF)= (120kg N, 60kg P and 40kg K)/ha.

T4: T3+ (15kg S+ 2.5kg Zn)/ha= (120kg N, 60kg P and 40kg K+15kg S+ 2.5kg Zn)/ha.

T5: 150% RDF= (180kg N, 90kg P, 60kg K)/ha.

T6: T5+ 15kg S+ 2.5kg Zn/ha=(180kg N+ 90kg P+60kg K+15kg S+ 2.5kg Zn)/ha.

T7: (96kg N+ 96kg P+42kg K)/ha

T8: T7+ 15kg S+ 2.5kg Zn/ha)=(96kg N+ 96kg P+42kg K+15kg S+ 2.5kg Zn)/ha

RESULTS AND DISCUSSION

This chapter describes the experimental results regarding yield qualities, yield, initial and post-harvest soil fertility state, economic evaluation of the treatments, and uptake as acquired. The data on the aforementioned factors were statistically examined and are shown in the table.

Yield attributes

1. Length of earhead

Different treatments resulted in considerable differences in earhead length. The length of the earhead grew considerably by 6.32 to 17.99% when treatment T 6 (180 kg N + 90 kg P2O5 + 60 kg K2O + 15 kg S + 2.5 kg Zn/ha) was applied compared to the other treatments (Table 4.9). T1 (100 kg DAP/ha) recorded the shortest earhead length (7.50 cm), closely followed by T2 (100 kg DAP + 15 kg S + 2.5 kg Zn/ha).

2. Number of grains per earhead

Different treatments resulted in a substantial variation in the number of grains per earhead. The number of grains per earhead increased considerably when NPK, S, and Zn were applied together or when NPK was applied alone at greater rates compared to when fertilizer was applied according to farmer practice. Treatment T 6 (180 kg N + 90 kg P2O5 + 60 kg K2O + 15 kg S + 2.5 kg Zn/ha) produced the highest quantity of grains (43.70/earhead), 4.92 to 24.32% more than that observed under the other treatments.

3. Weight of grains per plant

The statistical analysis of the data pertaining to the character weight of grains per plant is presented in Table 4.9. The different treatments caused a considerable difference in the weight of grains per plant. The application of 180 kg N + 90 kg P2O5 + 60 kg K2O + 20 kg S + 5 kg Zn/ha resulted in the highest grain weight (1.76 g/plant), but it was comparable to T5 (180 kg N + 90 kg P2O5 + 60 kg K2O/h a), T-l (120 kg N + 60 kg P2O5 + 40 kg K2O + 20 kg S + 5 kg Zn/ha), and T8 (96 kg N + 96 kg P2O5 + 42 kg K2O + 20 kg S + 5 kg Zn /ha), which increased grain weight per plant by 9.38, 10.76, 10.76, and 26.82 percent.

4. Straw weight per plant

The application of treatment T6 (180 kg N + 90 kg P205 + 60 kg K20 + 15 kg S + 2.5 kg Zn/ha) resulted in the largest weight of straw (1.24 g/plant), which was noticeably greater than the other treatments. Following T1 (100 kg DAP/ha), T2 (100 kg DAP + 15 kg S + 2.5 kg Zn/ha), T3 (120 kg N + 60 kg P2O5 + 40 kg K2O/ha), T 1 (96 kg N + 96 kg P2O5 + 42 kg K2O/ha), and T 8 (96 kg N + 96 kg P2O5 + 42 kg K2O+ 15 kg S + 2.5 kg Zn /ha) recorded the lowest weight of straw (0.86 g/plant).

5. Test weight (1000-grain weight)

The various experimental treatments had a substantial impact on the weight of thousand grains. The maximum value for 1000-grain weight (52.05 g) was recorded by T6 (180 kg N + 90 kg P2O5 + 60 kg K2O + 15 kg S + 2.5 kg Zn/ha) treatment, which was followed by T8 (96 kg N + 96 kg P2O5 + 42 kg K2O + 15 kg S + 2.5 kg Zn /ha) (51.85 g) and T4 (120 kg N + 60 kg P2O5 + 40 kg K2O + 15 kg S + 2.5 kg Zn/ha) (49.07 g). The results were summarized in Table 4.9. The remaining therapies were judged to be comparable to one another.

B. Yield

1. Biological yield

Crop fertilized with T 6 (180 kg N + 90 kg P_2O_5 + 60 kg K_2O + 15 kg S + 2.5 kg Zn/ha) gave maximum biological yield

(92.87 q/ha) and was statistically similar with treatments T 5 (180 kg N + 90 kg P_2O_5 + 60 kg K_2O /ha) and T 4 (120 kg N + 60 kg P_2O_5 + 40 kg K_2O + 15 kg S + 2.5 kg Zn/ha) but higher than the rest of the treatments. The minimum biological yield of 62.68 q/ha was recorded with T1 (100 kg DAP/ha) closely followed by T2 (100 kg DAP + 15 kg S + 2.5 kg Zn/ha) (Table 4. 10).

2. Grain yield

Grain yield was also significantly influenced by various treatments. Treatment T 6 (180 kg N + 90 kg P_2O_5 + 60 kg K_2O + 15 kg S + 2.5 kg Zn/ha) gave maximum grain yield (37.15 q/ha) and was at par with treatments T5 (180 kg N + 90 kg P_2O_5 + 60 kg K_2O/ha), T4 (120 kg N + 60 kg P_2O_5 + 40 kg K_2O + 15 kg S + 2.5 kg Zn/ha), T 8 (96 kg N + 96 kg P_2O_5 + 42 kg K_2O+ 15 kg S + 2.5 kg Zn /ha) and T 3 (120 kg N + 60 kg P_2O_5 + 40 kg K_2O/ha) but significantly higher than the treatments T 1 (100 kg DAP/ha), T2 (100 kg DAP + 15 kg S + 2.5 kg Zn/ha) and T 7(96 kg N + 96 kg P_2O_5 + 42 kg K_2O / ha). The lower grain yield of 26.22 q/ha was recorded in treatment T1 (100 kg DAP/ha) closely followed by T2 (T1 + 20 Kg S + 5 Kg Zn /ha) and T 7 (96 kg N + 96 kg P_2O_5 + 42 kg K_2O/ ha). The magnitude of the grain yield increase under treatment T6 (180 kg N + 90 kg P_2O_5 + 60 kg K_2O + 15 kg S + 2.5 kg Zn/ha) was 24.11 25.76 and 41.71 per cent over the treatments T 7 (96 kg N + 96 kg P_2O_5 + 42 kg K_2O / ha) T2 (100 kg DAP + 15 kg S + 2.5 kg Zn/ha) and T1 (100 kg DAP/ha) respectively.

3. Straw yield

The analysis of variance revealed that the response of crop to different treatments in terms of straw yield was found to be significant. Treatment T 6 (180 kg N + 90 kg P_2O_5 + 60 kg K_2O + 15 kg S + 2.5 kg Zn/h a) recorded maximum straw yield (55.71q/ha) and did not differ significantly with treatment T 5 (180 kg N + 90 kg P_2O_5 + 60 kg K_2O /ha) but gave straw yield remarkably higher than rest of the treatments.

4. Harvest index

Different treatments did not exert any significant impact on harvest index. The maximum harvest index (43.52%) as recorded under the influence of T 8 (96 kg N + 96 kg P_2O_5 + 42 kg K_2O + 15 kg S + 2.5 kg Zn/ha) while minimum (40.00% under T6 (180 kg N + 90 kg P_2O_{5+} 60 kg K_2O + 15 kg S + 2.5 kg Zn/ha.

Table 1: Effect of several treatments on wheat yield-related characteristics.

Treatment	**Average length of earhead (em)**	**No. of grains/ earhead**	**Wt. of grains/ plant (g)**	**Straw wt./plant (g)**	**1000 grain wt. (g)**
T 1 Fertilizer dose as per farmers' practice (100 kg DAP/ha)	7.50	35.16	1.39	0.86	43.82
T2 T1+ 15 kg S/ha + 2.5 kg Zn/ha	7.75	36.20	1.55	0.87	44.12
T3 RDF (120:60:40 N:P_2O_5:K_2O kg/ha)	7.98	38.00	1.55	0.96	45.07
T4 T 3+ 15 kg S/ha + 2.5 kg Zn/ha	8.25	38.75	1.72	1.05	49.07
T5 150°/o of RDF	8.38	41.65	1.72	1.05	46.30
T6 T_5+ 15 kg S/ha + 2.5 kg Zn/ha	8.93	43.70	1.76	1.24	52.05
T7 STCR based NPK for 40 q/ha yield target (96:96:42 N:P_2O_5:K_2O k /ha)	8.26	36.70	1.60	0.92	45.83
T8 T 7+ 15 kg S/ha + 2.5 k Zn/ha	8.32	37.80	1.65	0.92	51.85
SE (m) ±	0.7	0.36	0.4	0.6	1.28
CD (at 5%)	0.20	1.05	0.10	0.17	3.77

Table 2: Effect of different treatments on harvest index, grain, straw, and biological yield.

Treatment	**Biological yield (q/ha)**	**Grain yield (q/ha)**	**Straw yield q/ha)**	**Harvest index**
T 1 Fertilizer dose as per farmers' practice (100 kg DAP/ha)	62.68	26.22	36.46	41.83
T2 T1+ 15 kg S/ha + 2.5 kg Zn/ha	71.57	29.54	42.03	41.28
T3 RDF (120:60:40 N:P_2O_5:K_2O kg/ha)	80.46	33.5	46.96	41.63
T4 T 3+ 15 kg S/ha + 2.5 kg Zn/ha	83.55	35.69	47.86	42.70
T5 150°/o of RDF	89.71	36.88	52.84	41.10
T6 T_5+ 15 kg S/ha + 2.5 kg Zn/ha	92.87	37.15	55.71	40.00
T7 STCR based NPK for 40 q/ha yield target (96:96:42 N:P_2O_5:K_2O k /ha)	73.71	29.93	43.78	40.60
T8 T 7+ 15 kg S/ha + 2.5 k Zn/ha	80.76	35.15	45.60	43.52
SE (m) ±	1.383	0.488	0.620	0.689
CD (at 5%)	4.235	1.493	1.899	N/S

CONCLUSION:

- Compared to farmers' practices (100-kilogram DAP/ha), the integrated application of 150°/o RDF (180 kg N + 90 kg P2O5 + 60 kg K2O/ha), 15 kg S, and 2.5 kg Zn/ha showed to be the most effective, yielding 10.93 kg/ha greater grain production and Rs. 11228.29/ha more net revenue.
- The application of 150°/o RDF was determined to be the second best treatment, exhibiting superior yield contributing characteristics and grain production, despite being slightly more economical than T 6 (180 kg N + 90 kg P2O5 + 60 kg K2O + 15 kg S + 2.5 kg Zn/ha).

Based on the results of this experiment, farmers can choose to implement treatment T 6 (180 kg N + 90 kg P2O5 + 60 kg K2O + 15 kg S + 2.5 kg Zn/ha) to maximize grain yield, or they can choose to implement treatment T 5 (180 kg N + 90 kg P2O5 + 60 kg K2O /ha), which has the highest net returns and B:C ratio and is therefore the most advantageous from an economic standpoint.

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REFERENCES

1. **Behera, A.K. (1993).** Effect of seed rate, row spacing and fertilizer on wheat (Triticum aestivum). Indian J. Agron. 40(3): 510-511.
2. **Behera, S.K.; D. Singh, B.S. Dwivedi, S. Singh, K. Kumar and D.S. Rana (2008).** Distribution of fractions of zinc and their contribution towards availability and plant uptake of zinc under long-term maize (Zea mays L.)-wheat (Triticum aestivum L.) cropping on an lnceptisol. Australian J. Soil Res. 46(1) 83-89.
3. **Dhiman, S.D.; D.P. Nandal and Hari Om (2000).** Productivity of rice (Oryza sativa)-wheat (Triticum aestivum) cropping system as affected by its residue management and fertility levels. Indian J. Agron. 45 (1): 1-5.
4. **Yadav, K.K. and B.R. Chhipa (2007).** Effect of FYM, gypsum and iron pyrites on fertility status of soil and yield of wheat irrigated with high RSC water. J. Indian Society Soil Sci. 55(3): 324-329 .
5. **Verma, U.N.; R. Thakur, S.K. Pal, M.K. Singh and S.P. Singh (2000).** Nutrient management of late planted wheat. Indian J. Agron. 45 (1): 118-123.
6. **Singh, R.N. and R.K. Pathak (2002).** Effect of integrated use of nutrients and biofertitizer on yield and nutrients uptake of wheat. Ann. Pl. Soil. Res. 4(2): 226-230.
7. **Singh K.N.:B. Prasad and S.K. Sinha (2001).** Effect of integrated nutrient management on a typical plaquent on yield and nutrient availability in a rice-wheat cropping system. Australian J. Agric. Res. 58 (8): 855-858.
8. **Setia, R.K. and K.N. Sharma (2007).** Dynamics of forms of inorganic phosphorus durin wheat growth in a continuous maize-wheat cropping system. J. Indian Soc. Soil Sci. 55(2): 139-146.
9. **Saran, O. M.; J.P. Pandey and R.K. Pathak (2004).** Direct and residual effect of sulphur on rice-wheat crop sequence. Ann. Pl. Soil Res. 6(1): 23-25.
10. **Ravankar, H.N.; R.T. Patil and P.A. Swaroop (2003**). Impact of inorganic fertilizers and organic manures on soil properties and crop yields under soybean-wheat system. Research on Crops. 4 (3): 301-304.
11. **Rajput M.l. Z.A. Soomro and S.A. Si ddiqui (2004).** Ev aluation of bread wheat on different fertilizer levels. J. Pl. Sci. 3 (1): 143-144.