*Original Research Article*

# Growth and Production of Wheat (*Triticum aestivum* L.) as Influenced by Levels and Methods of N P K Fertilizer Application in Arid Region of Rajasthan


## ABSTRACT

A field experiment was conducted at Instructional Farm, Swami Keshwanand Rajasthan Agricultural University, Bikaner during *rabi* season of 2019-20 on Growth and Production of Wheat (*Triticum aestivum* L.) as Influenced by Levels and Methods of N P K Fertilizer Application in Arid Region of Rajasthan. The experiment was laid out with 20 treatment combinations comprising in a split plot design and replicated three times. The results revealed that 100% recommended dose of fertilizer resulted in significantly higher growth and yield attributes as well as grain and straw yield over all other fertility levels. Application of 100% RDF recorded significantly maximum gross and net profit (₹ 108568 $ha^{-1}$ and ₹ 76682 $ha^{-1}$) with B:C ratio of 2.40 over the other applied treatments. Maximum growth and yield attributes as well as grain and straw yield were recorded under three foliar spray of soluble N: P: K over rest of treatments but remained statistically at par with four foliar spray. Gross and net return was highly influenced with foliar fertilization as three and four foliar spray and these accrued significantly higher gross & net returns (₹ 98116 $ha^{-1}$ & ₹ 67326 $ha^{-1}$ and ₹ 99923 $ha^{-1}$ & ₹ 68257 $ha^{-1}$) with B: C ratio of 2.16 and 2.13, respectively in comparison to rest levels of foliar fertilization.



**Key words:** Economics, Fertility level, Foliar fertilization, RDF, Wheat and Yield


## 1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is second most important grain crop in India and most important in the world. It is worldwide staple food grain crop, so wheat is called as “King of cereals”. In term of area and production India has second position in the world. In India, wheat is cultivated in 29.58 million hectare with total production of 99.70 million tons, with average yield of 5090 kg $ha^{-1}$ in 2018-19 (GOI 2018-19). It contains starch (60-90 per cent), protein (11-16.5 per cent), fat (1.5-2 per cent), inorganic ions (1.2-2 per cent) and vitamins (B-complex and vitamin E) (Ayala *et al.* 2011). There are number of 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 for increased 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). There are known several types of fertilizer applications. One of the methods is drilling of fertilizers over the soil surface (Finck, 1982). Another method is a 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). 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 (Narang *et al.,* 1997). Fertilizer is one of the most important management system for crop and excessive addition of chemical fertilizers is a problem because it leads to increase environmental pollution (Savci, 2012). 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 in order to reduce the quantities of fertilizers added while ensuring the benefit of fertilizers (Haytova, 2013. There is also evidence that utilization of nutrients is faster by foliar spray as compare 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 nutrient are the need of the hour.

## 2. MATERIALS AND METHOD

The field experiment was conducted during the winter seasons of 2019-20 at the Instructional Farm, S. K. Rajasthan Agricultural University, Bikaner (28°38' N, 77°11' E, 228.6 m above mean sea-level), to study the growth and production of wheat as influenced by levels and method of N P K fertilizer application in arid region in split plot design with three replications. The soil of the experimental site was loamy sand, with bulk density of 1.55 g $cm^{-1}$. It had 0.15% organic carbon, 92.26 kg $KMnO_4$ oxidizable N $ha^{-1}$, 14.68 kg 0.5 N $NaHCO_3$ extractable P $ha^{-1}$, 207.06 kg 1.0 N $NH_4OAC$-exchangeable K $ha^{-1}$, 8.3 pH and 0.13 $dSm^{-1}$ electrical conductivity at the start of the experiment. The treatment consisted of four fertility levels in main plot, *viz.* $F_0$ - control, $F_1$ - 50% recommended dose of fertilizer (RDF), $F_2$ - 75% recommended dose of fertilizer (RDF), $F_3$ - 100% recommended dose of fertilizer (RDF) and five foliar fertilization with soluble N P K in the sub plot *viz.* $S_0$- control (no spray), $S_1$- one spray (60 DAS), $S_2$- two spray (45 & 60 DAS), $S_3$- three spray (45, 60 & 75 DAS), $S_4$- four

spray (45, 60, 75 & 90 DAS). Crop was sown on 26 November and harvested on 01 April in cropping season 2019-20. 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,* 1st and 2nd irrigation time. Foliar fertilization was applied as soluble N: P: K (19:19:19) fertilizer at different crop growth stages. Five plants were selected randomly from the second row of each plot for the measurements of plant height, spike length, spikelets spike$^{-1}$ & grain spike$^{-1}$ and per meter row length area were selected after leaving the first row of each plot for the measurement of plant stand, dry-matter accumulation and effective tillers. After harvesting, threshing, cleaning and drying, the grain yield was recorded. Net returns of the crop were computed on the basis of grain and straw yield, their prevailing market prices and cost of cultivation. In order to test the significance of variance in experiments, the data obtained for various treatment effects were statistically analysed using the F-test as per procedure described by Panse and Sukhatme (1985). The results are presented at 5% level of significance (P= 0.05) for making comparison between treatments.

## 3. RESULTS AND DISCUSSION

**Effect of RDF levels: -** Application of 100 % RDF recorded maximum growth and yield attributes. Plant stand of wheat at 20 DAS and harvesting stage could not influence due to fertility levels (Kumar and Satyvan, 2017). The highest values of plant height and dry-matter accumulation at different crop growth stages were registered at 100% RDF, which were significantly higher than the rest of treatments. Application of 100, 75 and 50 per cent RDF increased the dry matter production to the tune of 19.23, 13.99 and 8.60 per cent at harvesting stage over control, respectively. The plant height and dry matter accumulation increased in 100 per cent RDF might be due to higher N uptake, leading to increased protein synthesis, cell division and cell enlargement which in turn are elaborated into protoplast and thus increased plant height and dry matter accumulation. These results are in close conformity with the findings of Hashim *et al.,* (2015) and Choudhary (2017). Yield attributes namely effective tillers per meter row length, spike length, grain/ spike and test weight were found significantly higher with 100 % RDF over rest of treatments. Number of effective tillers increase with application of 100, 75 and 50 per cent RDF was in the order of 73.39, 62.40 and 40.00 per cent over control. Probably this increase in number of effective tillers per meter row length is due to the better supply of photosynthates from leaves to effective tillers. Chaturvedi *et*

*al.,* (2006). Significantly highest grain, straw and biological yield were obtained with application of 100 % RDF as compared to control, 50 and 75 per cent RDF. Application of 100 per cent RDF increases grain and straw yield to the tune of 76.11, 20.16 & 7.95 and 63.66, 16.65 & 7.34 % over control, 50 and 75% RDF. Grain yield of any crop is combined effects of all attributing characters of those crops, if treatments influence attributing characters positively it reflects as higher grain yield. Well-nourished plants with higher amounts of fertilization increased the grain and biological yield of wheat which might be due to improvement in yield attributes i.e. increased effective tillers, grain spike$^{-1}$ and spike length (Jat *et al.,* 2014).

**Effect of foliar spray: -** Foliar fertilization of soluble N P K at different growth stages were gave directly responds to the growth and yield attributes as well as yield of wheat. Plant stand at 20 DAS and harvesting stage recorded statistically at par due foliar fertilization. Plant height and DMA observed significantly higher with the application of three foliar spray over all other treatments but it was recorded statistically at par with four foliar spray. This suggests the quick absorption of nitrogen, phosphorus and potash due to foliar spray of soluble N: P: K at different growth stages and helped in expansion of leaf area owing to increased meristematic activity and provided greater photosynthetic surface to intercept more radiant energy and improved the capacity of the plants to utilize more available nutrients and net photosynthesis (Yassen, 2010). The yield attributes *viz,* effective tillers per meter row length and length of spike of wheat were significantly higher in treated plot than the control. Effective tillers and length of spike were recorded significantly higher with three foliar spray over rest of spray but closely at par four foliar This increase in yield components was mainly due to increasing levels of foliar fertilization that is increase leaf area and photosynthesis process in growth attributes this show high dry matter production and its partition in fruiting parts which in turns give significantly high yield (Bhosale, 2013). Increasing trend found in respect of number of grain spike$^{-1}$, spikelet spike$^{-1}$ and test weight of wheat but it was not influenced significantly by different foliar fertilization levels. This might be due to spikelet spike$^{-1}$ and test weight is basically a genetic character it was not influenced by levels of foliar fertilization (Kumar S. 2017).

Significantly higher grain yields, straw and biological yield 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 yield of wheat to the trend of 21.53, 15.76 and

10.26 per cent over control, one and two foliar spray of soluble N: P: K fertilizer, respectively. 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. (Kumar S. 2017 and Bhosale 2013).

**Economics: -** Application of 100% RDF recorded the significantly maximum gross and net profit (108568 and 76682 ₹ $ha^{-1}$) as well as with 2.40 benefit: cost ratio, followed by 75% RDF 100668, 69909 ₹ $ha^{-1}$ and 2.27, respectively. In point of view foliar fertilization, three foliar spray of soluble N: P: K observed the significantly higher gross and net return (98116 and 67326 ₹ $ha^{-1}$) and maximum benefit: cost ratio 2.16 over rest of the treatments, but it was recorded the statistically at par with four foliar spray of soluble N: P: K (99923 and 68257 ₹ $ha^{-1}$ with 2.13 B:C). (Sharma, 2016 and Bairwa *et al.* 2018)

## 4. CONCLUSION

Hence application of 100% RDF through chemical fertilizers as basal dose and three foliar spray of soluble N: P: K (19:19:19) of wheat was found better nutrient-management practice for higher growth, yield and net returns from wheat crop.

**Table: 1. Effect of levels and method of NPK fertilizer application on growth attributes of wheat**

| Treatments | Growth attributes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Plant stand $m^{-1}$ row length | | Plant height (cm) | | | Dry matter accumulation $m^{-1}$ row length (g) | | | |
| | 20 DAS | Harvest | 60 DAS | 90 DAS | Harvest | 30 DAS | 60 DAS | 90 DAS | Harvest |
| **Fertilizer levels** | | | | | | | | | |
| $F_0$ | 41.17 | 39.25 | 38.93 | 70.01 | 74.30 | 19.46 | 48.34 | 90.61 | 110.22 |
| $F_1$ | 41.73 | 39.76 | 42.25 | 77.90 | 81.39 | 20.25 | 53.03 | 99.19 | 119.69 |
| $F_2$ | 42.07 | 40.06 | 44.53 | 83.31 | 86.70 | 20.76 | 55.20 | 103.11 | 125.64 |
| $F_3$ | 42.22 | 40.20 | 46.63 | 88.25 | 91.02 | 21.13 | 57.35 | 106.67 | 131.41 |
| **S. Em ±** | 0.91 | 0.83 | 0.54 | 0.88 | 1.21 | 0.40 | 0.61 | 0.85 | 1.64 |
| **CD(P=0.05)** | NS | NS | 1.88 | 3.03 | 4.19 | NS | 2.12 | 2.93 | 5.69 |
| **Foliar spray @ 1 % N P K** | | | | | | | | | |
| $S_0$ | 41.33 | 39.39 | 41.47 | 69.22 | 73.64 | 19.78 | 49.75 | 88.89 | 109.01 |
| $S_1$ | 41.57 | 39.61 | 41.76 | 73.77 | 77.06 | 19.92 | 51.14 | 95.67 | 116.34 |
| $S_2$ | 41.82 | 39.83 | 43.84 | 79.46 | 82.04 | 20.53 | 55.22 | 100.24 | 121.61 |
| $S_3$ | 42.09 | 40.08 | 44.01 | 88.14 | 90.90 | 20.67 | 55.39 | 107.02 | 129.19 |
| $S_4$ | 42.20 | 40.18 | 44.33 | 88.75 | 93.13 | 21.10 | 55.91 | 107.66 | 132.54 |
| **S. Em ±** | 0.94 | 0.85 | 0.72 | 1.27 | 0.99 | 0.94 | 1.40 | 1.16 | 1.38 |
| **CD(P=0.05)** | NS | NS | 2.06 | 3.66 | 2.84 | NS | 4.04 | 3.34 | 3.98 |

Recommended Dose Fertilizer (RDF): - 120: 40: 40 kg $ha^{-1}$, Foliar spray of N: P: K (19: 19: 19) @ 1%

**Table: 2. Effect of levels and method of NPK fertilizer application on yield attributes and yield of wheat**

| Treatments | Yield attributes | | | | | Yield (kg ha$^{-1}$) | | | Harvest index (%) |
|---|---|---|---|---|---|---|---|---|---|
| | Effective Tillers mrl$^{-1}$ | Spike length (cm) | Spikelet spike$^{-1}$ | Grain spike$^{-1}$ | Test weight (g) | Grain yield | Straw yield | Biological yield | |
| **Fertilizer levels** | | | | | | | | | |
| **$F_0$** | 76.36 | 8.06 | 14.94 | 38.52 | 36.91 | 2545 | 3855 | 6401 | 39.76 |
| **$F_1$** | 106.91 | 8.58 | 15.38 | 40.60 | 38.89 | 3730 | 5409 | 9139 | 40.83 |
| **$F_2$** | 124.02 | 8.97 | 15.58 | 40.95 | 39.97 | 4152 | 5878 | 10180 | 40.79 |
| **$F_3$** | 132.41 | 9.45 | 15.73 | 41.17 | 40.69 | 4482 | 6310 | 10792 | 41.53 |
| **S. Em ±** | 1.85 | 0.10 | 0.19 | 0.33 | 0.64 | 89 | 108 | 130 | 0.74 |
| **CD(P=0.05)** | 6.41 | 0.34 | NS | 1.14 | 2.20 | 310 | 375 | 449 | NS |
| **Foliar spray @ 1 % N P K** | | | | | | | | | |
| **$S_0$** | 98.03 | 7.62 | 15.22 | 39.54 | 38.01 | 3326 | 4834 | 8197 | 40.43 |
| **$S_1$** | 105.00 | 8.44 | 15.27 | 39.96 | 38.79 | 3492 | 5079 | 8608 | 40.44 |
| **$S_2$** | 109.72 | 8.98 | 15.35 | 40.33 | 39.21 | 3666 | 5245 | 8949 | 40.90 |
| **$S_3$** | 117.51 | 9.30 | 15.50 | 40.75 | 39.64 | 4042 | 5759 | 9839 | 40.92 |
| **$S_4$** | 119.36 | 9.48 | 15.70 | 41.05 | 39.93 | 4111 | 5898 | 10047 | 40.94 |
| **S. Em ±** | 1.99 | 0.17 | 0.25 | 0.64 | 0.68 | 71 | 103 | 132 | 0.57 |
| **CD(P=0.05)** | 5.74 | 0.49 | NS | NS | NS | 204 | 298 | 381 | NS |

Recommended Dose Fertilizer (RDF): - 120: 40: 40 kg ha$^{-1}$, Foliar spray of N: P: K (19: 19: 19) @ 1%

**Table: 3. Effect of levels and method of NPK fertilizer application on economics of wheat**

| Treatments | Gross return (₹ $ha^{-1}$) | Net return (₹ $ha^{-1}$) | B C ratio |
|---|---|---|---|
| **Fertilizer levels** | | | |
| **$F_0$** | 62475 | 35097 | 1.28 |
| **$F_1$** | 90834 | 61202 | 2.06 |
| **$F_2$** | 100668 | 69909 | 2.27 |
| **$F_3$** | 108568 | 76682 | 2.40 |
| **S. Em ±** | 1770 | 1770 | 0.04 |
| **CD(P=0.05)** | 6125 | 6125 | 0.12 |
| **Foliar spray @ 1 % N P K** | | | |
| **$S_0$** | 81018 | 52857 | 1.85 |
| **$S_1$** | 85072 | 56034 | 1.91 |
| **$S_2$** | 89052 | 59138 | 1.96 |
| **$S_3$** | 98116 | 67326 | 2.16 |
| **$S_4$** | 99923 | 68257 | 2.13 |
| **S. Em ±** | 1485 | 1485 | 0.03 |
| **CD(P=0.05)** | 4279 | 4279 | 0.09 |

Recommended Dose Fertilizer (RDF): - 120: 40: 40 kg $ha^{-1}$, Foliar spray of N: P: K (19: 19: 19) @ 1%

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