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# Influenced Quality of Wheat (*Triticum aestivum* L.) and Abate the Environmental Pollution by Soil Applied with Foliar Fertilization of NPK Fertilizer in Saline Soil

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## ABSTRACT

A field experiment to assess different levels and methods of NPK fertilizer application on wheat crop was conducted on loamy sand soil at Instructional farm, College of Agriculture, Bikaner during *rabi* season of 2019-2020. The trial was laid out in split plot design and replicated three times. A total of 20 treatment combinations comprises A. Main plot : Four RDF levels prior to sowing viz., $F_0$ = Absolute control, $F_1$= 50% RDF, $F_2$= 75 % RDF and $F_2$= 100 % RDF and B. Sub plot : Five foliar fertilization levels of soluble NPK (1%) namely $S_0$= no fertilization (control), $S_1$= two spray (At 45and 60 DAS), $S_2$= three foliar spray (At 45, 60 and 75 DAS), $S_3$= four foliar spray (At 45, 60, 75 and 90 DAS). Basal application of 100% RDF with three foliar spray of soluble NPK (19:19:19) at 45, 60 and 75 DAS gave significantly higher average grain and straw yield and N, P, K content and uptake in grain and straw than other treatments, including control.

**Keywords** Foliar fertilization, Recommended dose of fertilizer, Yield, Protein.

## INTRODUCTION

Wheat is one of the most important staple food crop of India and occupies a notable position among the food grain crops not only in area and production but also in its versatility in adaptation to a wide range of agro-climatic conditions. It is a worldwide staple food grain crop, so wheat is called as “King of cereals”. In India, wheat is cultivated in 30.5 million hectare with total production of 107.59 million tons, with an average yield of 3421 kg ha$^{-1}$ in 2020 (GOI 2021-22). Ever encouraging population in India coupled with the decline arable land areas, calls for improvement in grain yield to meet ever increasing food demand. Efficient inputs management along with varietal improvement is the two basic aspects that can help us in achieving the target (Singh *et al.* 2011). It contains starch (60-90%), protein (11-16.5%), fat (1.5-2%),

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inorganic ions (1.2-2%) and vitamins (B-complex and vitamin E) (Ayala *et al.* 2011). There are several constraints responsible for reducing wheat productivity i.e. biotic and abiotic factors. Among abiotic factors, nutrient management is the major constraint for limiting the productivity of wheat so to increase the yield adopt proper nutrient management. Optimal fertilizer management is necessary to maintain sustainable yields, improve nutrient use efficiency of fertilizers and save fertilizer resources (Chuan *et al.* 2016). Enhanced use of chemical fertilizers by soil application for increasing production has been widely recognized but their indiscriminate use may have adverse effects on soil health, ecology and other natural resources, the high cost of fertilizer also restricts their large scale use. Therefore, to reduce soil application of fertilizers and maintaining high production levels are vital issues in modern agriculture which is only possible through foliar fertilization of nutrients at critical growth stages. There are known several types of fertilizer applications. One of the methods is drilling of fertilizers over the soil surface. Another method is foliar fertilization, also known as foliar feeding. It is a technique of feeding plants by applying liquid fertilizers directly on the leaves or the stem (Nasiri *et al.* 2010). Foliar application is credited with the advantage of quick and efficient utilization of nutrients, eliminating losses through leaching and fixation and helping in regulating the uptake of nutrients by plants (Manomani and Srimathi 2009). The foliar application of nutrients is more effective as compared to soil applied nutrients because of effective utilization by plant and minimum cost per unit area. Therefore, the trend started to rely on the initial addition of the codified fertilizer as soil fertilization and replace the complementary fertilizers by foliar fertilization to reduce the quantities of fertilizers added while ensuring the benefit of fertilizers (Haytova 2013). The soil of Rajasthan faces stress conditions several times in the cropping season special in *kharif* season by the application of fertilizer as a foliar spray it's also mitigate some stress conditions of the plants. There is also evidence that utilization of nutrients is faster by foliar spray as compared to its basal application, in foliar condition we are able to supply the nutrient immediately the requirement of plants. Considering these above facts, adoption of soil application recommended dose of fertilizer conjunction with foliar fertilization to improve production, productivity, profitability and efficient utilization of nutrients and abate the soil and environmental pollution are the need of the hour. Hence an attempt was made to assess the direct and cumulative effects of primary nutrient management on wheat.

## MATERIALS AND METHODS

A field experiment was conducted during *rabi* season 2019-20 at Instructional Farm College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner. This site has hot arid type of climate with deep, sandy and coarse loamy, desert soils with low water holding capacity. The mean values of minimum and maximum temperature recorded during growing seasons ranged 2.3 to 35.4 $^0$C. The value of minimum to maximum relative humidity during growing season was 21.7 to 92.9. The average sunshine hours during growing season 7.57 hr day$^{-1}$ while total amount of rainfall was 56 mm. The soil of the field was sandy loam, having pH 8.3, EC 0.13 dSm$^{-1}$, very low organic carbon (0.15%), low available nitrogen (92.26 kg ha$^{-1}$), medium in phosphorus (14.68 kg ha$^{-1}$) and available potash (207.6 kg ha$^{-1}$).

The field experiment was laid out in a split plot design with thrice time replicated consisting four levels of RDF (control, 50%, 75% and 100% RDF), applied in main plots and five levels of foliar spray of water soluble NPK (19:19:19) (control, one spray (45 DAS), two spray (45 and 60 DAS), three spray (45, 60 and 75 DAS) and four spray (45, 60, 75 and 90 DAS)) in sub plot comprising of total 20 treatment combinations.

Crop was sown on 26 November and harvested on 01 April in cropping season 2019-20. The experiment was conducted to know the direct effect of different treatments on wheat crop. Recommended dose of fertilizer (RDF) were applied through chemical fertilizers. Half N and full dose of P and K through urea, diammonium phosphate and muriate of potash, respectively were applied at the time of sowing and the remaining N was applied in two split doses viz., 1$^{st}$ and 2$^{nd}$ irrigation time. Foliar fertilization were applied as soluble N:P:K (19:19:19) fertilizer at different crop growth stages (Above mentioned).

All the other management practices were adopted as per recommendation of the crop grown under arid conditions. Five plants were selected randomly from the second row of the each plot for the measurements of spike length, spikelets spike$^{-1}$, grain spike$^{-1}$ and per meter row length area was selected after leaving the first row of the each plot for the measurement of effective tillers. After harvesting, threshing, cleaning and drying, the grain yield was recorded. Straw yield was obtained by subtracting grain yield from the total biomass yield. Net returns of the crop were computed on the basis of grain and straw yield, their prevailing market prices and cost of cultivation. Benefit: cost ratio was computed by dividing the net returns by total cost of cultivation.

The grain and straw nitrogen content was estimated using Kjeldahl's method (Snell and Snell 1949), phosphorus content by Vanadomolybdo phosphoric acid, yellow color method (Jackson 1973) and potash content by Tri-acid digested material by using Flame photometer (Jackson 1973). The grain protein content estimated by nitrogen content in grain multiplies with protein factor 6.25.

Nutrient use efficiency may be defined as yield (produce) per unit fertilizer used or in terms of recovery of fertilizer applied. Nutrient-use efficiency (NUE) was computed with the formulae given below:

$$\text{Nutrient use efficiency (kg grain kg}^{-1}\text{ nutrient)} = \frac{\text{Pod yield (kg ha}^{-1}\text{) in treated plot} - \text{Pod yield in control plot}}{\text{Nutrient applied (kg ha}^{-1}\text{)}}$$

## RESULTS AND DISCUSSION

### Effect of RDF levels on yield

Application of 100 % RDF through chemical fertilizers recorded maximum yields. Significantly highest grain, straw and biological yield were obtained with application of 100% RDF as compared to control, 50 and 75 % RDF (Table 1). Application of 100 % RDF increases grain and straw yield to the tune of 76.11, 20.16 and 7.95 and 63.66, 16.65 and 7.34 % over control, 50 and 75% RDF. Grain yield of any crop is combined effects of all yield attributing traits of those crops, if treatments influence attributing traits positively it's reflect as higher grain yield (Jat *et al*. 2014). Chopra *et al*. (2016) reported that the application of fertilizers has supplied adequate amount of nutrients that helped in expansion of leaf area which might have accelerated the photosynthesis rate and in turn increased the supply of carbohydrates to the plants. Similarly these results are in agreement with Jat *et al*. (2014) and Chauhan (2014). Thus significant increase in biological yield with the application of N, P and K could be ascribed due to increased grain and straw yields. Harvest index of wheat did not influenced due to fertility levels (Table 1). This might due to that the grain and biological part both improved unanimously as per increase in fertility levels.

**Table 1.** Effect of levels and method of NPK fertilizer application on yield of wheat.

| Treatments | Grain yield (kg ha$^{-1}$) | Straw yield (kg ha$^{-1}$) | Biological yield (kg ha$^{-1}$) | Harvest index % |
|---|---|---|---|---|
| Fertilizer levels | | | | |
| Control | 2545 | 3855 | 6401 | 39.76 |
| 50% RDF | 3730 | 5409 | 9139 | 40.83 |
| 75% RDF | 4152 | 5878 | 10180 | 40.79 |
| 100% RDF | 4482 | 6310 | 10792 | 41.53 |
| SEm ± | 89 | 108 | 130 | 0.74 |
| CD (p=0.05) | 310 | 375 | 449 | NS |
| Foliar spray @ 1 % NPK | | | | |
| Control (No spray) | 3326 | 4834 | 8197 | 40.43 |
| One spray (60 DAS) | 3492 | 5079 | 8608 | 40.44 |
| Two spray (45 and 60 DAS) | 3666 | 5245 | 8949 | 40.90 |
| Three Spray (45, 60 and 75 DAS) | 4042 | 5759 | 9839 | 40.92 |
| Four spray (45, 60, 75 and 90 DAS) | 4111 | 5898 | 10047 | 40.94 |
| SEm ± | 71 | 103 | 132 | 0.57 |
| CD (p=0.05) | 204 | 298 | 381 | NS |

Recommended dose fertilizer (NPK) : - 120:40:40 kg ha$^{-1}$, Foliar spray of N:P:K (19:19:19) @ 1%.

### Effect of foliar spray on yield

Foliar fertilization of soluble N P K at different growth stages were gave directly responds to the yield. Significantly higher grain, straw and biological yields of wheat were recorded with the application of three

foliar spray over remaining treatments and it remained statistically similar with four foliar spray of soluble N P K fertilizer. The three foliar spray of soluble N:P:K was increased grain and straw yield of wheat to the trend of 21.53, 15.76, 10.26 and 19.15, 13.40 and 9.80% over control, one (60 DAS) and two (45 and 60 DAS) foliar spray of soluble N:P:K fertilizer, respectively (Table 1). Significant rise in grain and biological yield of wheat with foliar fertilization of soluble N:P:K at different growth stages owing to raised radiation interception driven by a rise in growth rate and leaf area index, which ultimately raised grain and straw production. These studies reported that foliar spray of N:P:K along with soil application increased growth, yield and yield components as compared to basal application of fertilizer. Kumar (2017) also found that the yield attributes as well as yield, also improved significantly with RDF along with foliar application of water soluble fertilizers NPK (18:18:18) 1.5 % at 40 DAS. The results also agreement with Bhosale (2013). Foliar application of nutrients along with recommended dose of fertilizers increased the yield components due to foliar spray as it facilitates the higher photosynthetic translocation to sink by increasing the photosynthesizing area and its capacity of particular crop. However, harvest index did not differ significantly. This might due to that the grain and biological part both improved unanimously as per increase in number of foliar N:P:K spray.

**Effect of RDF levels on quality**

The content and uptake of nitrogen, phosphorus and potash both in grain and straw of wheat crop increased significantly with the application of 100 % RDF over rest of treatment. The highest total nitrogen uptake was recorded with 100 % RDF followed by 75 and 50 % RDF i.e. 109.82, 84.45 and 56.68 % over control (Tables 2 –3).

The magnitude of total phosphorus uptake increased with incorporation of 100, 75 and 50 % RDF by 107.27, 84.11 and 57.89 % respectively, compare to control. The application of 100 % RDF increased total potash uptake of wheat by 84.15, 23.95 and 10.27 % compare to control, 50 and 75 % RDF, respectively (Table 3). The significant rise in nutrient contents was owing to greater availability of nutrients in soil applied through addition of fertilizers. The uptake of nutrients is a function of biomass production and nutrient content of that biomass raised with fertilizer application. Dhaka (2007) also supported the present outcome of increasing levels of N, P significantly increased N, P content in grain and straw and total

**Table 2.** Effect of levels and methods of NPK fertilizer application on nutrient content of wheat.

| Treatments | Nutrient content in grain (%) | | | Nutrient content in straw (%) | | | Protein content (%) | Nutrient use efficiency (%) |
|---|---|---|---|---|---|---|---|---|
| | N | P | K | N | P | K | | |
| Fertilizer levels | | | | | | | | |
| | 1.462 | 0.412 | 0.457 | 0.563 | 0.199 | 1.177 | 9.14 | - |
| 50% RDF | 1.544 | 0.462 | 0.490 | 0.640 | 0.211 | 1.229 | 9.65 | 16.39 |
| 75% RDF | 1.622 | 0.491 | 0.513 | 0.704 | 0.221 | 1.258 | 10.14 | 13.85 |
| 100% RDF | 1.702 | 0.518 | 0.535 | 0.753 | 0.229 | 1.287 | 10.64 | 12.05 |
| SEm ± | 0.022 | 0.007 | 0.006 | 0.009 | 0.002 | 0.008 | 0.14 | - |
| CD (p=0.05) | 0.077 | 0.025 | 0.020 | 0.030 | 0.006 | 0.028 | 0.48 | - |
| Foliar spray @ 1 % NPK | | | | | | | | |
| Control | 1.495 | 0.431 | 0.447 | 0.624 | 0.200 | 1.181 | 9.34 | - |
| One spray (60 DAS) | 1.513 | 0.452 | 0.458 | 0.634 | 0.207 | 1.211 | 9.46 | 11.83 |
| Two spray (45 and 60 DAS) | 1.564 | 0.470 | 0.487 | 0.660 | 0.212 | 1.226 | 9.78 | 12.76 |
| Three spray (45, 60 and 75 DAS) | 1.638 | 0.487 | 0.527 | 0.697 | 0.224 | 1.274 | 10.24 | 15.78 |
| Four spray (45, 60, 75 and 90 DAS) | 1.702 | 0.513 | 0.574 | 0.712 | 0.232 | 1.297 | 10.64 | 16.01 |
| SEm ± | 0.026 | 0.010 | 0.006 | 0.010 | 0.003 | 0.012 | 0.16 | - |
| CD (p=0.05) | 0.074 | 0.030 | 0.016 | 0.028 | 0.0078 | 0.034 | 0.46 | - |

Recommended dose fertilizer (NPK): - 120:40:40 kg $ha^{-1}$, Foliar spray of N:P:K (19:19:19) @ 1%.

**Table 3.** Effect of levels and methods of NPK fertilizer application on nutrient uptake of wheat.

| Treatments | Nutrient uptake in grain (kg $h^{a-1}$) | | | Nutrient uptake in straw (kg $ha^{-1}$) | | | Nutrient uptake in straw (kg $ha^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | P | K | N | P | K | N | P | K |
| Fertilizer levels | | | | | | | | | |
| Control | 37.38 | 10.53 | 11.73 | 21.78 | 7.69 | 45.51 | 59.16 | 18.22 | 57.23 |
| 50% RDF | 57.86 | 17.31 | 18.43 | 34.84 | 11.45 | 66.63 | 92.69 | 28.77 | 85.07 |
| 75% RDF | 67.54 | 20.50 | 21.46 | 41.59 | 13.05 | 74.13 | 109.12 | 33.55 | 95.59 |
| 100% RDF | 76.49 | 23.29 | 24.11 | 47.64 | 14.48 | 81.24 | 124.13 | 37.77 | 105.35 |
| SEm ± | 1.63 | 0.65 | 0.44 | 1.05 | 0.26 | 1.13 | 1.99 | 0.75 | 1.19 |
| CD (p=0.05) | 5.64 | 2.23 | 1.52 | 3.62 | 0.89 | 3.92 | 6.88 | 2.58 | 4.11 |
| Foliar spray @ 1 % N P K | | | | | | | | | |
| Control (No Spray) | 50.29 | 14.60 | 15.06 | 30.79 | 9.76 | 57.53 | 81.08 | 24.36 | 72.59 |
| One spray (60 DAS) | 53.37 | 16.00 | 16.15 | 32.66 | 10.57 | 61.82 | 86.03 | 26.57 | 77.98 |
| Two spray (45 and 60 DAS) | 57.89 | 17.46 | 18.01 | 35.07 | 11.21 | 64.56 | 92.96 | 28.66 | 82.57 |
| Three spray (45, 60 and 75 DAS) | 66.76 | 20.00 | 21.57 | 40.84 | 12.99 | 73.70 | 107.60 | 32.98 | 95.27 |
| Four spray (45, 60, 75 and 90 DAS) | 70.77 | 21.50 | 23.87 | 42.95 | 13.81 | 76.77 | 113.72 | 35.31 | 100.64 |
| SEm ± | 1.32 | 0.48 | 0.44 | 0.91 | 0.27 | 1.26 | 1.46 | 0.60 | 1.40 |
| CD (p=0.05) | 3.79 | 1.38 | 1.28 | 2.62 | 0.78 | 3.64 | 4.21 | 1.73 | 4.03 |

Recommended dose fertilizer (NPK): - 120:40:40 kg $ha^{-1}$, Foliar spray of N:P:K (19:19:19) @ 1%.

uptake of N and P. This might be due to improved nutritional environment in the rhizosphere as well as in the plant system leading to enhanced translocation especially of N and P to reproductive structures viz., ears, grains and other plant parts. Increased grain and straw yield coupled with higher nutrient content (N P K) in plant seemed to have the increased uptake of nitrogen, phosphorus and potassium by the crop due to RDF levels. However, the protein content was significantly influence by application of 100% RDF over rest of fertility levels. This grain protein content might be due to its dependence on nitrogen content, Akhtar *et al.* (2018), Kumar *et al.* (2015) and Gajanand *et al.* (2013).

Nutrient use efficiency (Agronomic use efficiency) was higher with 50 % RDF level. It was followed with 75 % RDF level. The lowest agronomic use efficiency was recorded with application of 100 % RDF (Table 3). As the recommended dose of fertilizer increases the yield per unit nutrient decreases thus although the 100 % RDF recorded higher yield the agronomic efficiency was lower. On the contrary, the 50 and 75 % RDF with lower amount of N, P, K recorded higher agronomic efficiency. This is again due to the fact that higher uptake of N, P, K was possible in lower doses and while higher doses did not match the uptake proportionately. Fageria and Baligar (2005) also reported that high agronomic efficiency is obtained if the yield increment per unit N, P, K applied is high because of reduced losses and increased uptake of N, P, K. (Zemichael *et al.* 2017 and Kakraliya *et al*. 2017).

**Effect of foliar spray on quality**

Nitrogen, phosphorus and potash content and uptake in both grain and straw were found significantly superior under application of four foliar spray over rest of foliar fertilization levels. Percentage increase total nitrogen uptake due to application of four, three, two and one foliar spray of soluble N:P:K to the tune of 40.27, 32.71, 14.66 and 6.11 % over control, respectively. Application of four, three, two and one foliar spray of soluble N:P:K increased phosphorus uptake by 44.93, 35.39, 17.66 and 9.06 % over control, respectively. The corresponding increase total potash uptake due to four, three, two and one foliar spray of soluble N:P:K to the tune of 38.93, 31.30, 12.16 and 7.44 % over control (Table 3). This may

be nutrient uptake is combined effect of yield and nutrient content both are increase simultaneously with application of N:P:K foliar fertilizer. This might suggest the better utilization and quick absorption by plants of nitrogen, phosphorus and potash from foliar fertilization of soluble N:P:K. This is might be due to the stimulating effect of soluble N:P:K through improving the physiological performance of plants and multiple advantage of foliar application method such rapid and efficient response to plant needs, less product needed and independence of soil conditions. The results also are in agreement with Bhosale (2013), Kumar (2017). Almost similar results of nitrogen content were observed for protein content of grain. Close conformity by Seilsepour (2007) and Gulsar *et al.* (2019) found that seed protein content increased significantly by foliar feeding of nitrogen.

Highest agronomic use efficiency was recorded with four foliar spray of soluble N:P:K followed by three and two foliar spray and lowest agronomic use efficiency (Table 3) and similar finding observed by Kara (2010) and Paik *et al.* (2020).

## CONCLUSION

Hence application of 100% RDF through chemical fertilizers as basal dose and three foliar spray of soluble N:P:K (19:19:19) at 45, 60 and 90 DAS of wheat was found better nutrient-management practice for higher yield, nutrient content, uptake and protein content from wheat crop.

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