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Nitrogen level with herbicidal combination on growth and yield attributes in wheat crop

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Abstract

An experiment was conducted at agronomy research farm on silty loam soil, having pH 8.6, EC 0.36 dSm⁻¹, organic carbon 0.31%, available N, P and K 178.0, 14.5 and 231.5 kg ha⁻¹, respectively. Experiment consisted of 9 treatment combinations together three levels of nitrogen viz. 80, 120 and 160 kg N ha⁻¹ and three herbicide treatments viz. pendimethalin fb 2, 4-D (1 + 0.5 kg a.i. ha⁻¹), clodinafop + metsulfuron (0.06 + 0.004 kg a.i. ha⁻¹) and sulfosulfuron (0.025 kg a.i. ha⁻¹) result reveal that All the herbicides applied as post-emergence, except pendimethalin. All the growth and yield contributing characters viz. plant height, Leaf Area Index, number of effective shoots, spike length, number of grain spike⁻¹ as well as test weight of grain were significantly higher in 160 kg N ha⁻¹ and clodinafop + metsulfuron (0.06 + 0.004 kg ha⁻¹). With respect to economics 160 kg N ha⁻¹ combined with clodinafop + metsulfuron (0.06 + 0.004 kg ha⁻¹).

Keywords: Nitrogen level, chemical herbicide, growth, yield attributes, wheat.

Introduction

Wheat (*Triticum aestivum* L.) is a staple food of the world as well as India and belongs to family Poaceae (Gramineae). It is the second most important food crop after rice. Wheat provide nearly 55% of the carbohydrate and 20% of food calories which is consumed by two billion people (36% of the world population) as staple food. India's wheat production increased by a whopping 900%. India's average wheat yield at 3.32 metric tonnes ha⁻¹ is above that of the USA's 3.20 metric tonnes ha⁻¹. India has overtaken USA, Russia, Canada, Australia, Argentina etc. in wheat production and yield. India produces more wheat than the USA and Canada combined (Anonymous 2019) [4]. Wheat ranks first in the world among the cereals both in respect of area 219.51 million hectare and production 758.02 million metric tonnes and productivity of 3450 kg ha⁻¹. India has the largest area under wheat (30.70 million hectares), but ranks second in production (98.51 million tonnes) after China with the average productivity of 3200 kg ha⁻¹ (USDA, 2017-18). Uttar Pradesh ranks first with respect to area (9.75 million ha) and production (30.3 million metric tonnes) but, the average productivity is much lower (3113 kg ha⁻¹) than Punjab (5097 kg ha⁻¹) and Haryana (5182 kg ha⁻¹) (Anonymous 2015) [3]. Wheat is the fastest growing food grain in India and all set to overtake rice (113 million metric tonnes). The demand of wheat by 2020 has been projected to be between 105 to 109 million tonnes in the country. The increase in production as to be managed from integrated use of resources, as the land area under wheat is not expected to expand further. One of the important components for increased production is the proper nutrition for growth and development of crop. Native fertility level of the soil with special reference to nitrogen is invariably insufficient for touching the peak production mark of a variety. Nitrogen plays a vital role in growth processes as it is an integral part of chlorophyll, protein and nucleic acid. So, nitrogen deficiency strongly reduces the photosynthetic activity at light saturation level. Consequently to get more crop production, nitrogen application is essential in the form of chemical fertilizer. The results showed that number of tillers per unit-1, plant height, spike's length, number of grain spike⁻¹ and 1000-grain weight were significantly increased by increasing nitrogen levels over control i.e. 0 kg (Ali *et al.*, 2011) [2].

Materials and Methods

The experiment was conducted during *Rabi* season of the year 2017-18 at Agronomy Research Farm of Acharya Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Ayodhya, (U.P.). The experimental site falls under sub-tropical region in Indo-Gangatic plains and lies between 26°47'N latitude and 82°12' E longitude at an altitude of about 113 meters from mean sea level, minimum and maximum temperatures during the crop season ranged from 5.50 to 17.20 °C and 18.34 to 37.60 °C and total rainfall received was 24.62 mm during the entire crop season. The experiment was conducted in Factorial Randomized Block Design with three replications. The treatments comprised of three levels of nitrogen and three herbicides treatment comprising with 9 treatment combinations. Experimental field was slightly alkaline in reaction (8.6 pH), low in organic carbon (0.31 %) and low in available nitrogen (178 kg ha⁻¹), medium in phosphorus (14.5 kg ha⁻¹) and potassium (231.5 kg ha⁻¹). Wheat cultivar PBW-373 was grown in the experimental field. The sown of crop was done on 10th December 2017 in rows at 20 cm apart at 4-5 cm deep by seed drill. Urea, SSP and MOP were used to supply (80, 120, 160 kg N) according to treatments, along with 60 kg P₂O₅ and 40 kg K₂O ha⁻¹. Pre-emergence application of pendimethalin @ (1 kg ha⁻¹) at (2nd DAS) and post emergence application of 2,4-D (0.5 kg ha⁻¹), VESTA 0.4 -clodinafop + metsulfuron (@0.06+0.004 kg ha⁻¹), sulfosulfuron (0.025 kg ha⁻¹) at (30 DAS) was done with the help of manually operated knapsack sprayer fitted with flat fan nozzle using 500 litres of water per hectare. The was recorded observations for growths and yield attributes at three place in a plot and then data statistically analysed.

Results and Discussion

Plant height (cm)

The results in Table 1 showed the various nitrogen levels and herbicides had effect on plant height. The application of nitrogen @ 160 kg ha⁻¹ (N₃) recorded significantly more plant height over lower nitrogen levels at various stages of crop growth, except 30 days stage mainly due to the availability of sufficient quantity of nitrogen to increase protein synthesis, cell division and cell elongation and enlargement which expressed morphological an increase in height of plant. Similar findings were reported by Savic *et al.* (2007) [8], Alemu *et al.* (2016) [11] and Imdad *et al.* (2018) [5]. Among the herbicide treatments, the maximum plant height was recorded in (W₂) clodinafop+ metsulfuron. This might be due to the fact that clodinafop + metsulfuron effectively controlled grassy and broad leaf weeds which were predominant in crop and increased the crop growth resulted these treatments had higher plant height. Similar results was reported by Pisal *et al.*, (2013) [7], Nanher *et al.*, (2015).

Leaf area index (LAI)

Nitrogen levels treatments significantly affect leaf area index at 60 and 90 DAS stage of crop in (Table 2). Increasing nitrogen rates gradually increased the LAI having the significantly highest values at 160 kg N ha⁻¹ (N₃) at 60, 90 DAS stage of crop growth. The increased in leaf area index with higher nitrogen levels might be due to more leaf area on account of more accumulation of assimilates. The nitrogen is very essential for chlorophyll synthesis in leaves, which helps in more photosynthesis and production of dry matter resulting increasing leaf area. Singh *et al.*, (1996) [10] also reported similar result. The data observed on leaf area index was influenced significantly from 60 and 90 DAS due to various herbicides. The leaf area index was recorded maximum with the application of W₂ (clodinafop + metsulfuron @ 0.06+0.004 kg ha⁻¹) at 60 and 90 DAS, which was significantly higher over the W₁ (pendimethalin fb 2, 4-D @ 1+0.5 kg ha⁻¹). It might be due to the pre dominance of broad leaf weeds, which were effectively controlled by W₂ (clodinafop + metsulfuron @ 0.06+0.004 kgha⁻¹) than W₁ (pendimethalin fb 2, 4-D @ 1+0.5 kg ha⁻¹) and sulfosulfuron. Similar results were reported by Nanher *et al.*, (2015).

Yield attributes

The yield attributing characters *viz.* length of spike (cm), number of grains spike⁻¹, 1000-grain weight (g) increased but not to the level of significance due to nitrogen application, except effective shoots (m⁻²). The number of effective shoots increased with increasing rate of nitrogen. Application of nitrogen @160 kg ha⁻¹ (N₃) produced significantly more number of effective shoots over lower level of nitrogen 80 kg N ha⁻¹ (N₁). Treatment (N₂) 120 kg N ha⁻¹ being *at par* with highest dose of nitrogen. This might be due to the fast rate of mineralization of chemical nitrogen which was sufficient for plant growth and development (Table 3). Similar results have been reported by Upasani *et al.*, (2013) [11], Singh *et al.*, (2015) [9]. Regarding the maximum number of grains spike⁻¹ recorded from herbicide W₂ (clodinafop + metsulfuron @ 0.06+0.004 kg ha⁻¹) followed by sulfosulfuron (W₃) and lowest in W₁ (pendimethalin fb 2, 4-D @ 1+0.5 kg ha⁻¹). Length of spike (cm) also followed the same trend as number of grains spike⁻¹ with respective treatments. To some extent, spike length is a genetic trait but at the same time environmental factors may also affect the yield attributes and yield especially length of spike and 1000-grains weight was recorded highest with W₂ (clodinafop + metsulfuron @ 0.06+0.004 kg ha⁻¹) followed by W₃(sulfosulfuron @ 0.025 kg ha⁻¹) and lowest in pendimethalin fb 2, 4-D (W₁). It is might be density and dry weight of weeds which were significantly low due to the herbicides application and have a very close negative correlation on effective shoots. Similar results have been reported by Yadav *et al.*, (2005), Imdad *et al.*, (2018) [5].

Table 1: Effects of nitrogen levels and herbicides on plant height (cm) at various growth stages of wheat

Treatments	30 DAS	60 DAS	90 DAS	At harvest
A. Nitrogen levels (kg ha⁻¹)				
N ₁ -80 kg N ha ⁻¹	23.10	59.27	77.73	76.57
N ₂ -120 kg N ha ⁻¹	24.33	63.37	82.67	81.83
N ₃ -160 kg N ha ⁻¹	25.17	67.30	87.80	86.97
SEm±	0.69	1.74	2.12	1.84
CD at 5 %	NS	5.23	6.37	5.52
B. Herbicides (kg ha⁻¹)				
W ₁ -Pendimethalin fb 2,4-D (@ 1+0.5 kg ha ⁻¹)	24.07	60.00	78.80	78.00

W ₂ -Clodinafop + metsulfuron (@0.06+0.004 kg ha ⁻¹)	24.63	67.17	87.00	85.80
W ₃ -Sulfosulfuron (@ 0.025 kg ha ⁻¹)	23.70	62.77	82.40	81.57
SEm±	0.69	1.74	2.12	1.84
CD at 5 %	NS	5.23	6.37	5.52

Table 2: Effect of nitrogen levels and herbicides on leaf area index of wheat at various growth stages of wheat

Treatments	30 DAS	60 DAS	90 DAS
A. Nitrogen levels (kg ha⁻¹)			
N ₁ -80 kg N ha ⁻¹	1.45	3.98	4.11
N ₂ -120 kg N ha ⁻¹	1.51	4.24	4.40
N ₃ -160 kg N ha ⁻¹	1.57	4.51	4.67
SEm±	0.004	0.08	0.10
CD at 5 %	NS	0.24	0.30
B. Herbicides (kg ha⁻¹)			
W ₁ -Pendimethalin fb 2,4-D (@ 1+0.5 kg ha ⁻¹)	1.51	4.06	4.18
W ₂ -Clodinafop + metsulfuron (@0.06+0.004 kg ha ⁻¹)	1.54	4.43	4.63
W ₃ -Sulfosulfuron (@ 0.025 kg ha ⁻¹)	1.49	4.24	4.38
SEm±	0.004	0.08	0.10
CD at 5 %	NS	0.24	0.30

Table 3: Effect of nitrogen levels and herbicides yield attributing

Treatments	Effective shoot (m ²)	Spike length (cm)	Grains spike ⁻¹	1000 grain weight (g)
A. Nitrogen levels (kg ha⁻¹)				
N ₁ -80 kg N ha ⁻¹	344.73	8.90	42.60	36.12
N ₂ -120 kg N ha ⁻¹	368.67	9.23	45.77	36.35
N ₃ -160 kg N ha ⁻¹	391.57	9.70	48.53	36.55
SEm±	9.00	0.26	1.25	0.80
CD at 5 %	26.99	NS	NS	NS
B. Herbicides (kg ha⁻¹)				
W ₁ -Pendimethalin fb 2,4-D (@ 1+0.5 kg ha ⁻¹)	350.97	9.27	43.17	36.35
W ₂ -Clodinafop + metsulfuron (@0.06+0.004 kg ha ⁻¹)	386.70	9.40	48.20	36.40
W ₃ -Sulfosulfuron (@ 0.025 kg ha ⁻¹)	367.30	9.17	45.53	36.27
SEm±	9.00	0.26	1.25	0.80
CD at 5 %	26.99	NS	NS	NS

Conclusions

Application of @160 kg N ha⁻¹ recorded tallest plant (cm) significantly at 60, 90 DAS and at harvest stage of crop at lower dose of nitrogen @ 80 kg N ha⁻¹, except at 30 days stage. Growth parameters like leaf area index were significantly affected due to different N levels at all stages of crop growth, except 30 DAS stage. Maximum grain yield (q ha⁻¹) was recorded under W₂ (clodinafop + metsulfuron @ 0.06 + 0.004kg ha⁻¹), which is being followed by W₃ (sulfosulfuron@ 0.025kg ha⁻¹). The value of harvest index was not influence significantly by herbicide treatments. Yield attributes character *i.e.* spike length (cm), grains spike⁻¹, 1000-grain weight (g) were found not significant due to various nitrogen levels. The maximum value of above characters was recorded in 160 kg N ha⁻¹, and minimum at lower dose of nitrogen (80 kg N ha⁻¹). Crop fertilized with 160 kg N ha⁻¹ produced highest number of effective tillers (m⁻²) over rest nitrogen level. Yield attributes character *i.e.* spike length (cm), grains spike⁻¹, 1000-grains weight (g) was found not significant due to different herbicides except number of effective tillers (m⁻²). Highest value of yield attributing characters was recorded with W₂ (clodinafop + metsulfuron @ 0.06 + 0.004kg ha⁻¹), which was followed by W₃

(sulfosulfuron@ 0.025kg ha⁻¹) and significantly superior than W₁ (pendimethalin fb 2, 4-D @ 1 + 0.5kg ha⁻¹).

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