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Effect of wheat varieties, moisture regimes and nutrient supply system on yield, quality and nutrient uptake of late sown wheat (*Triticum aestivum*)

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Abstract
A field experiment was conducted during the Rabi season 2012-2013 and 2013-2014 at Agronomy Research Farm of NDUAT, Faizabad, to study the effect of wheat varieties, moisture regimes and nutrient supply system on wheat (*Triticum aestivum* L.) were studied in spilt plot design Pooled data revealed that the yield and quality increased significantly with the application of variety PBW-373, moisture regime 1.0 IW/CPE and nutrient level of 150:60:40/NPK kg h^{-1} (RDF) over rest of the treatments during both the years The significantly higher nutrient uptake of nitrogen, phosphorus, potassium, by grain and straw was recorded under variety PBW-373, moisture regime 1.0 IW/CPE and nutrient level of 150:60:40/NPK kg h^{-1} (RDF) over rest of the treatments during both the years. Interaction effect between RDF × 1.0 IW/CPE proved significantly superior over all combination of treatments with respect to grain yield of wheat during both the years. Wheat variety PBW-373 × 0.8 IW/CPE × (RDN 50% + 50% N through neem cake) recorded higher WUE.

Keywords: Wheat, IW/CPE, FYM, RDN, Quality, Uptake

1. Introduction
The importance of irrigation management has further increase with the introduction of the dwarf wheat cultivars throughout the country, for achieving the maximum yield of different wheat varieties optimum irrigation facilities are very essential. In the U.P. generally 4-5 irrigation are recommended which may be increased upto 5-6 irrigation depending upon the climatic conditions as well as underground water table.

The efficiency of both nitrogen and phosphorus is greatly enhanced with the application in combination; potassium fertilization further improves the utilization of nitrogen and phosphorus. It is observed now days that soils are going sick. Improvement soil health may be essential to sustain soil health and crop productivity. Some efforts have been done in this direction by involving organic manure with chemical fertilizers, FYM, vermin-compost, bio-compost and some other organic sources. Hence the study of the effect of various fertilizers and manures in balanced proportion on yield of wheat will be of immense significance to understand the fertilizer requirement, because they reach their full yield potential with adequate supply of various fertilizers. Therefore, the application of adequate irrigation and fertilizers in balance proportion is necessary for the sustainable yield.

Productivity of wheat under late sowing condition is very low because of a cut in the growing time and delayed emergence of seedlings due to prevailing low temperature and forced maturity due to high temperature and hot desiccating wind during grain filling stage (Sardana *et al*., 2002) [7].

2. Materials and Methods
The investigation was carried out during the winter (rabi) season of 2012-13. And 2013-14 at Kumarganj Faizabad. The soil was silt loam with 8.21 pH 0.35 organic carbon, 0.34 EC, available N (109.40 and 115.40 kg/ha). P (15.82 and 17.60 kg/ha), S (9.84 and 10.80 kg/ha), and medium in K (245.20 and 251.47 kg/ha). The experiment was laid out in split-plot design with 3 replications.

Keeping combinations of three varieties (NW-2036, PBW-373, HUW-234) and two irrigation levels (Irrigation at 0.8 IW/CPE ratio, Irrigation at 1.0 IW/CPE ratio) in main plots and three fertility sources (100% NPK through chemical fertilizers (150:60:40 kg NPK ha^{-1}), 50% N+ 50% N through FYM and50% N + 50% N neem cake was sown on 20 December 2012 during the first year and 21 December 2013 during the second year using a seed rate of 125 kg/ha at a row spacing of 20.0 cm. 100% RDF (150:60:40 NPK) were applied as urea, DAP, MOP in first treatment. (50% RDF) Along with FYM were in the form applied in second treatment. (50% RDF) along with Neem cake were applied in third treatment. In all the treatment half dose of nitrogen and full dose of phosphorus, potash, FYM and Neem cake was applied at the time of sowing of the wheat crop and remaining dose of nitrogen were applied in the form of top dressed after first irrigation. The mode of top dressing of urea was similar in both the years.

3. Results and Discussion

Yield attributes which determine yield, is the resultant of the vegetative development of the plant. All the attributes of yield *viz.*, number of spike m^{-2}, length of spike, number of grains $spike^{-1}$, and weight of grains $spike^{-1}$ were influenced significantly due to change in moisture regime. Maximum values of number of spike m^{-2}, length of spike, number of grains $spike^{-1}$, and weight of grain $spike^{-1}$ were recorded under 1.0 IW/CPE ratio over 0.8 IW/CPE ratio, due to favourable vegetative growth and development because it received adequate moisture during entire period of growth. As under adequate moisture, the plant height, leaf area index were highest which contributed to highest yield attributes probably due to increased photosynthetic activity of leaves. Besides, translocation of photosynthates from source to sink also increased under wettest condition through higher uptake of potassium. Minimum yield attributes with recorded where 0.8 IW/CPE ratio, because plant were unable to extract more water and nutrients under poor moisture condition which resulted in poor growth and yield attributes. These results' are in conformity with those of Mumtaz *et al.* (2014) [3] and Noonari *et al.* (2016) [5].

Significantly values of N P & K uptake was recorded with 100% RDF as compare to 50% N substitution through FYM or neem cake.

The uptake of nutrients (NPK) by wheat crop significantly influenced by different level of moisture regime. The translocation of nutrient from soil to the plant under sufficient moisture content, because water is the good transporter of nutrients. Higher uptake of nutrients (NPK) were recorded under 1.0 IW/CPE ratio due to favourable vegetative growth and development as compare to 0.8 IW/CPE ratio. Similarly the protein content in wheat grains was also recorded maximum under moisture regime of 1.0 IW/CPE ratio. The similar results also were reported by Naser *et al.* (2000) [4] and Singh *et al.* (2013) [8].

Water use efficiency (WUE) was markedly influenced by different moisture regimes. The highest water use efficiency of 207.68 kg ha^{-1} cm^{-1} was recorded under 3 irrigations at 0.8 IW/CPE ratio. This might be due to the fact that under lower moisture regime, plant yielded more at per unit of water consumed. Chavan and Pawar (1987) [1] also reported decrease in water use efficiency with increasing irrigation levels and increase with decreased in irrigation level.

4. Quality

4.1 Protein content

Protein content was not affected significantly by various wheat varieties, moisture regime and nutrient supply system during both the years, as all the treatments recorded almost similar protein content of 9.13 to 9.38 % during both the years.

4.2 Uptake at Nutrient

Among the varieties, maximum uptake of N by the plants in grain (60.77 and 62.62 kg ha^{-1}) and in straw (31.41 & 32.31 kg ha^{-1}) was recorded with variety PBW-373 which was significantly superior over NW-2036 & HUW-234 in both of the years.

On an average, maximum nitrogen uptake in grain (55.59 kg ha^{-1}) and in straw (28.19 kg ha^{-1}) was observed under moisture regime of 1.0 IW/CPE ratio which was significantly higher over those of 0.8 IW/CPE ratio.

Recommended fertilizer dose recorded significantly higher nitrogen uptake in grain (56.58 & 58.07 kg ha^{-1}) over that of 50 % N through fertilizer along with 50 % N through FYM or neem cake during 2012-13 and 2013-14, respectively. The highest total uptake of 83.61 and 87.63 $kgha^{-1}$ was recorded by RDN (100%) which was 8.46 & 7.82 $kgha^{-1}$ higher over 50 % N substitution through FYM and 9.97 & 9.73 $kgha^{-1}$ higher through neem cake, during first and second year respectively.

On an average, PBW-373 recorded total uptake of P (24.39 kg ha^{-1}) by the plants which was significantly superior over NW-2036 & HUW-234 with a magnitude of 19.98 and 18.73 kg ha^{-1} respectively.

The maximum P total uptake in grain and straw (21.17 and 21.89 kg ha^{-1}) was observed under moisture regime (1.0 IW/CPE ratio) showing an increase of 8.4 % in first year and 8.5 % in second year, respectively.

Recommended fertilizer dose recorded significantly higher P uptake in grain (15.01 & 15.39 kg ha^{-1}) and in straw (7.16 & 7.30 kg ha^{-1}) over that of 50 % N through fertilizer along with 50 % N through FYM or neem cake during 2012-13 and 2013-14, respectively.

Among the varieties, maximum uptake of K by the plants in grain (15.32 and 15.76 kg ha^{-1}) and in straw (87.15 & 89.29 kg ha^{-1}) was recorded with variety PBW-373 which was significantly superior over NW-2036 & HUW-234 in both of the years.

The maximum K uptake in grain (13.81 and 14.23 kg ha^{-1}) and in straw (77.04 & 79.16 kg ha^{-1}) was observed under moisture regime (1.0 IW/CPE ratio) during first and second year, respectively which was significantly higher than moisture regimes (0.8 IW/CPE ratio) during both the years. Similar results were also reported by Patel *et al.* (1995) [6] and Hedge (1998) [2].

Table 1: Effect of phosphorus, sulphur and zinc on yield attributes, yield and quality of wheat.

Treatment	Number of shoots (running meter)	Spike length (cm)	Number of spikelets spike^{-1}	Number of grains spike^{-1}	1000-grain weight(g)	Grain yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)	Protein content (%) in grain
Varieties									
V_1	57.04	7.73	19.85	36.43	31.78	30.56	42.05	72.60	9.335
V_2	71.48	8.93	23.05	42.16	33.30	35.71	47.73	83.43	9.865
V_3	74.56	9.17	23.74	43.53	33.93	36.73	49.48	86.21	10.475
SEm±	1.38	0.17	0.48	0.82	0.63	0.65	1.01	1.67	0.08
CD at 5%	5.42	0.68	1.87	3.22	NS	1.90	3.97	6.56	0.315
Moisture regime									
M_1	59.67	7.89	20.43	37.48	32.24	31.59	42.95	74.54	9.715
M_2	70.97	8.79	22.68	41.95	33.10	35.08	47.52	82.59	9.945
SEm±	1.00	0.16	0.31	0.78	0.60	0.65	0.67	1.57	0.385
CD at 5%	2.89	0.46	0.90	2.24	NS	31.59	1.94	4.53	0.23
Fertilizers levels (kg ha^{-1})									
F_1	65.83	8.36	21.81	39.67	32.56	33.41	45.55	78.96	9.745
F_2	64.65	8.23	20.56	38.67	32.12	32.34	44.98	77.96	8.675
F_3	69.56	8.82	22.62	41.84	33.45	35.25	47.28	82.53	10.035
SEm±	0.82	0.13	0.25	0.63	0.49	0.53	0.54	1.28	0.06
CD at 5%	2.36	0.38	0.73	1.83	NS	1.56	1.58	3.71	0.18

Table 2: Effect of phosphorus, sulphur and zinc on uptake of wheat.

Treatment	Total N uptake kg/ha	Total P uptake kg/ha	Total K uptake kg/ha	Total S uptake kg/ha	Total Zn uptake g/ha
Varieties					
V_1	67.22	15.99	67.51	12.61	153.28
V_2	82.14	19.30	81.36	14.82	178.18
V_3	89.65	21.20	89.24	16.09	190.06
SEm±	0.93	0.26	1.37	0.21	2.72
CD at 5%	3.64	1.04	5.37	0.84	10.69
Moisture regime					
M_1	72.07	15.97	72.01	12.32	158.13
M_2	81.76	19.55	81.57	15.07	177.98
SEm±	1.09	0.28	1.05	0.20	2.19
CD at 5%	3.14	0.80	3.03	0.60	6.33
Fertilizers levels (kg ha^{-1})					
F_1	76.56	18.08	76.69	13.96	159.87
F_2	75.98	17.69	75.85	14.87	159.98
F_3	82.78	19.59	82.05	15.05	187.81
SEm±	0.89	0.23	0.85	0.16	1.79
CD at 5%	2.57	0.66	2.47	0.49	5.17

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