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Effect of foliar spray of water soluble fertilizers on quality and economics of wheat (*Triticum aestivum* L.)

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Abstract
A field experiment entitled "Effect of foliar spray of water soluble fertilizers on growth, yield and quality of wheat (*Triticum aestivum* L.)" was carried out under medium black clayey slightly alkaline soil in reaction with pH 7.8 and EC 0.33 dS/m during rabi season of 2019-20 at the Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh. The experiment consisting of 12 treatment combinations. The results of experiments indicated that quality parameters *viz.*, protein content and protein yield in grain significantly higher with the application of 75% RDF + foliar spray of Urea @ 2% at 30 DAS, 60 DAS & 90 DAS. Application of 75% RDF + foliar spray of 19:19:19 @ 0.5% at 30 DAS, 60 DAS & 90 DAS gave significantly higher gross return of 75976/ha, net return of 41673/ha and benefit cost ratio (2.21) over 100% RDF and 75% RDF.

Keywords: Economic, quality, Water soluble fertilizer, and wheat

Introduction
These days, foliar feeding is a widely used crop management practice to ensure optimal crop performance. It does this through enhancing crop development at specific growth stages, addressing nutrient deficiencies in the crop, and fortifying crop tolerance in unfavourable settings. The technique of directly dousing crop canopy with liquid fertilizer—either in suspension or solution—to supply plants with nutrients is known as foliar feeding. When combined with soil fertiliser and administered properly, it can be more affordable, safe for the environment, focused on specific goals, and efficient.

When soil fertiliser is applied foliarly, some of the drawbacks of conventional fertilisation are circumvented. These include leaching, precipitation of insoluble fertilisers, antagonistic interactions between specific nutrients, heterogeneous soils that are unsuitable for low dosages, and fixation/absorption reactions involving phosphorus and potassium. Foliar sprays should only be applied with fertilisers that have a low salt index, high solubility, and Its scope includes all water-soluble fertilisers (WSF), slow-release fertilisers, micronutrients, and customised fertilisers. Water-soluble fertilisers are available in a variety of formulas with varying amounts of nitrogen, potassium, and phosphorus (NPK), but they may also include micronutrients or other nutrients. A wide range of crops, including fruits, vegetables, cereals, oil seeds, pulses, cotton, coriander, tobacco, sugarcane, and tea, are grown with greater yields and higher quality thanks to the application of water soluble fertilisers as chemical fertilisers in sprinkler and drip irrigation systems and foliar sprays. Applying water-soluble fertilisers topically to crops has been shown to positively affect their growth, quality, and yield [5]. Foliar nutrition is therefore acknowledged as a crucial technique of fertilisation in contemporary agriculture. A great way to treat nutrient deficits and give essential nutrients to a crop that needs a lot of them is through foliar fertilisation. Crop wastes and leaves have more nutrients as a result of this. When a plant's physiological ability to absorb nutrients from the soil is diminished in the late growing season, it can effectively supply nutrients to the plant. Foliar fertilisation has a significant potential to boost yield in intensive farming systems when used in conjunction with soil fertilisation.

Materials and Methods
Field experiment was conducted at Instructional Farm, Junagadh Agricultural University, Gujarat, (21°51´ N latitude and 70°55´ E longitude), during rabi 2019-20 season. Soil was medium black clayey in texture (pH 7.8, EC 0.33 d S m^{-1}. RDF was applied as soil application through Urea, DAP and MOP. P_2O5 and K_2O was applied as basal at sowing of crop, while nitrogen applied in three splits i.e. 25% at sowing, 50% at 25 DAS and 25% at 35 DAS).

The experimental field was laid out in randomized block design comprising of 8 treatments and 3 replications i.e., T_1 100% RDF T_2 – 75% RDF (control), T_3 – T_2 + foliar spray (FS) of Urea @ 2% at 30 DAS, T_4 – T_2 + FS of Urea @ 2% at 30 DAS & 60 DAS, T_5 – T_2 + FS of Urea @ 2% at 30 DAS, 60 DAS & 90 DAS, T_6 - T_2 + FS of 19:19:19 @ 0.5% at 30 DAS, T_7 – T_2 + FS of 19:19:19 @ 0.5% at 30 DAS & 60 DAS, T_8 – T_2 + FS of 19:19:19 @ 0.5% at 30 DAS, 60 DAS & 90 DAS, T_9-T_2 + FS of Urea @ 2% at 30 DAS + FS of 19:19:19 @ 0.5% at 60 DAS, T_{10}- T_2 + FS of Urea @ 2% at 30 DAS + FS of 13:00:45 @ 0.5% at 60 DAS, T_{11}-T_2 + FS of Urea @ 2% at 30 DAS + FS of 19:19:19 @ 0.5% at 60 DAS + FS of 13:00:45 @ 0.5% at 90 DAS and T_{12}-T_2 + FS of 19:19:19 @ 0.5% at 30 DAS + FS of 13:00:45 @ 0.5% at 60 DAS. Wheat was grown under GW 463 variety. The initial plant population was noted at 60 days after sowing and at harvest This was accomplished by calculating the number of plants per hectare based on the no. of plants per 1 meter row length from three different spots within each net plot area. The original plant population was noted at harvest and 60 days after sowing. Each net plot's output was threshed and cleaned separately, and the grain yield was calculated in kilograms per net plot. On a hectare basis, the grain yield per net plot was changed to kilograms. Analysis of variance (ANOVA) was performed on the experiment's data in excel sheet accordance with Gomez and Gomez's [6].

Results and Discussion

Protein content in grain (%): Table 1 presents information on the protein content of grain as affected by different treatments as well as statistical inference. The data in Table 1.1 clearly show the results of the analysis of variance, which showed that increasing the foliar spray of water soluble fertilisers significantly affected the protein content of grain. Application of 75% RDF + foliar spray of Urea @ 2% at 30 DAS, 60 DAS & 90 DAS (T_5) recorded significantly higher protein content (12%), but at par with 75% RDF + foliar spray of Urea@ 2% at 30 DAS + foliar spray of 19:19:19 @ 0.5% at 60 DAS (T_9) and 75% RDF + foliar spray of Urea @ 2% at 30 DAS + Foliar spray of 19:19:19 @ 0.5% at 60 DAS + foliar spray of 13:00:45 @ 0.5% at 90 DAS (T_{11}). while significantly the lower protein content (7.07%) was recorded under treatment 75% RDF (T_2).

Protein yield (kg/ha): Table 1. provides information on the protein content of grain as influenced by different treatments as well as statistical inference. The findings shown in Table 1.1 clearly demonstrate the analysis of variance, which shows that increasing the foliar spray of water soluble fertilisers significantly affected the protein content of grain. Application of 75% RDF + foliar spray of Urea @ 2% at 30 DAS, 60 DAS & 90 DAS (T_5) recorded significantly higher protein content (12%), but at par with 75% RDF + foliar spray of Urea@ 2% at 30 DAS + foliar spray of 19:19:19 @ 0.5% at 60 DAS (T_9) and 75% RDF + foliar spray of Urea @ 2% at 30 DAS + Foliar spray of 19:19:19 @ 0.5% at 60 DAS + foliar spray of 13:00:45 @ 0.5% at 90 DAS (T_{11}). while significantly the lower protein content (7.07%) was recorded under treatment 75% RDF (T_2).

Table 1: Protein content in grain and Protein yield of wheat as influenced by different treatments

Tr. No.	Treatments	Protein content in grain (%)	Protein yield (kg ha^{-1})
T_1	100% RDF	9.57	328
T_2	75% RDF (control)	7.07	203
T_3	75% RDF + foliar spray of Urea @ 2% at 30 DAS	9.04	283
T_4	75% RDF + foliar spray of Urea @ 2% at 30 DAS & 60 DAS	8.46	275
T_5	75% RDF + foliar spray of Urea @ 2% at 30 DAS, 60 DAS & 90 DAS	12	389
T_6	75% RDF + foliar spray of 19:19:19 @ 0.5% at 30 DAS	7.94	311
T_7	75% RDF + foliar spray of 19:19:19 @ 0.5% at 30 DAS & 60 DAS	8.64	352
T_8	75% RDF + foliar spray of 19:19:19 @ 0.5% at 30 DAS, 60 DAS & 90 DAS	8.23	386
T_9	75% RDF + foliar spray of Urea @ 2% at 30 DAS + foliar spray of 19:19:19 @ 0.5% at 60 DAS	11.07	484
T_{10}	75% RDF + foliar spray of Urea @ 2% at 30 DAS + foliar spray of 13:00:45 @ 0.5% at 60 DAS	9.97	408
T_{11}	75% RDF + foliar spray of Urea @ 2% at 30 DAS + Foliar spray of 19:19:19 @ 0.5% at 60 DAS + foliar spray of 13:00:45 @ 0.5% at 90 DAS	10.32	436
T_{12}	75%RDF + foliar spray of 19:19:19 @ 0.5% at 30 DAS +foliar spray of 13:00:45 @ 0.5% at 60 DAS	9.68	397
	S.Em.±	0.45	15.99
	C.D. at 5%	1.33	46.90
	C.V.%	7.85	7.20

The details of gross realization, net realization and benefit cost ratio (BCR) for different treatments of water soluble fertilizers were worked out and are presented in table 2. The perusal of data given in Table 2 showed that the highest gross realization (₹ 75976 ha^{-1}) from wheat crop was secured from treatment receiving 75% RDF + foliar spray of 19:19:19 @ 0.5% at 30 DAS, 60 DAS & 90 DAS (T_8). the highest net realization (₹ 41673 ha^{-1}) and BCR (2.21) from wheat crop was secured from treatment receiving 75% RDF + foliar spray of 19:19:19 @ 0.5% at 30 DAS, 60 DAS & 90 DAS (T_8). The next treatment in view of gross realization was 75% RDF + foliar spray of Urea @ 2% at 30 DAS + foliar spray of 19:19:19 @ 0.5% at 60 DAS (T_9) which recorded the gross realization of ₹ 70988 ha^{-1} and the next treatment in view of net realization and BCR was also same treatment 75% RDF + foliar spray of Urea @ 2% at 30 DAS + foliar spray of 19:19:19 @ 0.5% at 60 DAS (T_9) with net realization 37848 kg/ha and BCR value 2.14. The lowest gross realization (₹ 46994 ha^{-1}), net realization (₹ 15424 ha^{-1}) and BCR (1.49) with treatment 75% RDF (T_2)

Table 2: Economics of different treatments

Treatments	Yield (kg ha^{-1})		Gross return (₹ /ha)	Cost of cultivation (₹ /ha)	Net return (₹ /ha)	B:C ratio
	Grain	Straw				
T_1	342 5	4759	55823	33184	22640	1.68
T_2	2868	4508	46994	31571	15424	1.49
T_3	3126	5057	51220	32229	18991	1.59
T_4	3246	5008	53090	32887	20203	1.61
T_5	3241	4959	53035	33545	19491	1.58
T_6	3918	5079	63649	32481	31167	1.96
T_7	4069	5159	66046	33392	32654	1.98
T_8	4688	5689	75976	34303	41673	2.21
T_9	4369	5683	70988	33139	37848	2.14
T_{10}	4092	5398	66523	33139	33383	2.01
T_{11}	4228	5401	68646	34050	34595	2.02
T_{12}	4102	5276	66618	33392	33225	2.00

Discussion

Among the grain quality parameters studied in different treatments, protein content is an important component of wheat. Significantly higher protein content was recorded with application 75% RDF + foliar spray of Urea @ 2% at 30 DAS, 60 DAS & 90 DAS (T5) recorded significantly higher protein content (12%) and remained at par 75% RDF + foliar spray of Urea @ 2% at 30 DAS + foliar spray of 19:19:19 @ 0.5% at 60 DAS (Table 1.). Since, the higher nitrogen supply through foliar application at different crop growth stages resulted in enhancement of protein content of seeds, suggesting that hydrocarbons synthesized during photosynthetic process are diverted to form more of proteins. These results are in support with the findings of Amany (2007) [1] and Venkatesh and Basu (2011) [9].

The acceptance of any generated technology is ultimately depends on the economics involved in the crop production. Among the different indicators of monetary Discussion 72 efficiency in any production system, the economics in terms of net returns and the benefit cost ratio have a greater impact on the practical utility and acceptance of the technology. In the present investigation, the significantly maximum gross returns, net returns and B:C ratio was obtained with the application of 75% RDF + foliar spray of 19:19:19 @ 0.5% at 30 DAS, 60 DAS and 90 DAS (Table 2). This might be attributed to higher grain and straw yields obtained with comparatively less cost than additional income under these treatments. Similar results were also reported by Palaniappan *et al*. (1999) [7], Karpagam *et al*. (2004) [4], Chaurasia *et al*. (2005) [2], Premsekhar and Rajashree (2009) [8], Kamal *et al*. (2011) [3], Mukundgowda *et al*. (2015) [6] and Mudalagiriyappa *et al*. (2016) [5].

Conclusion

Foliar spray of water soluble fertilizers had significant influence on protein content of grain. Application of 75% RDF + foliar spray of Urea @ 2% at 30 DAS, 60 DAS & 90 DAS (T_5) recorded significantly higher protein content (12%), but at par with 75% RDF + foliar spray of Urea @ 2% at 30 DAS + foliar spray of 19:19:19 @ 0.5% at 60 DAS (T_9) and 75% RDF + foliar spray of Urea @ 2% at 30 DAS + Foliar spray of 19:19:19 @ 0.5% at 60 DAS + foliar spray of 13:00:45 @ 0.5% at 90 DAS (T_{11}). while significantly the lower protein content (7.07%) was recorded under treatment 75% RDF (T_2). 2. Application of 75% RDF + foliar spray of 19:19:19 @ 0.5% at 30 DAS, 60 DAS & 90 DAS gave maximum gross return (₹ 75976/ha), net return (₹ 41673/ha) with B:C ratio of 2.21.

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