Original Research Article

Influence of Different Levels and Methods of N P K Fertilizer Application on the Growth and Production of Wheat (*Triticum aestivum* L.) 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 to find out the Influence of different levels and methods of N P K fertilizer application on the growth and production of wheat (*Triticum aestivum* L.) 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 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). 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. Similarly, three foliar spray of soluble N: P: K recorded maximum growth and yield attributes as well as grain and straw yield of wheat over rest of treatments but remained statistically at par with four foliar spray. The same treatment also recorded significantly higher gross & net returns (₹ 98116 ha^{-1} and ₹ 67326 ha^{-1}, respectively) with B: C ratio of 2.16 in comparison to rest levels of foliar fertilization except four foliar spray of soluble N: P: K.

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

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is belong to gramineae family and 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”. India stands in second position next to china in the world with regard to area and production of wheat. In India, wheat is grown

on 29.14 million hectares with total production of 102.19 million tonnes with average productivity of 3507 kg ha^{-1} [1]. Rajasthan contributed 10.49 million tonnes of wheat from 3.0 million hectares area with productivity of 3501 kg ha^{-1} [1] to the national pool. 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. Therefore, to increase crop yields, it is important to adopt proper nutrient management. In this way, 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 recognized to be more effective compared to nutrients application in the soil, because of effective utilization by plant and minimum cost per unit area (Narang et al., 1997). The use of fertilizers is one of the most important management systems for crops (ref), but excessive addition of chemical fertilizers in crops represents a major ecological threat 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. This process contributes to reduce the quantities of fertilizers added while ensuring the benefit of fertilizers (Haytova, 2013). Given the above considerations, the adoption and application of a recommended dose of fertilizers to the soil in conjunction with foliar fertilization is a current need. This can improve crop productivity and cost-effectiveness, and helps to the rational use of fertilizers."

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). 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 experiment was conducted in a split plot design with three replications. The treatments consisted of four fertility levels in the main plot and five spray-level for foliar fertilization with soluble N P K in the sub plots. The four treatments were: F_0 - control, F_1 - 50% recommended dose of fertilizer (RDF), F_2 - 75% recommended dose of fertilizer (RDF), and F_3 - 100% recommended dose of fertilizer (RDF). The five spray-level for foliar fertilization were: 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), and S_4- four spray (45, 60, 75 & 90 DAS). Crop was sown on November 26 and harvested on April 1st in the 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 (45, 60 & 75 DAS). Five plants were selected randomly from each plot for the measurements of the plant height, dry matter accumulation per meter row length, spike length, spikelets $spike^{-1}$ & grain $spike^{-1}$ and per meter row length area were selected for the measurement of plant stand, dry-matter accumulation and effective tillers. After harvesting, the grain yield was recorded per plot and then converts into kg/ha. 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).

3. RESULTS AND DISCUSSION

Effect of RDF levels: -. 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 accumulation per meter row length 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 supported by

Hashim *et al.* (2015) and Choudhary *et al*. (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 spray @ 1 % 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 dry matter accumulation 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 may be due to the quick absorption of nitrogen, phosphorus and potash 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). Effective tillers and length of spike were recorded significantly higher with three foliar spray over rest of spray but closely at par four foliar spray. This might be due to 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). 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. 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 (grain) by increasing the photosynthesizing area and its capacity of particular crop (Kumar 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. Three foliar spray of soluble N: P: K observed the significantly higher gross and net return (98116 and 67326 ₹ ha^{-1}) over rest of the treatments, but statistically at par with four foliar spray of soluble N:P:K (99923 and 68257 ₹ ha^{-1}). (Sharma, 2016 and Bairwa *et al.* 2018). Three foliar spray of soluble N: P: K observed the significantly higher 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 (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. We suggested to farmer on the result of our experiment if four foliar application of NPK then we got maximum yield and net return.

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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