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RATES AND METHODS OF NITROGEN AND SULFUR APPLICATION INFLUENCE AND COST BENEFIT ANALYSIS OF WHEAT

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ABSTRACT

The field study was conducted at New Developmental Farm, Khyber Pukhtunkhwa Agricultural University, Peshawar, Pakistan for economic analysis of different nitrogen and sulfur application methods on grain and straw yield of wheat as well as found its cost benefit analysis in Peshawar region. The findings of the study showed that the maximum total cost in rupees (Rs.9251/-) that vary was found for treatment number-8 [60 kg N/ha at sowing + 40 kg N/ha at tillering + 10 kg N/ha at anthesis (Foliar) +10 kg N/ha after anthesis (Foliar)] + [15 kg S/ha at sowing + 10 kg S/ha at anthesis (Foliar) + 5 kg S/ha after anthesis (Foliar)] and the gross field benefit obtained from the concern treatment was (Rs.162205/-) and its net benefit was (Rs.152953/-). While the no fertilizers (check plots) treatment showed a net benefit of (Rs.91826/-) having gross field benefit of (Rs.91826/-). More specifically treatment number - 8 presented maximum net return as well as maximum gross income compared with other treatments as its grain as well as straw yield resulted high yields as compared with other treatments.

Keywords: wheat, foliar applied N and S, soil applied N and S, economic analysis, grain yield, straw yield.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most widely cultivated of all the cereal and is the major source of nourishment. Wheat requirements in Pakistan are growing at an exorbitant rate due to its rapid expansion in population. Balance use of fertilizers and agronomic measures are needed to raise production of this crop. The role of macro and micro nutrients is crucial in crop nutrition for achieving higher yields (Raun and Jhonson, 1999). The soils of Pakistan are deficient in nitrogen and are supplemented with chemical fertilizers for enhancing crop productivity. Balanced nutrition is an essential component of nutrient management and plays a significant role in increasing crop production and its quality. For the major processes of plant development and yield formation the presence of nutrients like N, P, K, S and Mg etc in balance form is essential (Randhawa and Arora 2000).

The low efficiency of high analysis chemical fertilizers particularly nitrogen on one hand and wide spread deficiency of secondary nutrient elements on the other hand are raising concerns in wheat production. In recent years sulfur particularly under intensive agriculture is receiving greater attention throughout the world and according to McCune (1982), sulfur nutrition is more important for higher and sustained wheat production in tropics and subtropics. A part from the yield influences, nitrogen and sulfur being the part and parcel of protein blocks are important for obtaining quality grains.

There are many factors responsible for high yield in wheat. Among them fertilizer management is considered the major factor. Further the fertilizer management practices should be performed in a way that one can obtain maximum output with minimum inputs. The present price hike of fertilizers is one of the main constraints to increase the economic yield of crops. Thus efforts are needed to minimize its losses and to enhance its economic use.

Looking the economic importance of soil and foliar application of sulfur and nitrogen on wheat, an experiment was designed to find out the impact of nitrogen and sulfur application methods on straw and grain yield and cost benefit analysis of wheat in Khyber Pukhtunkhwa region.

MATERIALS AND METHODS

Site description and experimental design

Experiment was conducted at New Developmental Farm of Khyber Pakhtunkhwa Agricultural University Peshawar, Pakistan during 2008-09 and 2009-10. Soil of the experimental site is clay loam, low in nitrogen (0.03-0.04 %), low in organic matter (0.8-0.9 %), extractable phosphorus (6.57 mg kg^{-1}), exchangeable potassium (121 mg kg^{-1}) and alkaline in reaction with a pH of 8.0-8.2 (Amanullah *et al*., 2009). A basal dose of P (100 kg/ha) and K (60 kg/ha) was applied at sowing. Urea was applied as a source for nitrogen and ammonium sulphate was applied as a source for sulfur. In which half dose of urea and ammonium sulphate was applied at the time of sowing and the remaining half dose of both was applied at different growth stages. The experimental setup was randomized complete block (RCB) design having four replications. Subplots size was 5m x 3m having 10 rows 5m long and 30cm apart. Two varieties Pirsabaq-2005 and Khyber-87 were used.

Fertilizer treatments

Details of the fertilizer treatments are as follows:
Control: without fertilization (CK) (treatment number-1);

Recommended dose of N (60 kg N/ha at sowing + 60 kg N/ha at tillering) (treatment number-2);
Soil applied N (60 kg N/ha at sowing + 40 kg N/ha at tillering + 10 kg N/ha anthesis + 10 kg N/ha after anthesis) (treatment number-3);
Soil+ foliar applied N [60 kg N/ha at sowing + 40 kg N/ha at tillering + 10 kg N/ha at anthesis (foliar) +10 kg N/ha after anthesis (foliar)] (treatment number-4);
Soil applied S (15 kg S/ha at sowing + 10 kg S/ha at anthesis + 5 kg S/ha after anthesis) (treatment number-5);
Soil+ foliar applied S [(15 kg S/ha at sowing + 10 kg S/ha at anthesis (foliar) + 5 kg S/ha after anthesis (foliar)] (treatment number-6);
Soil applied N + soil applied S (combination of soil applied N and soil applied S) (treatment number-7);
Soil and foliar applied N + soil and foliar applied S (combination of soil + foliar applied N and soil + foliar applied S) (treatment number-8).

Economic analysis

Net benefit

It is the total benefit minus total cost.

Gross benefit

It is the actual cost of materials, production cost, transport cost, each and everything that incurs a cost before the end product.

Dominance analysis

It was done to arrange the treatments in ascending order with corresponding net benefit, eliminating the dominated treatments.

Marginal rate of return (MRR)

It was performed through marginal analysis. This presented the non dominated treatments on a net benefit curve and calculated the MRR between pair of adjacent treatments. Compared the MRR to minimum rate of return in order to select acceptable treatments.

RESULTS AND DISCUSSIONS

The details of economics of two wheat varieties using different nitrogen and sulfur treatment combinations are presented in Table-1. The concern data revealed that different fertilizer treatments of nitrogen and sulfur application reported significant and positive effect on grain and straw yield for best economic return. The maximum total cost of 9251PKR ha^{-1} that vary was found for treatment number-8 [60 kg N/ha at sowing + 40 kg N/ha at tillering + 10 kg N/ha at anthesis (foliar) +10 kg N/ha after anthesis (foliar)] + [(15 kg S/ha at sowing + 10 kg S/ha at anthesis (foliar) + 5 kg S/ha after anthesis (foliar)] presented in Table-1 (part- A) and the gross field benefit obtained from the concern treatment was 162205 PKR and its net benefit was 152953 PKR shown in Table-1 (Part- B). While no fertilizers (control plots) treatment showed a net benefit of 91826 PKR having grossed field benefit of 91826 PKR reported in Table-1 (part- B). More specifically treatment number -8 [60 kg N/ha at sowing + 40 kg N/ha at tillering + 10 kg N/ha at anthesis (foliar) +10 kg N/ha after anthesis (foliar)] + [(15 kg S/ha at sowing + 10 kg S/ha at anthesis (foliar) + 5 kg S/ha after anthesis (foliar)] presented maximum net return as well as maximum gross income compared with other treatments as its grain yield (4644 $kgha^{-1}$) as well as straw yield (8458 $kgha^{-1}$) resulted high yields as compared with other treatments (Table-1 part B). The increase in grain yield with different rates of nitrogen and sulfur application at different growth stages of wheat was the possible cause of higher net return. Different rates and methods of nitrogen and sulfur application at various growth stages opposed the findings of Mariga *et al*., (2000) who reported that nitrogen application at different rates and growth stages is uneconomical because of the higher labor cost. The differential response between our results and the results drawn by Mariga *et al*., (2000) probably may be due to the difference in transportation charges, labor cost, rate and methods of fertilizer application, variation in genetic makeup of varieties and response of varieties to fertilizers application under different environments. It was also observed from Table-1 (part- A and B) that there is a consistent variation among all the treatments in ascending sequence. Through dominance analysis all the treatments were arranged in ascending order with correspondence to net benefit and eliminating the dominated treatments. This analysis reported treatments number-2 which is recommended practice (60 kg N/ha at sowing + 60 kg N/ha at tillering), treatment number-3 which is four splits of soil application of nitrogen (60 kg N/ha at sowing + 40 kg N/ha at tillering + 10 kg N/ha anthesis + 10 kg N/ha after anthesis) and treatment number-4 which is four splits of soil and foliar application N [60 kg N/ha at sowing + 40 kg N/ha at tillering + 10 kg N/ha at anthesis (foliar) +10 kg N/ha after anthesis (foliar)] as dominated treatments. The increase in net return of the dominated treatments may due to maximum grain as well as straw yields. This statement is supported by Gehl *et al*., (2005), who suggested that efficient use of nitrogen for maize production is important for increasing grain yield and maximizing economic return. From calculation of marginal rate of return ignoring the dominating treatments it was found that during pair comparison of no fertilizer vs. treatment -5 (15 kg S/ha at sowing + 10 kg S/ha at anthesis + 5 kg S/ha after anthesis) it was suggested that the marginal rate of return MRR of treatment-5 (15 kg S/ha at sowing + 10 kg S/ha at anthesis + 5 kg S/ha after anthesis) and treatment number-1 (control practice) was 763 % presented in Figure-a. Similarly the marginal rate of return MRR of treatment-5 (15 kg S/ha at sowing + 10 kg S/ha at anthesis + 5 kg S/ha after anthesis) and treatment-6 [(15 kg S/ha at sowing + 10 kg S/ha at anthesis (foliar) + 5 kg S/ha after anthesis (foliar)] investigated that the cost on treatment-6 [(15 kg S/ha at sowing + 10 kg S/ha at anthesis (foliar) + 5 kg S/ha after anthesis (foliar)] was 150 PKR and the benefit obtained was 2861 PKR and its MRR was 1907 % shown in Figure-a. Likewise marginal rate of return MRR calculation of

treatment-6 [(15 kg S/ha at sowing + 10 kg S/ha at anthesis (foliar) + 5 kg S/ha after anthesis (foliar)] and treatment number-7 [(60 kg N/ha at sowing + 40 kg N/ha at tillering + 10 kg N/ha anthesis + 10 kg N/ha after anthesis) + (15 kg S/ha at sowing + 10 kg S/ha at anthesis + 5 kg S/ha after anthesis)] presented that the MRR for treatment-7 was 322% shown in Figure-a and its cost was 3825 PKR and its benefit was 12331 PKR which is more than treatment-6 [(15 kg S/ha at sowing + 10 kg S/ha at anthesis (foliar) + 5 kg S/ha after anthesis (foliar)] (Table-1 part C). While from pair comparison of treatment-7 [(60 kg N/ha at sowing + 40 kg N/ha at tillering + 10 kg N/ha anthesis + 10 kg N/ha after anthesis) + (15 kg S/ha at sowing + 10 kg S/ha at anthesis + 5 kg S/ha after anthesis)] and treatment number 8 [60 kg N/ha at sowing + 40 kg N/ha at tillering + 10 kg N/ha at anthesis (foliar) +10 kg N/ha after anthesis (foliar)] + [(15 kg S/ha at sowing + 10 kg S/ha at anthesis (foliar) + 5 kg S/ha after anthesis (foliar)] presented in Table-1 (part A) for calculation of MRR resulted that the benefit obtained from treatment-7 was higher 12331 PKR than treatment-8 6838 PKR. From the marginal of treatment-5 and treatment number-7 as well as treatment-5 and treatment number-8 it was proposed that the MRR for treatment-7 was found 382 % and that for treatment-8 was reported as 534 % (Table-1 part C). Keeping aside the economic advantage of all the fertilizer treatments, the trend between net benefit and total cost presented a sequential increased from treatment number-1 (control treatment) to treatment number-8 [60 kg N/ha at sowing + 40 kg N/ha at tillering + 10 kg N/ha at anthesis (foliar) +10 kg N/ha after anthesis (foliar)] + [(15 kg S/ha at sowing + 10 kg S/ha at anthesis (foliar) + 5 kg S/ha after anthesis (foliar)] presented in Figure-1.

Table 1. Economic analysis of fertilizers experiment on two wheat varieties based on average of the two varieties.

Part (A): Calculation of total cost that vary

Fertilizers	**Pak rupees**			
	Market price	**Transportation charges**	**Field price**	**Nutrient field price**
One bag of 50 kg urea	900	50	950	41.30 /kg N
One bag of 50 kg ammonium sulfate	1800	50	1850	
Price of N in Ammonium Sulfate 21% N			433.7	
Price of S in one bag of Ammonium sulfate 23 % S			1416.3	123.16 /kg S

Treatment #	Treatment details [So stand for soil, F stands foliar, U stand for urea, and AS stands for ammonium sulfate]	**Pak rupees**				
		Field cost of		**Application charges of**		**Total variable**
		N	**S**	**N**	**S**	**Cost**
1	No fertilizers (check plots)	0	0	0	0	0
2	Recommended practice (120 kg N/ha)	4956.5	0	300		5256.5
3	Four split So application (120 kg N/ha, U)	4956.5	0	450		5406.5
4	Four split So and F application (120 kg N/ha, U)	4956.5	0	600		5556.5
5	Three split So application (27 kg N+ 30 kg S/ha, AS)	1131.3	3694.7		300	5126.0
6	Three split So and F application (27 kg N+ 30 kg S/ha, AS)	1131.3	3694.7		450	5276.0
7	Treatment 3+ 5 (120 kg N+30 kg S/ha, U+ AS)	4956.5	3694.7	450		9101.2
8	Treatment 4+ 6 (120 kg N+ 30 kg S/ha, U+ AS)	4956.5	3694.7	600		9251.2

Part (B): Calculation of field benefit

	Market price per 50 kg bag	Transportation per 50 kg bag	Field price per 50 kg bag	Field price per kg
Grain price	PKR 1300	PKR 100	PKR 1200	PKR 24
Straw price	PKR 400	PKR 100	PKR 300	PKR 6

Treatment Number	Grain yield	Straw yield	Gross field benefit in PKR from			Net benefit in PKR
			Grain yield	Straw yield	Total	
1	2435	5564	58441	33385	91826	91826
2	2679	5759	64305	34553	98858	93602
3	3445	6518	82672	39106	121779	116372
4	3557	6764	85377	40584	125961	120404
5	3797	7488	91123	44927	136050	130924
6	3850	7778	92391	46670	139060	133784
7	4443	8096	106639	48577	155217	146116
8	4644	8458	111456	50749	162205	152953

Part (C): Dominance analysis and calculation of marginal rate of return (MRR).

Treatment Number	Total cost that vary	Net benefits	Dominance analysis	Successive marginal ignoring D			Pairs compared
				Cost	Benefit	MRR %	
1	0	91826					}
5	5126	130924		5126	39098	763	
2	5257	93602	D				}
6	5276	133784		150	2860	1907	
3	5407	116372	D				}
4	5557	120404	D				
7	9101	146116		3825	12331	322	
8	9251	152953		150	6838	4558	}

Treatment Number	Total cost that vary	Net benefits	D	Marginal of treatment 5 vs. treatment 7				Marginal of treatment 5 vs. treatment 8			
				Cost	Benefit	MRR %		Cost	Benefit	MRR %	
1	0	91826									
5	5126	130924									}
2	5257	93602	D				}				
6	5276	133784									
3	5407	116372	D								
4	5557	120404	D				}				
7	9101	146116		3975	15191	382					
8	9251	152953						4125	22029	534	}

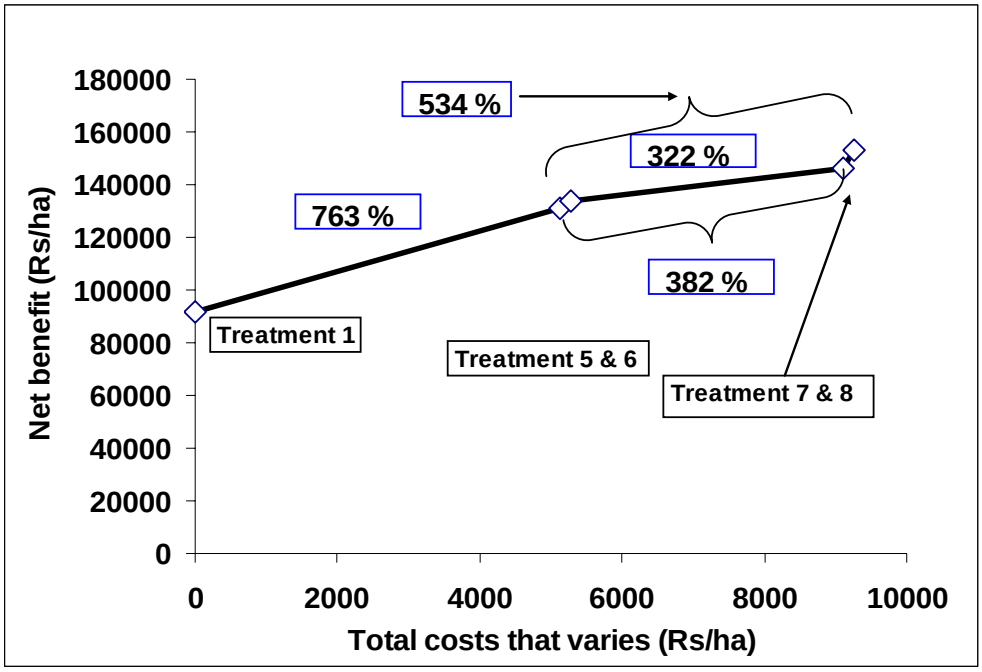

Figure-1. Net benefit curve for the un-dominated fertilizers treatments (1, 5, 6, 7 and 8) with marginal rate of return in text boxes based on average of the two wheat varieties.

CONCLUSIONS

In the light of economic analysis of nitrogen and sulfur application at different rates and at various growth stages of wheat, it can be concluded that specifically treatment number - 8 [60 kg N/ha at sowing + 40 kg N/ha at tillering + 10 kg N/ha at anthesis (foliar) +10 kg N/ha after anthesis (foliar)] + [(15 kg S/ha at sowing + 10 kg S/ha at anthesis (foliar) + 5 kg S/ha after anthesis (foliar)] presented maximum net return as well as maximum gross income compared with other treatments as its grain yield as well as straw yield resulted higher yields as compared with other treatments. Therefore, the local farmers are recommended to bring sulfur containing fertilizers in their common practice along with nitrogen because of its affordable prices and their easy availability in the market.

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