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Rachana Patel
Research Scholar, Department of Agronomy, CCS Haryana Agricultural University, Hisar, Haryana, India

Dr. SK Thakral
Professor, Department of Agronomy, CCS Haryana Agricultural University, Hisar, Haryana, India

Sanju Dudi
Research Scholar, Department of Agronomy, CCS Haryana Agricultural University, Hisar, Haryana, India

Corresponding Author:
Rachana Patel
Research Scholar, Department of Agronomy, CCS Haryana Agricultural University, Hisar, Haryana, India

Effect of nutrient management and growth retardants on wheat (*Triticum aestivum*) growth attributes and productivity

Rachana Patel, Dr. SK Thakral and Sanju Dudi

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 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. Results revealed that application of RDF+ 15 t ha^{-1} FYM significantly improved growth parameter (plant height and dry matter accumulation), 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 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, growth parameters, yield

Introduction
Wheat [*Triticum aestivum* (L.) emend. Fiori & Paol.] is the most important staple food crop of the world and emerged as the backbone of India's food security. It is grown all over the world for its wider adaptability and high nutritive value. It is an important winter cereal contributing about 38% of the total food grain production in India. India is the second largest wheat producer (approximately 12 per cent world's wheat production) and consumer after China. However, there is need to further increase the production to fulfil the requirement of exploding population, maintenance of adequate buffer stock and to meet out demand for processing industries (Anonymous, 2014)

But currently, there is a growing concern about the stagnant yields of wheat in major wheat growing regions like Punjab, Haryana, Madhya Pradesh and Rajasthan. 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) [1]. Integration of FYM and inorganic fertilizers improves soil fertility and thereby increases the productivity and monetary returns from wheat (Sarma *et al.*, 2007) [2]. In addition, this integration also helps to improve fertilizer use efficiency of inorganic fertilizers.

Growth retardants reduce plant lodging and improve plant architecture and thus increase solar radiation capturing and other environmental resources. These morphological changes can affect assimilate partitioning, improve seed filling and consequently the physiological quality of seeds.

Most commonly used growth retardant in wheat is chlormequat chloride. Chlormequat chloride is a derivative of Choline (2- chloro ethyl trimethyl ammonium chloride). Chlormequat chloride or Cycocel belongs to the group of ammonium compounds and is one of the most frequently used plant growth moderators particularly in India and nowadays it is highly used to reduce lodging and to control vegetative growth of crops especially grain cereals. (Pirasteh-Anosheh *et al.*, 2014) [3]. It also increases the ability to use nitrogen manures in cereals (Miranzadeh *et al.*, 2011) [4].

Folicur (tebuconazole) is a compound of triazole group which is known not only for its antifungal properties but also for inhibitory effect on stem elongation in certain crops. Application of Folicur during early stem extension reduces stem growth and lodging and increases canopy erectness and seed yield of crop before harvesting, significantly. Folicur used

in combination with other growth retardants can reduce lodging, improve plant disease resistance and other physiological properties of plant.

Materials and methods

The experiment was conducted during rabi season of 2016-17 at research farm of Wheat and Barley section, Department of Genetics and Plant Breeding, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana (India), which is situated at 29°10' N latitude and 75°46' E longitude at an elevation of 215.2 m above mean sea level. 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.

Growth parameters

Plant height

Plant height of five randomly tagged plants from each sub plot was recorded at 30, 60, 90 and 120 DAS and at maturity. The height of each plant was measured with the help of wooden scale from the soil surface to fully opened top leaf of the plant before ear emergence and up to the ear head after heading stage

Dry matter accumulation

Plants in per metre row length from the second row on either side in each sub plot, were cut close to the ground at 30, 60, 90, 120 DAS and at maturity to record dry matter accumulation per metre row length. These samples were first sun dried and then oven dried till a constant weight was obtained at each stage. After drying at 65 °C ± 2 °C, the samples were weighed for recording dry weight in grams per metre row length.

Yield

Biological yield

After harvesting the net plot area, the bundles of wheat crop were sun dried and then weight was recorded and converted into q/ha.

Grain yield

Grains were separated from straw with the help of thresher in each net plot area. The grain yield thus obtained from net plot area was converted into q/ha.

Straw yield

Straw yield was worked out by subtracting the grain yield from total biological yield of net plot area and expressed in q/ha.

Harvest index

Harvest index was calculated for each plot by using following formula:

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

Results and discussion

Growth Attributes

Plant height

The data related to plant height is indicated in Table 1. Plant height of the crop increased upto 120 DAS and then declined slightly at maturity. Initially at 30 DAS, plant height was not influenced by nutrient levels and sprays; however, at later growth stages significant variation in plant height by nutrient levels and sprays was recorded.

Dry matter accumulation

The perusal of data in Table 2 indicated that dry matter accumulation per metre row length at various growth stages increased progressively from vegetative stage to harvest stage. The dry matter accumulation at 30 DAS was non-significant under different treatments. The variations in dry matter accumulation under different treatments at all the other growth stages was significant.

Among different nutrient levels, RDF+ 15 t ha^{-1} FYM produced maximum dry matter at 90, 120 DAS and at maturity. However, at 60 DAS, maximum dry matter was produced in 125% RDN which was significantly higher than RDF and control. The dry matter accumulation with RDF+ 15 t ha^{-1} FYMwas statistically at par with125% RDN at all the growth stages.

The maximum dry matter was produced with Folicur spray which was significantly higher over Cycocel and Cycocel + Folicur at 90, 120 DAS and at maturity. However, at 60 DAS, maximum dry matter was produced in water spray. The dry matter accumulation was significantly at par in water and Folicur spray at all the growth stages.

Yields

Grain yield

Grain yield of wheat as influenced by different nutrient levels and sprays, is given in Table 3. The data revealed that 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 3). 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 3. 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 3 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}).

Harvest index

Harvest index of wheat as influenced by different nutrient levels and sprays, is presented in Table 3. 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.

Table 1: Effect of nutrient levels and sprays on plant height (cm) at various growth stages of wheat

Treatments	Plant height (cm)				
	30 DAS	60 DAS	90 DAS	120 DAS	Maturity
Nutrient levels					
Control	22.6	47.3	78.7	91.0	90.2
RDF	22.3	53.2	85.2	98.6	96.6
125% RDN	23.1	57.2	90.6	104.2	102.0
RDF +15 t ha^{-1} FYM	24.4	56.5	91.7	106.1	104.4
SEm±	1.3	0.8	0.8	1.1	1.3
CD at 5%	NS	2.8	3.0	3.9	4.6
Sprays					
Water	24.0	55.3	90.1	103.1	101.4
Cycocel @ 0.2%	23.5	53.1	84.7	97.1	96.2
Folicur @ 0.1%	21.9	54.1	89.0	104.5	101.0
Cycocel @ 0.2%+ Folicur @	23.0	51.9	82.3	95.3	94.5
0.1%					
SEm±	1.0	0.5	0.7	0.7	0.7
CD at 5%	NS	1.6	2.2	2.1	2.0

Table 2: Effect of nutrient levels and sprays on dry matter accumulation (g m^{-1} row length) at various growth stages of wheat

Treatments	Dry matter accumulation (g m^{-1} row length)				
	30 DAS	60 DAS	90 DAS	120 DAS	Maturity
Nutrient levels					
Control	10.6	39.0	120.3	200.1	204.0
RDF	11.5	48.7	190.9	294.0	296.7
125% RDN	12.5	52.6	202.5	327.7	331.1
RDF + 15 t ha^{-1} FYM	12.1	51.9	204.2	334.9	337.4
SEm±	0.6	1.0	3.1	4.3	2.6
CD at 5%	NS	3.5	11.2	15.1	9.1
Sprays					
Water	12.3	50.4	186.7	301.7	303.2
Cycocel @ 0.2%	11.4	47.0	173.9	278.0	283.8
Folicur @ 0.1%	11.4	49.5	187.2	304.8	304.9
Cycocel @ 0.2%+ Folicur @	11.7	46.4	170.2	272.1	277.3
0.1%					
SEm±	0.4	0.8	2.0	2.9	2.5
CD at 5%	NS	2.3	6.1	8.5	7.5

Table 3: 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

Conclusion

Based on one year study, it can be concluded that, application of RDF + 15 t ha^{-1} FYM for wheat was found optimum in terms of growth and yield. Among the sprays, Cycocel and Cycocel+ Folicur combination found useful in reducing plant height significantly. Cycocel + Folicur combination recorded maximum grain yield and thus affected the yield significantly.

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