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Short Note

Enhancing protein content in wheat through agronomic manipulations under mid hill conditions of Himachal Pradesh

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Wheat is one of the most important cereal crops of Himachal Pradesh and this crop is being cultivated on 378.8 thousand hectares which comes about 66 percent of the total cropped area (Anonymous, 2003). Wheat forms a major part of daily diet of inhabitants of this State because of its nutritive value due to high content of protein especially, Thiamine and Niacin. However, the protein content of Indian wheat varieties vary only between 8 to 12 per cent .The protein content of varieties being cultivated in Himachal Pradesh is HPW 42 (10.85 %), HS 295 (10.34 %), HS 240 (12.9%) and HPW 184(12.8%). However, wheat varieties being cultivated in Australia and American countries have protein content up to 14 per cent. Therefore, the Indian wheat can not compete with other wheat exporting countries in the International market because of its lower protein content. The productivity of wheat in Himachal Pradesh is quite low i.e. only 16 q/ha (FAI, 2003). One of the main reasons for poor yield is low and imbalanced use of chemical fertilizers. In recent years, sulphur has emerged as the fourth important plant nutrient after N, P and K. There has been an increase in sulphur deficiency in the last decade due to imbalanced use of fertilizer application and low use of sulphur containing fertilizers. It has also been observed that grain sulphur has marked effect on protein composition and other properties of dough, with effects on quality more common than effects on grain yield (Zhao *et al.* 1995). The most obvious function of sulphur is its participation in protein structure in the form of sulphur bearing amino acids like cysteine, cystine and methionine which shows that role of sulphur is important in improving protein content in grains. Experiments have shown that when N was applied at later stages or at heading time followed by rain or irrigation, there was increase in the protein per cent by about 2 % without measurably affecting yield. The present study was, therefore under taken to enhance protein content and yield in wheat with the use of FYM, time of N application and use of sulphur under mid hill conditions of Himachal Pradesh

A field experiment was conducted at the Experimental Farm of the department of Agronomy, CSK HPKV Palampur during *Rabi* season of 2001-2002.Two FYM levels *viz.* No FYM and FYM @ 10t/ha, three sulphur levels *viz.* No sulphur, sulphur @ 25 and 50 Kg/ha and three times of N application *viz.* 1/2 at sowing + 1/2 at 1st irrigation, 1/2 at sowing + 1/4 at tillering + 1/4 at milk stage, 1/3rd at sowing + 1/3rd at 1st node stage + 1/3rd at flowering comprising eighteen treatment combinations were tried in Randomized Block Design with three replications. The soil of the experimental field was silty clay loam in texture, acidic in reaction (pH 5.7) and medium in organic carbon (8.3 g/kg). The fertility of the soil was medium in available N (321 kg ha^{-1}), available P (18 kg ha^{-1}) and K (177 kg ha^{-1}). The available sulphur content was 18.5 kg ha^{-1}. Wheat variety HPW-89 (Surbhi) was sown on 27th November, 2001 with row to row spacing of 23 cm and seed rate of 100 kg/ha. Seed was sown at a depth of 3 to 5 cm. Nitrogen, phosphorus and potassium were applied @ 120:60:40 kg N, P_2O_5 and K_2O per ha. Whole of P_2O_5 and part of N and K_2O were applied through Himalayan khad (12:32:16). Rest of the nitrogen and K_2O were applied through urea & MOP, respectively. Sulphur was applied through elemental sulphur. Harvesting was done on May 15, 2002

Effect of FYM application: The yield contributing characters like number of effective tillers/m^2, spike length, number of grains/ spike, grain weight/ spike and 1000 grain weight were, significantly higher with FYM application @ 10 t ha^{-1} over no FYM application (Table 1). Rathore *et al.* (1995) has also reported increase in yield attributes of wheat with application of organic manure. Application of FYM @ 10 t ha^{-1} also resulsted in significant increase in grain yield and straw yield of wheat.

The increase in grain yield and straw yield of wheat was 36.01and 38.22 per cent, respectively. **Increased** grain and straw yield of wheat with **FYM** application could be owed to higher **availability** of nutrients because of proliferous root system under FYM application resulting in adequate uptake of nutrients. Protein content (%) was also significantly higher with the application of FYM @10 t ha^{-1}(Table 2). Kumar and Yadav (1995) have also reported similar effect of FYM on grain and straw yield.

Effect of time of N-application: The different yield contributing characters like effective tillers/m^2, number of grains/spike, grain weight /spike and 1000 grain weight were significantly increased with nitrogen application splited as 1/3rd at sowing, 1/3rd at 1st node and 1/3rd at flowering over normal mode of N application i.e. 1/2 at sowing and 1/2 at first irrigation.

Table 1. Treatments effect on yield and yield contributing characters of wheat

Treatment	Number of effective tillers/m^2	Spike length (cm)	Number of grains / spike	Grains weight per spike (g)	1000- grain weight (g)
A. FYM levels					
No FYM	154.76	10.59	47.76	2.18	41.41
FYM @ 10t/ha	198.96	11.07	53.07	2.38	44.50
CD (P=0.05)	11.66	0.38	2.66	0.12	1.31
B. Time of N- application					
1/2 at sowing + 1/2 at Ist irrigation	148.92	10.78	47.18	2.16	40.77
1/2 at sowing+ 1/4 at tillering + 1/4 at milk stage	186.48	10.83	50.145	2.27	44.32
1/3 at sowing + 1/3 at Ist node + 1/3 at flowering	195.18	10.87	53.92	2.42	43.78
CD (P=0.05)	14.28	NS	3.26	0.14	1.61
C. Sulphur levels (kg/ha)					
0	157.01	10.53	47.89	2.17	41.71
25	178.75	10.81	50.28	2.29	43.08
50	194.81	11.16	53.08	2.39	44.07
CD (P=0.05)	14.28	0.46	3.26	0.14	1.61

Table 2. Treatments effect on grain yield, straw yield, harvest index and protein content of wheat

Treatment	Grain yield (q/ha)	Straw yield (q/ha)	Harvest Index	Protein Content (%)
FYM levels				
No FYM	24.69	40.05	0.36	11.41
FYM @ 10t/ha	33.78	55.36	0.38	11.87
CD (P=0.05)	0.84	1.45	NS	0.36
Time of N- application				
1/2 at sowing + 1/2 at Ist irrigation	25.23	42.60	0.37	11.18
1/2 at sowing+ 1/4 at tillering + 1/4 at milk stage	30.32	49.79	0.38	11.96
1/3 at sowing + 1/3 at Ist node + 1/3 at flowering	32.26	50.73	0.39	11.79
CD (P=0.05)	1.03	1.78	NS	0.44
Sulphur levels (kg/ha)				
0	27.0	44.40	0.38	11.37
25	29.58	47.68	0.38	11.58
50	31.06	51.03	0.38	11.98
CD (P=0.05)	1.03	1.78	NS	0.44

These results are in conformity with that of Thorne (1982) who has reported that nitrogen supplementation during flowering stage determines the sink capacity (grain number) of the inflorescence. Singh (1989) has also reported significant increase in test weight of wheat grains when N-was applied in three splits. Similarly, grain and straw yield of wheat recorded a significant increase when nitrogen was applied in these splits i e 1/3rd at sowing +1/3rd at 1st node +1/3rd at flowering over recommended practice of 1/2 at sowing +1/2 at 1st irrigation These results are in conformity with those of Raheja *et al.* (1959) who has also reported increased grain and straw yield with application of nitrogen at later stages. Significantly, higher protein content was recorded when nitrogen was applied in three splits i.e. 1/2at sowing +1/4th at tillering +1/4th at milk stage and 1/3rd at sowing+ 1/3rd at 1st node+1/3rd at flowering over recommended practice of 1/2 at sowing +1/2 at 1st irrigation. The findings of Liu and Wen (1997) corroborate with the present findings who have reported that nitrogen applied after flowering is translocated towards grain filling and most of this nitrogen is used for protein synthesis

Effect of sulphur application: Application of sulphur @ 25 and 50 kg ha^{-1} brought a significant increase in various yield contributing characters viz. number of spikes/m^2, spike length, number of grains /spike, grain weight/spike and 1000 grain weight over no sulphur application, however, 25 and 50kg ha^{-1} sulphur levels were at par to each other with respect to number of grains/spike, grain weight/spike and 1000 grain weight. Akbari *et al.* (1999) have also reported increase in yield attributes with increase in sulphur levels. Sulphur application also resulted in significant increase in grain yield and straw yield of wheat and increase was observed up to level of 50kg ha^{-1}. The behaviour of applied sulphur on various yield contributing characters is likely to be reflected in the grain yield of wheat. The findings corroborate with the results of Kushwaha and Prasad (1998) who reported that grain yield and yield components increased significantly with the application of sulphur. Different sulphur levels resulted in significant increase in protein content of grains, although, the maximum protein content was only 11.98 per cent at 50kg sulphur level ha^{-1}, which shows only marginal increase in protein content. Since the protein content is dependent upon the N-content of grain, the N- content increase with sulphur application was marginal, therefore, the protein content of grain also increased proportionately. The result corroborates the findings of Vyas *et al.* (1997).

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