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Performance of wheat varieties under different moisture regime and sulphur nutrient on the growth 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) 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) respectively both the years of experimentations.

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

Introduction
Wheat (*Triticum aestivum* L.) is the most important crop of the world. It belongs to Poaceae family. It is primarily grown in temperate regions and also at higher altitude under tropical climatic areas in winter season. 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. This was showed significant difference over control during both the year of study. Increase in growth with sulphur fertilization was recorded by Fazal and Sisodia (1989) [7]; Liu *et al.* (2002) [13]. Grain yield and straw yield was also significantly influenced by 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) [11] 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. PBW 343 and PBW 502 suitable for timely sown irrigated conditions were selected for this study.

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 drying harvesting and seed were cleaned. The final seed weight was recorded in kg per plot and converted in to q ha^{-1}.

Results and Discussion

The plant height increased with increasing age of crop and it attained its maximum value at harvest stage. At all the stages of crop growth, plant height was significantly higher in case of S_2 (20 kg/ha) sulphur application, except 30 days after sowing with PBW 502 at all growth stages of crop, except 30 DAS, The maximum plant height, number of shoot m^{-2}, LAI and dry matter accumulation was recorded higher with 20 kg sulphur /ha. Increase in growth with sulphur fertilization was recorded by Fazal and Sisodia (1989) [7]; Liu *et al.* (2002) [13]. Application of sulphur increase leaf area, tillering and ear number/plant and other yield attributing character. The graters dry matter accumulation, number of ear, ear length, number of grain per ear and 1000 seed weight (yield attributes) was recorded significantly higher with 20 kg S/ha application over the control during both the years. Grain yield and straw yield was also significantly influenced by sulphur level. Similar result was found by Chaudhary *et al*. (2003) [5]; Jasim (2011) [8]; Sidudinis and Lazauskas (2012) [17]. Significant varieties differences in plant height, number of shoot m^{-2}, LAI and dry matter accumulation was recorded with variety PBW 502 at all the growth stage of crops while differences at 30 DAS was recorded non-significant. The variation in growth development and yield might also be probably due to their characteristics. Variation in plant growth, development and yield of among varieties might also be probably due to their genetic characters. Similar finding in respect to varieties reported by Brijkishor (1998) [4].

Yield attributes which determined yield, is the resultant of the vegetative development of the plant. All the attributes of yield viz., effective tillers, number of grains per spike, and 1000-grain weight (g) were influenced significantly due to different moisture regime. Those were recorded maximum under 1.2 IW/CPE ratio followed by 1.0 IW/CPE. Owing to favourable vegetative growth and development because it received adequate moisture during entire period of growth. Under adequate moisture, the plant height, leaf area index were highest which contributed to highest yield attributes thereby increasing photosynthetic activity of leaves. Besides increased translocation of photosynthates from source to sink under wettest condition through higher uptake of potassium led more yield attributes. Minimum yield attributes were recorded with 0.6 IW/CPE ratio, because plant were unable to extract more water and nutrients under moisture deficit condition which resulted in poor growth and yield attributes during both the years of study. This result is close proximity to those obtained by Khola *et al*., (1989) [10]; Dubey and Sharma (1996) [6]; Bandyopadhyay (1997) [2]; Khatri *et al*., (2001) [9] (Table 2).

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 (19730; Kumar *et al*. (1994); Kumar *et al*. (1995) [11]; bandyopadhyay (1997) [2], Khatri *et al*. (2001) [9], Behara *et al*. (2002) [3].

Conclusions

Thus, it can be concluded that the 20 kg/ha sulphur nutrition was the most suitable sulphur dose 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.

Table 1: Effect of sulphur nutrient and moisture regimes on plant height (cm), Number of shoots (m^{-2}) and leaf area Index (LAI) of wheat varieties

Treatments	Plant height (cm)								Number of shoots (m^{-2})								Leaf area index (LAI)			
	30 DAS		60 DAS		90 DAS		At harvest		30 DAS		60 DAS		90 DAS		At harvest		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	2013-14	2014-15
Moisture regimes (IW/CPE Ratio)																				
0.6	20.37	20.31	45.92	46.69	76.36	77.64	73.58	74.82	119.04	118.69	300.23	305.29	337.44	343.12	310.17	315.39	3.40	3.45	4.05	4.11
0.8	20.42	20.36	48.08	48.91	79.94	81.33	77.04	78.38	119.35	119.01	314.34	319.78	353.30	359.42	324.74	330.37	3.56	3.62	4.24	4.31
1.0	20.66	20.58	50.49	51.32	83.96	85.34	80.92	82.24	120.79	120.29	330.15	335.56	371.07	377.14	341.08	346.67	3.73	3.80	4.45	4.52

1.2	21.61	22.26	52.51	53.27	87.32	90.85	84.15	87.56	126.34	130.10	343.35	357.23	395.84	413.08	363.85	379.70	3.88	3.94	4.75	4.95
SEm±	0.48	0.51	0.77	0.79	1.21	1.97	1.17	1.90	2.52	2.72	4.75	7.74	7.71	8.45	7.17	7.89	0.05	0.05	0.09	0.10
CD at 5%	N.S	N.S	2.68	2.72	4.18	6.81	4.03	6.56	N.S	N.S	16.45	26.77	26.67	29.25	24.79	27.29	0.19	0.19	0.32	0.36
Variety																				
PBW-343	20.69	20.80	47.46	48.16	78.92	80.08	76.05	77.17	120.96	121.55	310.30	314.88	348.76	353.91	320.57	325.31	3.51	3.56	4.18	4.24
PBW-502	20.84	20.96	51.04	51.94	84.88	87.50	81.80	84.32	121.80	122.49	333.73	344.05	380.06	392.48	349.35	360.76	3.77	3.84	4.56	4.71
SEm±	0.32	0.32	0.92	0.94	1.19	1.27	1.14	1.23	1.82	1.79	4.66	5.00	5.39	5.43	5.14	5.18	0.05	0.05	0.07	0.07
CD at 5%	N.S	N.S	3.01	3.05	3.86	4.15	3.72	4.00	N.S	N.S	15.20	16.31	17.58	17.71	16.74	16.89	0.17	0.17	0.22	0.22
Sulphur level kg/ha																				
0	20.35	20.29	47.17	47.90	78.43	79.66	75.59	76.77	118.96	118.62	308.41	313.22	346.63	352.04	318.62	323.59	308.41	313.22	346.63	352.04
20	21.29	21.81	50.63	51.51	84.19	87.35	81.13	84.18	124.45	127.46	331.02	343.48	379.50	394.73	348.83	362.83	331.02	343.48	379.50	394.73
40	20.66	20.53	49.96	50.73	83.07	84.36	80.05	81.30	120.73	119.98	326.62	331.70	367.11	372.81	337.44	342.68	326.62	331.70	367.11	372.81
S.Em±	0.45	0.48	0.84	0.86	1.07	1.86	1.03	1.79	2.78	2.97	4.19	7.32	8.67	9.38	8.25	8.89	4.19	7.32	8.67	9.38
CD at 5%	N.S	N.S	2.43	2.47	3.07	5.36	2.96	5.17	N.S	N.S	12.07	21.09	24.98	27.02	23.76	25.60	12.07	21.09	24.98	27.02

Table 2: Effect of sulphur nutrient and moisture regimes on yield attributes and yield of wheat varieties

Treatments	Effective tillers m^{-2}		Number of grains $spike^{-1}$		Test weight (g)		Grain yield (t/ha)		Straw yield	
	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	224.80	228.59	37.75	38.38	34.46	34.37	3.81	3.87	5.79	5.89
0.8	263.93	268.52	40.19	40.88	36.69	36.59	4.47	4.55	6.81	6.93
1.0	291.25	296.02	42.63	43.33	38.93	38.77	4.93	5.02	7.50	7.62
1.2	301.71	306.05	44.73	45.37	40.84	40.89	5.11	5.19	7.72	7.83
SEm±	3.83	5.26	0.87	0.83	0.80	0.75	0.65	0.89	0.65	1.01
CD at 5%	13.27	18.19	3.02	2.88	2.76	2.59	2.25	3.08	2.26	3.49
Variety										
PBW-343	262.18	266.04	40.71	41.31	37.17	37.09	4.44	4.51	6.71	6.81
PBW-502	278.66	283.55	41.94	42.67	38.30	38.22	4.42	4.80	7.19	7.32
SEm±	3.88	4.66	0.63	0.72	0.57	0.65	0.66	0.79	0.73	1.02
CD at 5%	12.67	15.19	N.S	N.S	N.S	N.S	2.15	2.58	2.38	3.33
Sulphur level kg/ha										
0	237.31	241.01	39.40	40.02	35.98	35.88	40.24	40.87	60.96	61.91
20	289.94	294.45	42.51	43.24	38.82	38.92	49.17	49.93	74.42	75.58
40	284.01	288.91	42.06	42.71	38.40	38.16	48.16	48.99	73.38	74.64
S.Em±	3.51	4.56	1.01	0.70	0.92	0.63	0.59	0.77	0.63	0.92
CD at 5%	10.10	13.13	2.91	2.03	2.66	1.83	1.71	2.23	1.81	2.65

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