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Effect of Priming, Biofertilizers and Nitrogen Levels on Yield and Nutrient Uptake by Wheat

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A B S T R A C T

A field experiment was conducted during *rabi* season 2015-16 at research farm of CCSHAU, Hisar to study the impact of priming, biofertilizers with different nitrogen levels on growth, yield and nutrient uptake of late sown wheat. The experiment comprised of 5 treatments *i.e.* no seed priming, seed priming with water, seed priming with water + *Azotobacter*, seed priming with water + AM fungi, seed priming with water + Biomix in main plot and 4 nitrogen levels *viz.* 120, 135, 150, 165 kg ha^{-1} in sub plot was carried out in split plot design with three replications. Priming with biofertiliser inoculations significantly improve yield and nutrient uptake. Yield and nutrient uptake is highest at biomix treated plot than others. The growth and yield and nutrient uptake showed an increase with increase in nitrogen dose up to 150 kg ha^{-1}.

Introduction

Wheat is an annual plant of gramineae family. It contains 12 % proteins which is more than other cereals. It is world's leading cereal crop, cultivated in an area about 215.26 million ha with a production of 584.76 million tones. Under late sowing, the yield reduction is principally due to delayed germination, insufficient seedling emergence and inappropriate stand establishment because of low temperature prevailing at sowing time. Pre-germinated seeds and seed priming is helpful in early germination and reducing the risk of poor stand establishment which also improves nutrient uptake.

For a sustainable agriculture, it is imperative to utilize renewable inputs which can maximize the ecological benefits and minimize the environmental hazards. One possible way of achieving this is to decrease dependence on use of chemical nitrogen fertilizers by harvesting the atmospheric nitrogen through biological processes (Kachroo and Razdan, 2006).

Biofertilizers play a very significant role in improving soil fertility by fixing atmospheric nitrogen, both, in association with plant roots and without it, solubilise insoluble soil phosphates and produces plant growth substances in the soil.

They are in fact being promoted to harvest the naturally available, biological system of nutrient mobilization (9). An integrated approach for use of biofertilizers with chemical fertilizers is considered as the need of hour, as biofertilizers are not replacement of fertilizers but can supplement their requirement. Thus in this investigation all factors combined in all possible combinations to improvise the yield of late sown of wheat and nutrient uptake.

Materials and Methods

A field experiment conducted during *rabi* 2015-16 at Research Farm of Department of Agronomy, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana (India). The important soil properties of the field were: pH 8.3, organic carbon 0.32 %, EC 0.30 dSm^{-1}, available N 161 kg/ha, available P 13 kg/ha and available K 356 kg/ha. Treatments consisted of no seed priming, seed priming with water, seed priming with water + *Azotobacter*, seed priming with water + AM fungi, seed priming with water + Biomix, 4 nitrogen levels in sub plots (120,135,150,165 kg N ha^{-1}). These treatment combinations were replicated thrice in a split plot design having priming and biofertiizers in main plots and nitrogen in sub-plots.

Wheat seeds were primed and inoculated with biofertilizers as per treatments. Recommended doses of P and K were applied through single superphosphate and muriate of potash, respectively. The wheat variety WH 1124 was sown on 29th December with 100 kg seed/ha. Appropriate management practices were adopted to raise the crop. Grain and straw yields were recorded at harvest of the crop. NPK content in grain and straw at harvest was determined. For analysis of NPK oven dried plant material (grain and straw at harvest) from each plot was grinded separately with grinder. Nitrogen (Nessler's reagent method, Lindner, 1944), phosphorus (Vanadomolybdo-phosphoric acid yellow colour method, Jackson, 1973) and potassium (Flame photometer method, Richards, 1954) contents in sample were analyzed.

The uptake of each nutrient was computed as:

Nutrient uptake by grain (kg ha^{-1}) =

$$\frac{\text{Nutrient content in grain (\%) x Grain yield (kg ha}^{-1}\text{) Nutrient}}{100}$$

Nutrient uptake by straw (kg ha^{-1}) =

$$\frac{\text{Nutrient content in straw (\%) × Straw yield (kg ha}^{-1}\text{)}}{100}$$

Results and Discussion

Yield studies

The results revealed that there was an increase of 9.5, 8.6, 6.1 and 2.7 % in grain yield with water priming of seed + Biomix, priming + AM, priming + *Azotobacter* and water priming of seed over unprimed, uninoculated treatment respectively. This increase in grain yield is due to the fact that there is positive correlation of the yield attributes with grain yield and yield attributes increased with biofertilizer inoculations thus yield also improved. The corresponding increase were 7.4, 6.6, 6.2 and 2.8 % for straw yield and 8.2, 7.4, 6.4 and 2.8% for biological yield. These findings are in conformity with the results of Behl *et al.*, (2003) for AM fungi; Milosevic *et al.*, (2012) and Narula *et al.*, (2005) for *Azotobacter*; Bahrani *et al.*, (2010) for *Azotobacter* and Mycorrhiza and Saber *et al.*, (2012), Singhal *et al.*, (2012) for PSB in wheat. Harvest index slightly improved with biofertilizer treatments but remained statistically non-significant. This might be on account of almost similar pattern

of increase in grain and straw yield and consequently biological yields under all the inoculation treatments. Similar results were reported by Jakhar (2004).

Grain, straw and biological yields were improved significantly with increase in N dose up to 150 kg ha^{-1} which was statistically at par with 165 kg N dose (Table 1). There was an increase of 4.5, 8.2 and 11.3% with 135, 150 and 165 kg N ha^{-1} over 120 kg ha^{-1}. The higher grain yield obtained with increasing nitrogen levels could be ascribed to its favorable effect on yield attributing characters. Increase in straw and biological yields of wheat with successive increase in N levels probably came through favorable influence of increasing N levels on growth parameters in terms of plant height, number of tillers, dry matter production and LAI. Corroborative findings have been reported by Beheraa and Rautaray (2010), Patel *et al.,* (2012); Pandey *et al.,* (2014), Kaur *et al.,* (2016); Narolia *et al.,* (2016), Nishant *et al.,* (2016) in wheat crop.

Nutrient concentration and uptake

The nitrogen contents of grain and straw (Table 2) were not significantly affected by the different treatments of seed priming with water and biofertilizer inoculations.

The nitrogen fixed by biofertilizers was utilized by the crop for producing higher dry matter and grain yield (Table 1) as compared to uninoculated treatment. Thus, the accumulation of nitrogen under biofertilizer inoculated plants at harvest was not substantial compared to uninoculated treatment. Similar findings were also reported by Jakhar (2004). However, other nutrients (P, K contents) were not influenced significantly by water priming with biofertilizer inoculations both in grain and straw. Similar results were reported by Suri and Choudhary (2010) for phosphorus and Jakhar (2004) for phosphorus and potassium. Nutrient contents were in a increasing trend up to priming with biomix except P content in straw, where P content in AM fungi treatment is higher than biomix as nutrient taken is diluted due to more grain yield in case of biomix than AM fungi (Table 2).

In case of nitrogen uptake by grain and straw, total uptake was not affected by seed priming with water significantly, but biofertilizer inoculations gave significantly higher N uptake by grain and total uptake. Similar results were reported by Kader *et al.,* (2002), Singh *et al.,* (2013), Pandey *et al.,* (2014) Narolia *et al.,* (2016), Nishant *et al.,* (2016). However, *Azotobacter* was at par with seed priming with water (Table 3) but significantly better as compared to no inoculation treatment. Whereas, N uptake by straw under seed priming with water and biofertilizer inoculations are statistically at par. Priming had no effect in improving uptake of P and K but biofertilizer inoculations significantly increased the P uptake except *Azotobacter* which was at par with priming with water (Table 3). Similar findings were reported by Sushila and Giri (2000) for phosphorus and Gupta (2002) for potassium.

Nitrogen content improved significantly with each successive increment of N levels (135, 150, 165 kg N ha^{-1}) which enhanced N uptake in grain as well as straw significantly over lower level (120 kg ha^{-1}) however, two higher nitrogen levels were statistically at par in case of straw (Table 2).

Total N uptake was significantly increased with each increment in nitrogen dose up to 165 kg ha^{-1}. This was mainly due to increase in N content as well as higher grain and straw yield with increasing N levels. Similar results were reported by Kader *et al.,* (2002), Singh *et al.,* (2013), Pandey *et al.,* (2014) Narolia *et al.,* (2016), Nishant *et al.,* (2016).

Table.1 Effect of seed priming, biofertilizer inoculations and nitrogen levels on yield of wheat

Treatment	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})
Seed priming and inoculation			
No seed priming	36.50	56.10	92.60
Seed priming with water	37.49	57.70	95.19
Seed priming + Inoculation with *Azotobacter*	38.73	59.57	98.50
Seed priming + Inoculation with AM fungi	39.64	59.82	99.46
Seed priming + Inoculation with Biomix	39.97	60.26	100.23
SEm±	0.66	0.86	0.94
CD at 5%	2.14	2.80	3.07
Nitrogen level (kg ha^{-1})			
120	36.29	55.65	91.94
135	37.92	57.76	95.68
150	39.26	60.33	99.59
165	40.39	61.03	101.42
SEm±	0.42	0.61	0.77
CD at 5%	1.21	1.76	2.22

Table.2 Effect of seed priming, biofertilizer inoculations and nitrogen levels on Nutrient content of wheat

Treatment	N content (%)		P content (%)		K content (%)	
	Grain	Straw	Grain	Straw	Grain	Straw
Seed priming and inoculation						
No seed priming	1.706	0.434	0.282	0.082	0.464	1.643
Seed priming with water	1.723	0.448	0.283	0.082	0.465	1.656
Seed priming + Inoculation with *Azotobacter*	1.731	0.454	0.283	0.083	0.468	1.676
Seed priming + Inoculation with AM fungi	1.743	0.457	0.284	0.084	0.468	1.680
Seed priming + Inoculation with Biomix	1.758	0.460	0.286	0.083	0.469	1.682
SEm±	0.014	0.009	0.003	0.001	0.001	0.010
CD at 5%	NS	NS	NS	NS	NS	NS
Nitrogen level (kg ha^{-1})						
120	1.677	0.431	0.281	0.082	0.464	1.653
135	1.713	0.441	0.282	0.082	0.467	1.663
150	1.757	0.462	0.285	0.083	0.469	1.674
165	1.783	0.469	0.286	0.083	0.468	1.679
SEm±	0.011	0.004	0.002	0.001	0.001	0.016
CD at 5%	0.033	0.013	NS	NS	NS	NS

Table.3 Effect of seed priming, biofertilizer inoculations and nitrogen levels on Nutrient uptake of wheat

Treatment	N uptake (kg ha^{-1})			P uptake in kg ha^{-1}			K uptake in kg ha^{-1}		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Seed priming and inoculation									
No seed priming	62.37	24.39	86.76	10.29	4.59	14.88	16.93	92.21	109.14
Seed priming with water	64.69	25.82	90.51	10.60	4.72	15.32	17.46	95.55	113.01
Seed priming + Inoculation with *Azotobacter*	67.10	27.08	94.18	10.96	4.92	15.88	18.13	99.82	117.95
Seed priming + Inoculation with AM fungi	69.15	27.35	96.50	11.26	5.05	16.31	18.57	100.58	119.15
Seed priming + Inoculation with Biomix	70.34	27.75	98.09	11.43	5.01	16.44	18.73	101.39	120.12
SEm±	1.33	0.68	1.46	0.23	0.05	0.24	0.32	1.58	1.57
CD at 5%	4.40	2.24	4.82	0.77	0.20	0.82	1.07	5.25	5.20
Nitrogen level (kg ha^{-1})									
120	60.89	23.96	84.85	10.20	4.59	14.79	16.83	92.02	108.85
135	64.97	25.45	90.42	10.68	4.76	15.44	17.70	96.09	113.79
150	69.01	27.89	96.90	11.21	5.01	16.22	18.40	101.04	119.44
165	72.04	28.62	100.66	11.55	5.07	16.62	18.91	102.51	121.42
SEm±	0.93	0.30	1.03	0.15	0.07	0.17	0.19	1.48	1.54
CD at 5%	2.70	0.87	2.99	0.42	0.19	0.48	0.54	4.29	4.47

Phosphorus and potassium content were not influenced significantly by nitrogen levels, however, the improvement in P and K uptake due to successive nitrogen levels was significant up to 150 kg ha^{-1} (Table 3). This was mainly due to the fact that nutrient uptake followed the yield pattern which increased with increasing level of nitrogen. Similar findings were reported by Ranwa (1997) and Tiwana and Narang (1997).

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