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Response of different wheat varieties under sulphur nutrient and moisture regimes on the nutrient uptake and yield

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Abstract
The field experiment was conducted at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) during *Rabi* season of 2013-14 and 2014-15. The growth attributes plant height, no of shoot m^{-2} and leaf area index was significantly superior 1.2 IW/CPE ratio with PBW 502 variety at all growth stages except 30 days after sowing.PBW-502 (V2) wheat cultivar recorded significantly higher yield of crop over PBW-343 (V1). Moisture regime 1.0 IW/CPE (I3) and the optimum dose of sulphur 20kg/ha (S2) has been found most suitable for wheat production. yield attributes like highest number of effective tillers m^{-2}, no. of fertile spikelets $spike^{-1,}$ spike length, number of grains/spike and 1000-grain weight were also recorded highest values with sulphur level of 20 kg/ha which was significantly to other than dose of sulphur. Wheat cultivar, PBW-502 (V2) recorded the significantly high uptake of NPK and sulphur under 1.0 IW/CPE moisture regime (I3) with 20kg/sulphur dose kg/ha. (S2). Wheat cultivar PBW-502 (V2) accrued the maximum net return with B: C ratio of 2.65 and 2.47 under 1.0 IW/CPE moisture regime (I3) with 20kg/ ha. Sulphur dose (S2) during the year 2013-14 and 2014-15, respectively.

Keywords: wheat; sulphur nutrient; IW/CPE ratio; varieties; growth; nutrient uptake; yield

Introduction
Wheat (*Triticum aestivum* L.) is the most important crop of the world. It belongs to Poaceae family. In India, about 90% of the total wheat production is contributed by northern states. Among them, Uttar Pradesh ranks first with respect to area (9.734 mha) and production (30.30 mt) but the productivity is much lower (3.113 t ha^{-1}) than Punjab with 4.724 t ha^{-1} (Anonymous, 2013) [1]. Fertility status occupies a predominant place in the growth and development of the plant. An insufficient sulphur supply can affect the yield and quality of wheat as to sulphur is required for protein and enzyme synthesis as well. It is a constituent of the amino acids, methionine and cystein. The maximum plant height, number of shoot m^{-2}, LAI and dry matter accumulation was recorded higher with 20 kg sulphur /ha which, significant difference over control during was recorded by Fazal and Sisodia (1989) [7]; Liu *et al.* (2002) [13]. Grain yield and straw yield was also significantly influenced by this sulphur level. Similar result was found by Chaudhary *et al.* (2003) [5]; Jasim (2011) [8]; Sidudinis and Lazauskas (2012) [17].
Efficient input management along with varietal improvement is the basic aspects that can help in achieving the sufficient production but also enhances the water productivity; it must achieve the water economy such that the demand of climate is balanced by the supply, available to it. Since water is very scare and costly input, so it must be used very judiciously by adopting an appropriate technique i.e. IW/CPE ratio or critical stages. Limon *et al.*, (2000) [12] reported that highest water use efficiency (WUE) 11.3 kg/ha mm and Harveer *et al.* (2013) has reported that the application of irrigation water at IW: CPE 1.2 proved to be optimum for exploiting the full production potential of wheat cultivar PBW-343 and also Ashok Kumar *et al.* (1995) was obserbed that the wheat cultivar. HD 2285 with IW: CPE ratio of 1.2 recorded the highest grain yield of 3.65 t/ha.

Material and Methods
The field experiment was conducted at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology Kumarganj, Faizabad (U.P.) during rabi season of 2013-14 and 2014-15. The farm is located 42 km away from Faizabad city on Faizabad-Raebareli road at 26.47˚ N latitude and 82.12˚ E longitude and about 113 metres above the mean sea level. The characters indicated that the soil of the experimental site was silt loam in texture, basic in reaction, high in organic carbon, low in available nitrogen, phosphorus and

medium in potassium. The treatment was carried out with 24 treatment combination formed with four irrigation levels, two varieties and three sulphur levels, in wheat which were allocated in split plot design with three replications. The four irrigation levels (a) I_1; 0.6 IW/CPE ratio (b) I_2; 0.8 IW/CPE ratio (c) I_3; 1.0 IW/CPE ratio and (c) I_4; 1.2 IW/CPE ratio with two varieties namely PBW 343 and PBW 502 and three sulphur levels (a) Control (b) 20 kg/ha (c) 40 kg/ha.

The variety PBW 502 may be grown in Entire North East region of India. The variety was released by CVRC in 2004 which was developed at PAU, Ludhiana**.** The variety is widely adopted in the area NWPZ. The variety PBW 343 may be grown in Western U.P. of India. This is developed in the year 1996 at PAU, Ludhiana and released by CVRC. The variety is widely adopted in the NWPZ.

The seed rate used was 100 kg/ha the crop was fertilised with an uniform dose of 60 kg P_2O_5/ha through single super phosphate, 40 kg K_2O/ha through muriate of potash and half dose of the Nitrogen through urea were applied as a basal dose while the remaining nitrogen was applied in two equal split doses at tillering and panicle initiation stages of crop growth. Irrigation was provided as per irrigation scheduling time. The number of shoots were counted at 30, 60, 90 DAS and at harvest by placing quadrate at three places in each plot and the plants which come within the quadrate were averaged out to express shoots per square meter Number of effective tillers (ear heads) were counted before harvesting from marked area of one square meter, Total number of spikelets from five selected spikes was counted and average values were recorded. From the individual plot the crop of net plot area was harvested. After air d harvesting and seed were cleaned. The final seed weight was recorded in kg per plot and coverted in to t/ha.

Result and Discussion

The data pertaining to different moisture regimes and varieties, plant growth and yield given in Table 1 reveal that the growth and yield of wheat was affected by moisture regimes. The wheat variety PBW 502 has been recorded maximum plant height was recorded with 1.2 IW/CPE under S_2 (20 kg/ha) application at all growth stages of crop, except 30 DAS, which was significantly superior to 0.6 and 0.8 IW/CPE ratio at all growth stages. The effect of moisture level (I4) on number of shoots m^{-2} at 60 DAS, 90 DAS and at harvest was found significant over I_1 moisture level. Leaf area index also significantly influenced by moisture regime at 60 and 90 DAS. Significantly higher leaf area index was observed with 1.2 IW/CPE ratio under S_2 (20 kg/ha) application with PBW 502. In the early stage of crop growth, various moisture regimes could not produce significant changes in plant height by affected significantly at later stage. This might be due to start of different treatment at 60 DAS. Increase in plant height at higher level of moisture regime has been positively due to maintenance of constant water supply to the plants, which maintained various metabolic processes reported by Yadav and Verma (1991) [19], Bandyopadhyay (1997) [2], Rehman *et al.* (2000) [16]. Highest grain yield was recorded under moisture regime of 1.2 IW/CPE. Yield is the result of coordinated inter play of growth characters and yield attributes. Grain and straw yield significantly influenced by the different moisture regime. This might be due to adequate moisture availability, which contributed to better growth parameters and yield attributes. Yield is the result of coordinated inter play of growth characters and yield attributes. Grain and straw yield were significantly influenced by the different moisture regimes. Highest grain yield was recorded of wheat variety PBW 502 under moisture regime of 1.2 IW/CPE ratio with S_2 (20 kg/ha) sulphur application. This might be due to adequate moisture availability, which contributed to better growth parameters and yield attributes. Productivity of crop collectively determined by vigor of the vegetative growth and yield attributes. Better vegetative growth coupled with higher yield attributes resulted in higher grain and straw yields. Lowest grain yield was recorded under 0.6 IW/CPE due to poor moisture supply with control Sulphur application during the period of growth. Poor moisture supply during the critical stages reduced the yield attributes and resulted in poor grain and straw yields during 2013-14 and 2014-15. The similar results were reported by Khola *et al*. (1989) [10], Parihar and Tripathi (1990); Patel and Upadhyay 1993 [15]; Kumar *et al*. (1994); Kumar *et al*. (1995) [11]; bandyopadhyay (1997) [2], Khatri *et al*. (2001) [9], Behara *et al*. (2002) [3].

Table 1: Effect of sulphur nutrient and moisture regimes on plant height, Number of shoots, leaf area Index (LAI), yield attributes and yield of wheat varieties

Treatments	Plant height (cm)				Number of shoots (m^{-2})				Leaf area index (LAI)				Effective tillers m^{-2}		Grain yield (t/ha)		Straw yield	
	60 Das		90 Das		60 Das		90 Das		60 Das		90 Das							
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
Moisture regimes (IW/CPE Ratio)																		
0.6	45.92	46.69	76.36	77.64	300.23	305.29	337.44	343.12	3.40	3.45	4.05	4.11	224.80	228.59	3.81	3.87	5.79	5.89
0.8	48.08	48.91	79.94	81.33	314.34	319.78	353.30	359.42	3.56	3.62	4.24	4.31	263.93	268.52	4.47	4.55	6.81	6.93
1.0	50.49	51.32	83.96	85.34	330.15	335.56	371.07	377.14	3.73	3.80	4.45	4.52	291.25	296.02	4.93	5.02	7.50	7.62
1.2	52.51	53.27	87.32	90.85	343.35	357.23	395.84	413.08	3.88	3.94	4.75	4.95	301.71	306.05	5.11	5.19	7.72	7.83
SEm±	0.77	0.79	1.21	1.97	4.75	7.74	7.71	8.45	0.05	0.05	0.09	0.10	3.83	5.26	0.65	0.89	0.65	1.01
CD at 5%	2.68	2.72	4.18	6.81	16.45	26.77	26.67	29.25	0.19	0.19	0.32	0.36	13.27	18.19	2.25	3.08	2.26	3.49
Variety																		
PBW-343	47.46	48.16	78.92	80.08	310.30	314.88	348.76	353.91	3.51	3.56	4.18	4.24	262.18	266.04	4.51	6.71	6.81	4.51
PBW-502	51.04	51.94	84.88	87.50	333.73	344.05	380.06	392.48	3.77	3.84	4.56	4.71	278.66	283.55	4.80	7.19	7.32	4.80
SEm±	0.92	0.94	1.19	1.27	4.66	5.00	5.39	5.43	0.05	0.05	0.07	0.07	3.88	4.66	0.79	0.73	1.02	0.79
CD at 5%	3.01	3.05	3.86	4.15	15.20	16.31	17.58	17.71	0.17	0.17	0.22	0.22	12.67	15.19	2.58	2.38	3.33	2.58
Sulphur level kg/ha																		
0	47.17	47.90	78.43	79.66	308.41	313.22	346.63	352.04	308.41	313.22	346.63	352.04	237.31	241.01	40.87	60.96	61.91	40.87
20	50.63	51.51	84.19	87.35	331.02	343.48	379.50	394.73	331.02	343.48	379.50	394.73	289.94	294.45	49.93	74.42	75.58	49.93
40	49.96	50.73	83.07	84.36	326.62	331.70	367.11	372.81	326.62	331.70	367.11	372.81	284.01	288.91	48.99	73.38	74.64	48.99
S.Em±	0.84	0.86	1.07	1.86	4.19	7.32	8.67	9.38	4.19	7.32	8.67	9.38	3.51	4.56	0.77	0.63	0.92	0.77
CD at 5%	2.43	2.47	3.07	5.36	12.07	21.09	24.98	27.02	12.07	21.09	24.98	27.02	10.10	13.13	2.23	1.81	2.65	2.23

Table 2: Effect of moisture regimes and sulphur nutrition on N, P, K and S uptake and Protein content in grain by wheat varieties

Treatments	N uptake (kg/ha)		N uptake (kg/ha)		N uptake (kg/ha)		N uptake (kg/ha)		N uptake (kg/ha)	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
Moisture regimes (IW/CPE Ratio)										
0.6	80.06	81.40	27.07	27.52	106.74	108.54	2.67	2.71	10.77	10.95
0.8	93.99	95.62	31.78	32.33	125.32	127.50	3.13	3.19	11.46	11.66
1.0	103.72	105.42	35.07	35.64	138.29	140.56	3.46	3.51	12.16	12.36
1.2	107.45	108.99	36.33	36.85	143.26	145.32	3.58	3.63	12.76	13.31
SEm±	1.37	1.28	0.46	0.43	1.82	1.71	0.05	0.04	0.25	0.27
CD at 5%	4.72	4.44	1.60	1.50	6.30	5.92	0.16	0.15	0.86	0.95
Variety										
PBW 343	93.37	94.74	31.57	32.03	124.49	126.32	3.11	3.16	11.61	11.78
PBW 502	99.24	100.98	33.55	34.14	132.32	134.64	3.31	3.37	11.96	12.36
SEm±	1.38	1.40	0.47	0.47	1.84	1.86	0.05	0.05	0.18	0.18
CD at 5%	4.51	4.55	1.53	1.54	6.01	6.07	0.15	0.15	N.S	N.S
Level of sulphur (kg/ha)										
0	84.51	85.83	28.57	29.02	112.68	114.44	2.82	2.86	11.24	11.41
20	103.25	104.86	34.91	35.45	137.67	139.81	3.37	3.43	12.13	12.61
40	101.14	102.89	34.20	34.79	134.86	137.18	3.44	3.50	12.00	12.18
SEm±	1.25	1.26	0.42	0.43	1.67	1.69	0.04	0.04	0.29	0.31
CD at 5%	3.60	3.64	1.22	1.23	4.80	4.85	0.12	0.12	N.S	0.90

The uptake of nutrients (NPK and S) by wheat varieties significantly influenced with different level of moisture regime under sulphure level. The translocation of nutrient from soil to the plant was recorded more at the sufficient moisture content, because water is the good transporter of nutrients. Uptake of nutrients was recorded more under 1.2 IW/CPE ratio due to favourable growth and development at vegetative stage while minimum uptake of N, P, K and S was recorded under 0.6 IW/CPE ratio during both the years. PBW 502 also has been found more promising in comparison to PBW 343 to provide higher values of nutrient uptake. Wheat crop expressed the significant response to the sulphur fertilization. Significantly higher uptake of N, P and K was recorded upto 20 kg S ha^{-1} application while the maximum uptake of sulphur was found under the 40 kg S ha^{-1}. Similarly the protein content in wheat variety (PBW 502) grain was recorded maximum under I(4) and lowest with I(1) moisture regimes under upto 20 kg S ha^{-1} application. The similar results were reported by Naser *et al*. (2000) and Singh *et al*. (2013).

Conclusions

Thus, it can be concluded that the 1.0 IW/CPE ratio was the most suitable moisture regimes for higher productivity of wheat the variety PBW 502 is most suitable for higher productivity of different varieties of wheat. Sowing of wheat variety PBW 502 under 1.0 IW/CPE ratio with 20 kg S ha^{-1} application may be most economical. The N uptake by plants significantly and highest N uptake 107.45 and 108.99 kg/ha, P, and K 143.26 and 145.32 kg/ha was recorded under I (4) moisture regime respectively during both the years where as S was recorded with I (4) moisture regime (3.58 kg/ha during first year and 3.63 kg/ha in next of the year).

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