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Wheat yield maximization through nutrient management and use of growth retardants

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Abstract
The field experiment was conducted during the *rabi* season of 2016-17 at research farm of Wheat and Barley Section, Chaudhary Charan Singh, Haryana Agricultural University, Hisar. The soil of experimental field was sandy loam in texture, slightly alkaline in reaction (8.2), low in available nitrogen (180 kg/ha), medium in available P (14kg/ha) and high in available K (375 kg/ha). The experiment consisted of four nutrient levels (control, RDF, 125% RDN and RDF+ 15 t ha^{-1} FYM) in main plot and four sprays (water, Cycocel @ 0.2 %, Folicur @ 0.1 %, and Cycocel @ 0.2 %+ Folicur @ 0.1 %) in sub plot in split plot design with three replications. Application of RDF+ 15 t ha^{-1} FYM significantly improved yields and harvest index as compared to control and RDF. However, it was at par with 125% RDN in all the parameters. Foliar application of growth retardants at first node and flag leaf stages responded favourably to wheat crop. Among the sprays, Cycocel + Folicur resulted in significantly higher grain yield and harvest index. Whereas, Folicur was found superior in respect of dry matter accumulation and resulted in higher straw yield and biological yield.

Keywords: Wheat, nutrient levels, growth retardants, sprays, yields, harvest index

Introduction
Wheat (*Triticum aestivum* L.) has been described as "king of cereals" and one of the most important staple food crop, which supplies roughly half of the world's dietary calories. Wheat has its own outstanding importance as a human food; it is rich in carbohydrates and protein (Desai *et al*., 2015) [1]. Wheat grain contains all essential nutrients i.e. about 12% water, 60-80% carbohydrate, 8- 15% proteins containing adequate amount of all essential amino acids (except lysine, tryptophan and methionine), 1.5-2% fats, vitamins (such as B complex, vitamin E) and 2.2% crude fibre. Wheat is cultivated in about 43 countries of the world. The leading countries in wheat cultivation are China, India, Thailand, Indonesia and U.S.A. India is the second largest producer of wheat in the world after China contributing about 12% to total world wheat production. In India, wheat was sown on an area of about 30.6 million ha leading to production of 98.4 million tonnes at an average productivity of 3216 kg/ha during 2016-17 (Anonymous, 2017).

The use of chemical fertilizers deteriorating soil health, declining soil organic matter and increase in micronutrient deficiencies, thus suspecting the sustainability of wheat production (Sepat *et al*., 2010) [2]. Thus, emerging need of judicious use of nutrients at appropriate time to cope with declining productivity has been realized in recent time. The integrated use of organic and inorganic nitrogenous fertilizers has received considerable attention in the past with a hope of meeting the farmers's economic need as well as maintaining favourable ecological conditions on long-term basis (Kumar *et al*., 2007) [3]. Appropriate combination of inorganic fertilizers with organic manures will be effective in improving soil health and hastening the nutrient-use efficiency (Upadhyay and Vishwakarma, 2014) [4].

Plant canopy architecture management using growth retardants such as Cycocel to reduce the lodging chances in cereals is a novel technique to exploit the use of higher amount of nitrogen to attain higher yield (Mohaghegh and Imam, 2007) [5]. Cycocel treatment decreases the cell size and the length of internodes and increases the cell wall thickness, chlorophyll content number of stem sets and the stem diametre. In addition, it also increases the ability to use nitrogen manures in cereals (Miranzadeh *et al*., 2011) [6]. Similarly, application of Folicur during early stem extension reduces stem growth and lodging and increases canopy erectness and seed yield of crop before harvesting, significantly.

Material and Methods
The observations of the grain, straw and biological yields and harvest index of each treatment were recorded after harvesting of wheat crop. The bundles were sun dried, weighted, threshed and finally seeds were cleaned and yields were recorded.

Results and Discussion

Grain yield

Grain yield of wheat as influenced by different nutrient levels and sprays, is given in Table 1. The data revealed that there was a significant increase in grain yield of wheat with different nutrient levels over control. The grain yield recorded with RDF+ 15 t ha^{-1} FYM (61.80 q ha^{-1}) was significantly higher (55.0% and 7.59%, respectively) than the yield recorded at control (39.87 q ha^{-1}) and RDF (57.44 q ha^{-1}) but was statistically at par with 125% RDN (60.32 q ha^{-1}).

The grain yield of wheat was significantly influenced by sprays (Table 4.8). The maximum grain yield (56.11 q ha^{-1}) was obtained with Cycocel+ Folicur combination which was significantly higher (3.98% and 3.23%, respectively) over the water spray (53.96 q ha^{-1}) and Cycocel (54.35 q ha^{-1}) but at par with Folicur spray (55.09 q ha^{-1}).

Straw yield

The data on straw yield as influenced by different treatments are presented in Table 1. It revealed that the straw yield of wheat increased significantly with different nutrient levels over control. RDF+ 15 t ha^{-1} FYM resulted in maximum straw yield (90.67 q ha^{-1}) which was significantly higher (37.44% and 4.72%, respectively) than the straw yield recorded at control (65.97 q ha^{-1}) and RDF (89.03 q ha^{-1}) but at par with 125% RDN (89.03 q ha^{-1}).

Maximum straw yield (87.29 q ha^{-1}) was recorded in the treatment with water spray which was significantly higher (8.54% and 11.96%, respectively) than spray of Cycocel (80.42 q ha^{-1}) and Cycocel+ Folicur (77.96 q ha^{-1}) but was at par with Folicur (86.57 q ha^{-1}).

Biological yield

A perusal of data in Table 1 revealed that biological yield of wheat was significantly influenced with different nutrient levels. The maximum biological yield (152.48 q ha^{-1}) was recorded with RDF+ 15 t ha^{-1} FYM which was significantly higher (44.05% and 5.85%, respectively) than control (108.85qha^{-1}) and RDF (144.04 q ha^{-1}) but was statistically at par with 125% RDN (149.35 q ha^{-1}).

The biological yield of wheat varied significantly among different sprays. The maximum biological yield (141.63 q ha^{-1}) was recorded with Folicur which registered non-significant increase over water spray (141.23 q ha^{-1}) but was significantly higher (5.08% and 5.63%, respectively) than Cycocel (134.78 q ha^{-1})and Cycocel+ Folicur (134.08 q ha^{-1}).

Table 1: Effect of nutrient levels and sprays on yields and harvest index of wheat

Treatments	Grain Yield (q ha^{-1})	Straw Yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest Index (%)
Nutrients				
Control	39.87	65.97	105.85	37.66
RDF	57.44	86.58	144.04	39.87
125% RDN	60.32	89.03	149.35	40.38
RDF + 15 t ha^{-1} FYM	61.80	90.67	152.48	40.52
SEm±	0.81	1.12	2.02	0.17
CD at 5%	2.87	3.97	7.15	0.62
Sprays				
Water	53.96	87.29	141.23	38.20
Cycocel @ 0.2%	54.35	80.42	134.78	40.32
Folicur @ 0.1%	55.09	86.57	141.63	38.89
Cycocel @ 0.2%+ Folicur @ 0.1%	56.11	77.96	134.08	41.84
SEm±	0.50	0.60	1.15	0.18
CD at 5%	1.48	1.78	3.37	0.53

Harvest index

Harvest index of wheat as influenced by different nutrient levels and sprays, is presented in Table 1. Among the different nutrient levels, harvest index was significantly higher in treatment comprising RDF+ 15 t ha^{-1} FYM (40.52%) over the control (37.66%) and RDF (39.87%) but it was at par with 125% RDN (40.38%).

Among the sprays, Cycocel+ Folicur recorded maximum harvest index (41.84%) which was significantly higher over all the other sprays.

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