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Influence of Soil and Foliar Nutrition on Growth, Yield and Economics of Wheat (*Triticum aestivum* L.)

Patel B. R., Chaudhari P. P., Hatti Veeresh

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ABSTRACT

A field experiment was conducted during *rabi* season of 2019-20 to study the effect of soil and foliar nutrition on growth, yield and economics of wheat at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar (Gujarat). The experiment was conducted using Randomized Complete Block Design with nine different treatments and four replications. Among different soil and foliar nutrition treatments, application of 50% RDF soil application + 2% foliar spray of urea, urea phosphate and MOP at 30, 45 and 60 DAS has recorded significantly higher growth parameters, grain, straw yield and higher gross, net realization and B:C ratio of wheat which remained statistically at par with 50% RDF through soil application + 2% foliar spray of soluble NPK (19:19:19) at 30, 45 and 60 DAS. Whereas, 100% RDF through soil application recorded lowest growth parameters, grain, straw yield and monetary realization.

Keywords: Wheat, Soil nutrition, Foliar nutrition, Yield, Economics.

Patel B. R.*, Chaudhari P. P., Hatti Veeresh
Department of Agronomy, CP. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar 385506, Gujarat, India
Email: bhautikpatel431@gmail.com
*Corresponding author

INTRODUCTION

Wheat (*Triticum* spp.) has been described as "Staff of life" or "King of cereals" and one of the most important staple food crop. Wheat belongs to *Poaceae* family and is the second important food grain crop of India next to rice. This is major responsible crop for the green revolution and mitigating the problem of food insecurity in India. About 35% of the world's population directly or indirectly depends upon wheat for food and it provides 20% of human dietary and serve as the main source of protein in developing nations. In India, wheat is the second most important cereal crop after rice covering an area of 29.5 million hectares. Total annual production of wheat in India is 99.51 Mt with the productivity of 3.37 t/ha during 2017-18. India is the second largest wheat producer (approximately 12% world's wheat production) and consumer after China (Dept of Agri and Farmers Welfare, 2018-19). The nutritive value of wheat is fairly high as compared to other cereals as it contains

11.80% protein, 1.50% fat, 71.20% carbohydrates, 1.50 per cent mineral matter, 0.50% calcium and 0.32% phosphorus (Swaminathan *et al.* 1981). Apart from being used as food, wheat grains also have industrial importance including manufacturing of paste, alcohol, gluten. Residues obtained after milling wheat grains i.e., bran is used as cattle feed. Wheat straw is utilized as a fodder for feeding the livestock and also used in manufacturing mattresses, straw hats, papers and art purposes.

Optimum nutrient supply in any crops/cropping system is an essential and foremost important practice to realize the yield potentiality of any crop (Hatti *et al.* 2018). Soil fertility and other agronomic practices play an indispensable role in determining the economic yield and wheat quality of wheat. Fertilizers have been and will continue to be the key inputs for achieving the estimated food grain production goals of the country. Application of fertilizers at proper time, in balance proportion and with appropriate method have a positive impact on crop yield. The importance of nitrogen, phosphorus and potassium application to wheat crop has been recognized since long and is the backbone of any fertilizer management program Nitrogen (N), phosphorus (P) and potassium (K) requirements are depend on the type of soil, climate, production practices, available moisture and cropping pattern. It is reported that 50 quintals of wheat grain per hectare can be secured with application of 100-150 kg nitrogen, 70-80 kg phosphorus and 125-150 kg potash (Mishra 1979). Foliar fertilization can complement soil fertilization. Crop responses to foliar application of nutrients can be seen in 3 to 4 days. Foliar fertilization can complement soil fertilization. Foliar fertilization will work as a visible economic way to supplement the plant nutrients for more efficient fertilization. Foliar fertilization will work as a visible economic way to supplement the plant nutrients for more efficient fertilization (Girma *et al.* 2007). Foliar application has advantages of quick and efficient utilization of nutrients, elimination of losses through leaching and fixation as well as regulating the uptake of nutrients by plant. Foliar nutrition is designed to eliminate the problems like fixation and immobilization of nutrients. Hence, foliar nutrition is recognized as an important method of fertilization in modern agriculture (Chaurasia *et al*. 2005). This method utilizes nutrients more efficiently and rapidly corrects deficiencies. Recently new generation special fertilizers have been introduced exclusively for foliar spray fertilization. Special fertilizers are a better source for foliar application. These fertilizers have differentiations of N, P and K which are highly water soluble and so amenable for foliar nutrition.

MATERIALS AND METHODS

A field experiment was conducted at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during *rabi* season of the year 2019-20. The location is situated at 24° 19' North latitude and 72° 19' East longitude with an elevation of 154.52 meters above the mean sea level. It is located in the North Gujarat Agro-climatic Zone of the Gujarat State. This zone is characterized by arid and semi-arid climate with fairly cold winter and hot and dry windy summer. The soil of the experimental field was loamy sand in texture, low in organic carbon (0.22%) and available nitrogen (165.8 kg ha^{-1}), medium in available phosphorus (43.8 kg ha^{-1}) and high in available potassium (330.9 kg ha^{-1}) with soil pH of 7.6. The experiment was comprised of nine treatments of different soil and foliar sprays viz., T_1 : 100% RDF soil application, T_2 : 75% RDF soil application +1% foliar sprays of urea, urea phosphate and MOP at 30 and 45 DAS , T_3 : 75% RDF soil application +1% foliar sprays of urea, urea phosphate and MOP at 30, 45 and 60 DAS, T_4 : 75% RDF soil application +1% foliar spray of soluble NPK (19:19:19) at 30 and 45 DAS, T_5 : 75% RDF soil application +1% foliar spray of soluble NPK (19:19:19) at 30, 45 and 60 DAS, T_6 : 50% RDF soil application + 2% foliar spray of urea, urea phosphate and MOP at 30 and 45 DAS, T_7 : 50% RDF soil application +2% foliar spray of urea, urea phosphate and MOP at 30, 45 and 60 DAS, T_8 : 50% RDF soil application +2% foliar spray of soluble NPK (19:19:19) at 30 and 45 DAS and T_9 : 50% RDF soil application +2% foliar spray of soluble NPK (19:19:19) at 30, 45 and 60 DAS. Land preparation was done by tractor drawn cultivator. Stubbles of the previous crop were collected and removed from the field. The entire quantity of recommended dose of phosphorus, potassium and half dose of nitrogen in form of DAP, MOP and urea respectively, were manually applied before sowing of wheat crop in the furrows as per treatments and properly covered with soil. The remaining half dose of nitrogen was applied in the form of urea in two equal splits (25% at CRI and 25% at flag leaf stage) after 2nd and 5th irrigation in each treatment plots. Whereas, foliar spay was applied as per the treatments. The previous crop grown on the experimental site was cowpea in *kharif* 2019-20. A pre-emergence application of pendimethalin @ 0.75 kg ha^{-1} on next day of sowing using Knapsack sprayer and one hand weeding at 40 DAS was done to manage the weeds. Total nine irrigations were given to wheat crop depending on soil and environmental conditions. Wheat variety 'Gujarat Wheat 451' was sown, keeping seed rate of 120 kg ha^{-1} with inters row spacing of 22.5 cm, after seed treatment with Fipronil 5 SC @6 ml kg^{-1} seed. The seeds were uniformly sown at 4 - 4.5 cm deep in a previously opened furrows on 17th Nov, 2019. Five previously tagged plants from each net plot were selected for recording growth and yield attributes. Grain and straw yield was computed from the plants harvested from net plot in each treatment. All the observations were made using standard procedures. The statistical analysis of the data generated during the course of investigation was carried out by following the procedure described by Cochran and Cox (1967). The different sources of variation in ANOVA were tested by "F-test" and compared with the value of Table F at 5% level of significance. SEm.±, critical differences and co-efficient of variance (CV %) were also worked out. Correlation and regression studies were done as suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Growth attributes and yield

The perusal of data on plant height at harvest (Table 1) reveals that plant population per meter row length at 20 DAS and at harvest and days to physiological maturity of wheat were not significantly differed by different soil and foliar nutrition treatments. Among different treatments, plant height and effective tillers per meter row length were found significantly higher in 50% RDF through soil application + 2% foliar spray of urea, urea phosphate and MOP at 30, 45 and 60 DAS treatment (87.04 cm and 102.41, respectively) which was on par with 50% RDF soil application along with various foliar sprays like

Table 1. Growth attributes and yield of wheat as influenced by different nutrient management treatments.

Treatments	Plant population per m row length at 20 DAS	Plant population per m row length in harvest	Plant height (cm) at harvest	Days to physiological maturity
T_1: 100% RDF soil application	27.50	25.16	72.00	99.75
T_2: 75% RDF soil application +1% foliar spray of urea, urea phosphate and MOP at 30 and 45DAS	26.35	24.93	76.69	104.00
T_3: 75% RDF soil application +1% foliar spray of urea, urea phosphate and MOP at 30, 45 & 60 DAS	27.29	25.11	78.17	105.75
T_4: 75% RDF soil application +1% foliar spray of soluble NPK (19:19:19) at 30 and 45 DAS	26.08	24.80	73.50	104.25
T_5: 75% RDF soil application +1% foliar spray of soluble NPK (19:19:19) at 30, 45 and 60 DAS	27.13	25.01	77.76	105.00
T_6: 50% RDF soil application +2% foliar spray of urea, urea phosphate and MOP at 30 and 45DAS	27.97	26.22	80.80	106.00
T_7: 50% RDF soil application +2% foliar spray of urea, urea phosphate and MOP at 30, 45 and 60 DAS	28.12	26.75	87.04	107.50
T_8: 50% RDF soil application +2% foliar spray of soluble NPK (19:19:19) at 30 and 45 DAS	27.58	26.13	80.50	105.00
T_9: 50% RDF soil application +2% foliar spray of soluble NPK (19:19:19) at 30, 45 and 60 DAS	28.08	26.37	84.85	106.50
SEm ±	0.92	0.90	2.93	2.63
CD (P=0.05)	NS	NS	8.56	NS
CV%	6.72	7.06	7.43	5.02

Table 1. Continued.

Treatments	Effective tillers per meter row length	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)
T_1: 100% RDF soil application	85.12	3598	4353	45.06
T_2: 75% RDF soil application +1% foliar spray of urea, urea phosphate and MOP at 30 and 45 DAS	87.64	3896	4765	45.07
T_3: 75% RDF soil application +1% foliar spray of urea, urea phosphate and MOP at 30, 45 and 60 DAS	92.43	3993	4827	45.39
T_4: 75% RDF soil application +1% foliar spray of soluble NPK (19:19:19) at 30 and 45 DAS	86.18	3812	4610	45.10
T_5: 75% RDF soil application +1% foliar spray of soluble NPK (19:19:19) at 30, 45 and 60 DAS	91.15	3904	4763	45.04
T_6: 50% RDF soil application +2% foliar spray of urea, urea phosphate and MOP at 30 and 45DAS	97.36	4044	4861	45.49
T_7: 50% RDF soil application +2% foliar spray of urea, urea phosphate and MOP at 30, 45 and 60 DAS	102.41	4543	5527	45.19
T_8: 50% RDF soil application +2% foliar spray of soluble NPK (19:19:19) at 30 and 45 DAS	96.63	3986	4829	45.31
T_9: 50% RDF soil application +2% foliar spray of soluble NPK (19:19:19) at 30, 45 and 60 DAS	98.63	4405	5383	45.03
SEm±	3.86	169	226	1.20
CD (p=0.05)	11.26	493	660	NS
CV %	8.29	8.41	9.26	5.33

2% soluble NPK (19:19:19) at 30, 45 and 60 DAS, 2% urea, urea phosphate and MOP at 30 and 45 DAS and 2% soluble NPK (19:19:19) at 30 and 45 DAS and followed by other treatments. Whereas, significantly lower plant height and effective tillers per meter row length were recorded under 100% RDF through soil application (72.00 cm and 85.12, respectively). The higher plant height and effective tillers per meter row length in 50% RDF through soil application +2% foliar spray of urea, urea phosphate and MOP at 30, 45 and 60 DAS treatment might be due to soil as well as foliar application of nutrients which resulted in optiun nutrient supply and hence increased the activity of meristimatic cell and cell elongation as they are known to have favorable effects on metabolic process and better vegetative growth. These results are in conformity with the findings of Arif *et al.* (2006) who observed significant increase in wheat growth with foliar application of different nutrients individually or in combination. The results are also attributed to higher dry matter production in source area due to foliar application of nutrients at different vegetative stages of wheat which increase translocation of photosynthesis from source (leaves and stem) to sink (spike and grains). Similar results were also reported by Wagan *et al.* (2017), Jarecki *et al.* (2017) and Vijayakumar *et al*. (2019).

Table 2. Correlation and regression relationship between growth parameters and yield as influenced by different nutrient management treatments.

Dependent variable (Y)	Independent variable (X)	Correlation coefficient (r)	Regression equation	R^2
Grain yield (kg/ha)	Plant height at harvest (cm)	0.969	Y= -527.91+57.54x	0.939
	Effective tillers per meter row length	0.903	Y= -9.73+43.30x	0.816
Straw yield (kg/ha)	Plant height at harvest (cm)	0.962	Y= -769.06+71.47x	0.926
	Effective tillers per meter row length	0.881	Y= -38.19+52.85x	0.777

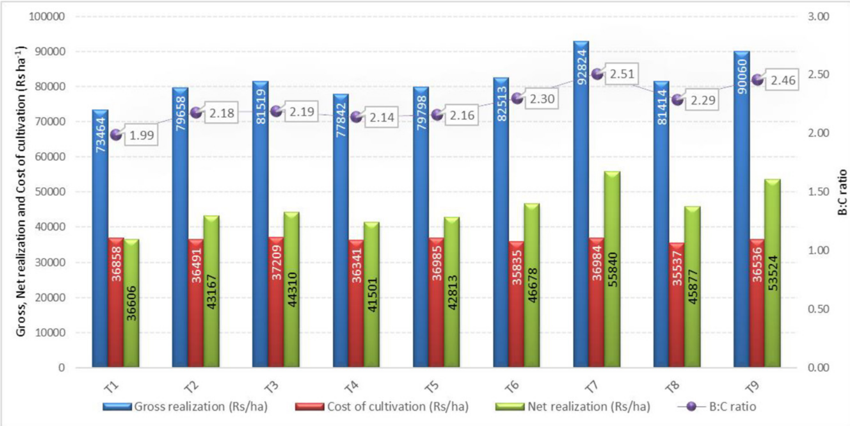

Fig. 1. Economics of wheat as influenced by different nutrient management treatments legend:

T_1: 100% RDF soil application
T_2: 75% RDF soil application +1% foliar spray of urea, urea phosphate and MOP at 30 and 45DAS
T_3: 75% RDF soil application +1% foliar spray of urea, urea phosphate and MOP at 30, 45 and 60 DAS
T_4: 75% RDF soil application +1% foliar spray of soluble NPK (19:19:19) at 30 and 45 DAS
T_5: 75% RDF soil application +1% foliar spray of soluble NPK (19:19:19) at 30, 45 and 60 DAS
T_6: 50% RDF soil application +2% foliar spray of urea, urea phosphate and MOP at 30 and 45DAS
T_7: 50% RDF soil application +2% foliar spray of urea, urea phosphate and MOP at 30, 45 and 60 DAS
T_8: 50% RDF soil application +2% foliar spray of soluble NPK (19:19:19) at 30 and 45 DAS
T_9: 50% RDF soil application +2% foliar spray of soluble NPK (19:19:19) at 30, 45 and 60 DAS

Yield

Crop yield is the complex function of physiological processes and biochemical activities, which modify plant anatomy and morphology of the growing plants. Application of 50% RDF soil application + 2% foliar spray of urea, urea phosphate and MOP at 30, 45 and 60 DAS gave significantly higher grain yield and straw yield (4543 and 5527 kg ha^{-1}, respectively) which was statistically found on par with 50% RDF soil application +2% foliar spray of soluble NPK (19:19:19) at 30, 45 and 60 DAS (4405 and 5383 kg ha^{-1}, respectively). While, significantly lower grain and straw yields were noticed in 100% RDF through soil application (3598 and 4353 kg ha^{-1}, respectively). The higher grain yield and straw yield with application of 50% RDF through soil +2% foliar spray of either urea, urea phosphate and MOP or soluble NPK (19:19:19) at 30, 45 and 60 DAS is due to improved wheat growth attributes like plant height and also due to more accumulation of dry matter in plant as evidenced by higher number of effective tillers per meter row length due to combined nutrient management through basal soil application of nutrients to meet initial vigorous growth requirement and foliar application of nutrients at different vegetative stages of wheat to meet later stage nutrients requirement which have led to higher dry matter production as indicated by higher straw yield which proportionately translocated the dry matter for grain development which reflected in increased grain yield (Table 1) (Fig. 1). The correlation and regression studies (Table 2) have also indicated that there is a positive correlation between plant height, effective tillers per meter row length with the grain yield (0.639 and 0.903, respectively) and straw yield (0.962 and 0.881, respectively). The quantification of relationship between growth attributes and yields have further indicated that each one cm increase in plant height and each one increase in effective tillers per meter row length of wheat results in increase in grain yield by 57.54 kg ha^{-1} and 43.30 kg ha^{-1}, respectively. Similarly, one cm increase in plant height and each one increase in effective tillers per meter row length of wheat results in increase in straw yield by 71.47 kg ha^{-1} and 52.85 kg ha^{-1}, respectively. These results are in complete agreement with those of Gul *et al*. (2011), Yassen *et al.* (2010), Gosavi *et al.* (2017), Shah *et al.* (2017), Jarecki *et al.* (2017) and Vijayakumar *et al*. (2019).

Economics

Due to higher grain and straw yields obtained, the maximum net realization of Rs 55840 ha^{-1} with B:C ratio of 2.51 was secured with treatment received 50% RDF through soil application +2% foliar spray of urea, urea phosphate and MOP at 30, 45 and 60 DAS followed by 50% RDF through soil application + 2% foliar spray of soluble NPK (19:19:19) at 30, 45 and 60 DAS (Rs. 53524 ha^{-1} and 2.46, respectively). Conversely, lowest value of net realization of Rs. 36606 ha^{-1} with B:C ration of 1.99 were witnessed under 100% RDF through soil application due to lower grain and straw yields recorded.

CONCLUSION

In light of the results obtained from present investigation, it is concluded that higher yield and net return from wheat could be obtained by fertilizing the crop with 50% RDF (120:60:40 kg N: P_2O_5: K_2O kg /ha) through soil application along with 2% foliar spray of either urea, urea phosphate and MOP or soluble NPK (19:19:19) at 30, 45 and 60 DAS in loamy sand soils of North Gujarat Agro-climatic Zone conditions.

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