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Response of wheat (*Triticum aestivum* L.) to different levels of Nitrogen and foliar spray of nutrient mixture under Allahabad conditions of Uttar Pradesh (India)

Latief Ahmad[1]*, R. A. Bhat[2], Tauseef A. Bhat[2] and Mohd. Kaleem[1]

[1]Allahabad Agricultural Institute-Deemed University Allahabad,-U.P, India.
[2]Sher-e-kashmir University of Agricultural Sciences and Technology of Kashmir-191121, India.

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A field experiment was conducted to study the "Response of wheat (*Triticum aestivum* L) to different levels of Nitrogen (N) and foliar spray of nutrient mixture under Allahabad conditions of Uttar Pradesh (India)" during Rabi 2007 to 2008 and 2008 to 2009 at Crop Research Farm, Department of Agronomy, Allahabad Agricultural Institute-Deemed University Allahabad- India. The results showed that, highest yield and growth attributes viz. periodic plant height, dry weight plant^{-1}, number of tillers plant^{-1} as well as number of spikes plant^{-1} were recorded with the application of 120 kg Nha^{-1} and foliar spray of 2% DAP + 1% KCl + nutrient mixture (F_2) whereas lowest value of yield and growth attributes was recorded with application of 30 kg Nha^{-1} and foliar spray of 2% DAP + 1% KCl + 100 ppm maleic hydrazide (F_4). Besides, foliar spray of 2% DAP + 1% KCl + 100 ppm salicylic acid 100 ppm (F_3) and 2% DAP + 1% KCl (F_1) also recorded significantly higher values of these growth characters over F_4 treatments.

Key words: Foliar spray, Nitrogen, nutrient mixture, growth, wheat.

INTRODUCTION

Wheat (*Triticum aestivum L*.) is the most important cereal crop of India. Average yield of wheat is lower than that of developed countries. In most wheat growing areas, inadequate supply of essential elements at improper developmental stages limit yield potential of wheat. In India, the use of sub optimal and imbalanced level of plant nutrients limit production potential of soils thus better plant nutrient management is therefore, necessary for achieving self reliance in agriculture. The application of only two or three plant essential elements (N and Phosphorous (P) with and without Potassium (K)) is not adequate to achieve potential yields of crops. Deficiency of one or more plant essential elements results reduction in yields and quality and makes the plants susceptible to many fungal and bacterial diseases.

Adequate nutrient management is among the most important factors in obtaining good yields of crops. It has been estimated that, at least 30 to 50% of crop yield is attributable to commercial fertiliser nutrient inputs. The importance of balance application of plant essential elements is well recognized throughout the world. The inorganic fertilizers provide only macronutrients viz. Nitrogen (N), phosphorous, and K but do not provide any micronutrient as a result of which the productivity of crops is being affected by the deficiency of micronutrients. A favourable balance of macro and micronutrients is required for optimum crop production. However, the nutrient imbalances can occur due to non- judicious and

*Corresponding author. E-mail: electricdream2003@yahoo.co.in.

liberal use of major nutrient and presence of low levels of micronutrients. The application of micronutrient combinations either in chelated or non-chelated forms gave greater biological and grain yields than individual applications of the micronutrients. The critical growth stage for nutrient application is one of the determinants of nutrient use efficiency. It has been found that, manipulating the timing of N application can optimize early tillering and yield component formation.

MATERIALS AND METHODS

The experiment was conduct at Crop Research Farm, Department of Agronomy, Allahabad Agricultural Institute-Deemed University Allahabad, India during Rabi 2007 to 2008 and 2008 to 2009. The soil of the experimental field was sandy loam in texture, low in available N 221 kg ha^{-1}, medium in available P 14.4 kg ha^{-1} and K 253.0 kg ha^{-1} with pH 7.9 (Alkaline) and 0.27% organic carbon.

The experiment was conducted on variety PBW-443, comprising of two factors (four N levels viz N_1:30 kg ha^{-1}, N_2:60kg ha^{-1}, N_3:90kg ha^{-1}, N_4:120kg ha^{-1} and four foliar spray of nutrient mixture viz F_1: 2% DAP + 1% KCl, F_2: 2% DAP + 1% KCl + nutrient mixture, F_3: 2% DAP + 1% KCl + 100 ppm salicylic acid and F_4: 2% DAP + 1% KCl + 100 ppm maleic hydrazide) was laid out in factorial randomized block design replicated thrice. (NB: Nutrient mixture = 0.5% MgSO4, 0.2% ZnSO4, 0.2% MnSO4 and 0.1% Borax, DAP = Di-ammonium phosphate and MOP = Murate of potash).

A uniform dose of P and K at the rate of 60 and 40 kg P_2O_5 and K_20/ha, respectively and half dose of N as per treatments was applied as basal at the time of sowing while as remaining half dose of N was applied in two equal splits, one each at 30 DAS and tillering stage as per treatment. N, P and K was applied through urea, DAP and MOP.

Foliar application of different nutrient mixtures was applied at full vegetative growth to each plot as per treatment. Plant height and number of tillers $plant^{-1}$ were recorded at 30, 60, 90, and 120 DAS from ten randomly tagged plants from two penultimate rows of each plot and subsequently averaged. Dry weight $plant^{-1}$ was determined by collecting plant samples from 50 cm row length (25 cm from each penultimate row) of each plot at 30, 60, 90, and 120 DAS. After sun drying for 2 to 3 days, the plant samples were oven dried at 60 to 65°C for 48 h to a constant weight. Similarly, number of spikes $plant^{-1}$ were recorded from ten randomly tagged plants from two penultimate rows of each plot one day before harvest and averaged to number of spikes $plant^{-1}$.The data obtained in respect of various observations was statistically analysed by the method described by Cochran and Cox (1963). The significance of “F” and “t” was tested at 5% level of significance.

RESULTS AND DISCUSSION

Plant height (cm)

Plant height was significantly influenced by N levels and foliar spray of nutrient mixture at 30 DAS, 60 DAS, 90 DAS and 120 DAS (Table 1) during both years. Polled data of two years reveals that, the plant height recorded with N_{90} level at 30, 60, 90 and 120 DAS was significantly higher over N_{60} and N_{30} levels. However, N_{90} and 120 levels were statistically at par with one another. Maximum increase in the plant height was observed with application of 120 kg N ha^{-1} that is, 21.2, 41.3, 88.4, and 91.9 cm at 30, 60, 90, and 120 DAS, respectively followed by 20.8, 40.8, 87.3, and 91.0 cm with 90 kg N ha^{-1} at 30, 60, 90, and 120 days, respectively, whereas least plant height of 19.4, 37.2, 83.8, and 87.4 cm at 30, 60, 90, and 120 DAS, respectively was recorded with 30 kg N ha^{-1}.

Significant increase in the plant height at N_{90} levels could be attributed to the fact that, N is an essential constituent of plant tissue and is involved in cell division and cell elongation. Jatoi (2003) also found that, N application at 120 $Kgha^{-1}$ significantly improved the plant height of wheat over 80 $kgNha^{-1}$.

Foliar spray of 2% DAP + 1% KCl + Nutrient mixture (F_2) significantly improved the plant height of wheat over 2% DAP + 1% KCl + 100 ppm Salicylic acid (F_3), 2% DAP + 1% KCl (F_1) and 2% DAP + 1% KCl +100 ppm Maleic hydrazide (F_4) at 30, 60, 90, and 120 DAS during both the years (Table 1). It was also found that, foliar spray with 2% DAP + 1% KCl +100 ppm Salicylic acid and 2% DAP + 1% KCl were statistically at par with one another but increased the plant height significantly over 2% DAP + 1% KCl + 100 ppm Maleic hydrazide at 30 and 90 DAS. The highest plant height of 22.0, 41.5, 88.9, and 92.5 cm at 30, 60, 90, and 120 DAS was recorded due to foliar spray with F_2 followed by foliar spray with F_3 that is, 20.5, 39.2, 85.8, and 90.0 cm at 30, 60, 90, and 120 DAS whereas, least plant of 20.5, 39.2, 85.8, and 90.0 cm at 30, 60, 90, and 120 DAS was observed in foliar spray with F_1. The significant increase in the plant height due to foliar spray of F_2 might be due to zinc application which is known to be involved in energy production and cell elongation as it is integral part in synthesis of Indole-3 acetic acid (Auxin) (Agarwal, 1992). Besides, manganese is essential for photosynthesis and N metabolism; while boron is primarily involved in cell wall formation, thus, micronutrients might have increased the general growth of plant including its height. Increase in the plant height due to foliar spray with F_3 might be due to the fact that, Salicylic acid a phytochrome plays role in the growth and development, photosynthesis, ion uptake and transport. Earlier, Kaydan and Yagmur (2007) also reported the increase in the plant height of wheat with foliar application of Salicylic acid. The significantly lower plant height recorded with F_4 treatment could be attributed to the fact that, Maleic hydrazide might have produced inhibitory effect on the plant growth even when used at low concentration (Henry and Cathey, 2009).

Dry weight $plant^{-1}$(g)

Dry weight was significantly influenced by N levels and foliar spray of nutrient mixture at 60 DAS, 90 DAS, and 120 DAS (Table 2) during both years and in the pooled data of two years, however, at 30 DAS dry weight remained unaffected due to N application and foliar spray of treatments.

Table 1. Response of wheat (*Triticum aestivum* L.) to different levels of nitrogen and foliar spray of nutrient mixture on Plant height (cm).

Treatments	Plant height (cm)											
	30 DAS			60 DAS			90 DAS			120 DAS		
Nitrogen levels (Kg ha^{-1})	2007-2008	2008-2009	Pooled	2007-2008	2008-2009	Pooled	2007-2008	2008-2009	Pooled	2007-2008	2008-2009	Pooled
N_{30}	19.2	19.7	19.4	36.9	36.5	37.2	83.2	84.4	83.8	87.0	87.9	87.4
N_{60}	20.5	20.8	20.6	38.6	38.4	39.0	85.1	86.3	85.6	89.1	90.1	89.6
N_{90}	20.9	21.3	20.8	40.3	40.7	40.8	86.7	88.1	87.3	90.4	91.6	91.0
N_{120}	21.1	21.5	21.0	40.9	40.7	41.3	87.4	89.5	88.4	91.5	92.3	91.9
F-test	S	S	S	S	S	S	S	S	S	S	S	S
SEd ±	0.156	0.186	0.151	0.789	0.82	0.808	0.563	0.622	0.593	0.603	0.656	0.647
CD (P=0.05)	0.32	0.38	0.31	1.61	1.69	1.65	1.15	1.27	1.21	1.23	1.34	1.32
Foliar spray of nutrient mixture												
F1	20.1	20.7	20.2	38.7	39.4	39	85.0	86.3	85.6	88.9	90.0	89.4
F1	21.8	22.2	22.0	41.1	41.9	41.5	88.1	89.8	88.9	91.9	93.2	92.5
F1	20.4	20.7	20.5	38.7	39.7	39.2	85.2	86.6	85.8	89.7	90.3	90.0
F1	19.6	20.0	19.8	38.2	38.9	38.7	84.1	85.5	84.8	87.5	88.4	88.0
F-test	S	S	S	S	S	S	S	S	S	S	S	S
CD (P=0.05)	0.156	0.186	0.151	0.789	0.82	0.808	0.563	0.622	0.593	0.603	0.656	0.647
SEd ±	0.32	0.38	0.31	1.61	1.69	1.65	1.15	1.27	1.21	1.23	1.34	1.32
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

F_1 = 2% DAP + 1% KCl, N_1 = 30 Kg ha^{-1} F_2 = 2% DAP + 1% KCl + Nutrient mixture*, N_2 = 60 Kg ha^{-1} F_3 = 2% DAP + 1% KCl + 100 ppm Salicylic acid, N_3 = 90 Kg ha^{-1}; F_4 = 2% DAP + 1% KCl + 100ppm Maleic hydrazide, N_4 = 120 Kg ha^{-1} *Nutrient mixture prepared by 0.5% $MgSO_4$, 0.25% MnSO4, 0.25% $ZnSO_4$ and 0.1 % Boric acid.

Pooled data of two years shows that, the dry weight recorded with 120 kg Nha^{-1} at 60, 90, and 120 DAS was significantly higher over 90, 60 and 30 Kg Nha^{-1}. Maximum increase in dry weight was observed with application of 120 Kg Nha^{-1}that is, 8.39, 15.6,1 and 15.96g per plant at 60, 90, and 120 DAS, respectively followed by 7.99, 14.90 and 15.23g per plant with 90 kg Nha^{-1} at 60, 90 and 120 DAS respectively whereas, as lowest dry weight of 6.78, 12.47 and 13.03g per plant was observed with 30 kg N ha^{-1} at 60, 90 and 120 DAS, respectively. Significantly higher dry weight obtained with 120 kg Nha^{-1} could be attributed to a fact that, N is an essential constituent of plant tissue and is involved in cell division and cell elongation. Besides, better uptake of N by crop with application of 120 kg Nha^{-1} may have also improved the growth of crop resulting in higher dry weight. Kumar et al. (1995) have also reported higher dry matter production in wheat at 120 kg Nha^{-1} application. The non-significant effect on the dry weight at 30 DAS with N application could be attributed to very low biomass increase due to varying rates of N application.

Foliar spray of 2% DAP + 1% KCl + Nutrient mixture (F_2) significantly increased the dry weight plant^{-1} over 2% DAP + 1% KCl + 100 ppm Salicylic acid (F_3), 2% DAP + 1% KCl (F_1) and 2% DAP + 1% KCl + Maleic hydrazide (F_4) at 60, 90, and 120 DAS, respectively, during both the years (Table 2). It was also found that, F_3 and F_1 treatments were statistically at par with one another but improved the dry weight plant^{-1} over F_4 treatments at 120 DAS.

The maximum dry weight plant^{-1} recorded with F_2 was 7.99, 15.26 and 15.42g at 60, 90 and 120 DAS, respectively followed by F_3 with dry weight plant^{-1} of 7.59, 14.54 at 60, 90 and 120 DAS and 14.51g, 7.58, 13.85 whereas lowest dry weight of 7.49, 13.44 and 13.83g was recorded with F_4 at 60, 90 and 120 DAS, respectively. Significantly highest dry weight recorded with F_2 treatment could be attributed to the application of micronutrients in addition to macronutrients which might have provided better nutrition to the crop to improve itsgrowth and development (Agrawal, 1992). The lowest dry weight recorded with F_4 treatment could be attributed to the fact that,

Table 2. Response of wheat (*Triticum aestivum* L.) to different levels of nitrogen and foliar spray of nutrient mixture on dry weight plant^{-1}(g).

Treatments	Dry weight plant^{-1}(g)											
	30 DAS			60 DAS			90 DAS			120 DAS		
Nitrogen levels (Kg ha^{-1})	2007-2008	2008-2009	Pooled	2007-2008	2008-2009	Pooled	2007-2008	2008-2009	Pooled	2007-2008	2008-2009	Pooled
N_{30}	0.59	0.67	0.65	6.64	6.92	6.78	12.28	12.67	12.47	12.94	13.14	13.03
N_{60}	0.65	0.73	0.69	7.41	7.50	7.48	13.44	13.76	13.60	14.06	14.41	14.23
N_{90}	0.69	0.78	0.73	8.01	7.97	7.99	14.41	14.65	14.9	15.12	15.34	15.23
N_{120}	0.72	0.82	0.77	8.38	8.41	8.39	15.27	15.72	15.61	15.70	15.83	15.76
F-test	S	S	S	S	S	S	S	S	S	S	S	S
SEd ±	0.059	0.045	0.034	0.132	0.093	0.156	0.333	0.416	0.318	0.304	0.186	0.235
CD (P=0.05)	-	-	-	0.27	0.19	0.32	0.68	0.85	0.65	0.62	0.38	0.48
Foliar spray of nutrient mixture												
F1	0.66	0.74	0.7	7.52	7.64	7.58	13.34	13.96	13.85	14.35	14.59	14.47
F1	0.71	0.8	0.77	7.93	8.04	7.99	14.67	15.11	15.26	15.31	15.53	15.42
F1	0.68	0.77	0.72	7.53	7.64	7.59	13.85	14.23	14.94	14.38	14.65	14.51
F1	0.61	0.69	0.76	7.45	7.48	7.49	13.14	13.5	13.44	13.76	13.97	13.83
F-test	S	S	S	S	S	S	S	S	S	S	S	S
SEd ±	0.059	0.045	0.034	0.132	0.093	0.156	0.333	0.416	0.318	0.304	0.186	0.235
CD (P=0.05)	-	-	-	0.27	0.19	0.32	0.68	0.85	0.65	0.62	0.38	0.48
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

F_1 = 2% DAP + 1% KCl,N_1 = 30 Kg ha^{-1} F_2 = 2% DAP + 1% KCl + Nutrient mixture*, N_2 = 60 Kg ha^{-1} F_3 = 2% DAP + 1% KCl + 100 ppm Salicylic acid, N_3 = 90 Kg ha^{-1}; F_4 = 2% DAP + 1% KCl + 100ppm Maleic hydrazide, N_4 = 120 Kg ha^{-1} * Nutrient mixture prepared by 0.5% $MgSO_4$, 0.25% MnSO4, 0.25% $ZnSO_4$ and 0.1 % Boric acid.

Maleic hydrazide is known to suppress epical dominance by completely inhibiting cell division in the apical meristems and produces plants with short internodes and unexpanded leaf blades (Cathey, 2009).

Tillers plant^{-1}

Tiller number plant^{-1} was significantly influenced by N levels and foliar spray of nutrient mixture at 30, 60, 90 and 120 DAS (Table 3) respectively, during both years.

Pooled data of the two years showed that, the number of tillers plant^{-1} recorded with application of 120 Kg Nha^{-1} at 30, 60, 90, and 120 DAS were significantly higher over 30, 60, and 90 Kg Nha^{-1} application. The maximum number of tillers plant^{-1} with application of 120 kg N ha^{-1} were 5.44, 8.99, 6.78, and 3.64 at 30, 60, 90, and 120 DAS, respectively followed by 5.30, 8.72, 6.36, and 3.51 with application of 90 kg Nha^{-1} whereas least number of tillers plant^{-1} at 30, 60, 90 and 120 DAS were recorded with 30 Kg Nha^{-1} as 4.70, 7.85, 5.63, and 3.28, respectively. Increase in the tiller number plant^{-1} could be explained on the basis of more uptake of P by the plant at higher N application because of synergistic effect between N and P thereby leading to increased root growth and proliferation at the vegetative growth of the plant. Earlier Khan and Hasan (2000) reported that, K is involved in tiller formation. Moreover, it was found that, tiller production maintained an increasing trend up to 60 DAS and there after declined gradually up to harvest. Decrease in the number of tillers after 60 DAS could be due to senescence of lower leaves by shading effect (Naeem, 2001).

Significant increase in the number of tillers plant^{-1} was recorded with foliar spray of 2% DAP + 1% KCl + nutrient mixture (F_2) over foliar spray of 2% DAP + 1% KCl + Salicylic acid (F_3), 2% DAP + 1% KCl (F_1) and 2% DAP + 1% KCl + Maleic hydrazide (F_4) at 30, 60, 90, and 120 DAS during both the years (Table 3). It was also found that both F_3 and F_1 also significantly improved the tiller number plant^{-1} over F_4 treatment at 30, 60 90 and120 DAS. The tiller number plant^{-1} was highest

Table 3. Response of wheat (*Triticum aestivum* L.) to different levels of nitrogen and foliar spray of nutrient mixture on number of tillers plant^{-1}.

Treatments	No. of Tillers plant^{-1}											
	30 DAS			60 DAS			90 DAS			120 DAS		
Nitrogen levels (Kg ha^{-1})	2007-2008	2008-2009	Pooled	2007-2008	2008-2009	Pooled	2007-2008	2008-2009	Pooled	2007-2008	2008-2009	Pooled
N_{30}	4.67	4.75	4.70	7.85	7.92	7.85	5.63	5..64	5.63	3.27	3.30	3.28
N_{60}	5.02	5.07	5.22	8.36	8.39	8.37	6.00	5.99	6.12	3.33	3.35	3.34
N_{90}	5.27	5.34	5.30	8.71	8.74	8.72	6.35	6.38	6.36	3.50	3.53	3.51
N_{120}	5.43	5.49	5.44	8.96	9.02	8.99	6.65	6.66	6.78	3.62	3.66	3.64
F-test	S	S	S	S	S	S	S	S	S	S	S	S
SEd ±	0.073	0.049	0.034	0.117	0.113	0.122	0.137	0.122	0.103	0.024	0.019	0.024
CD (P=0.05)	0.15	0.10	0.07	0.24	0.23	0.25	0.28	0.25	0.21	0.05	0.04	0.05
Foliar spray of nutrient mixture												
F1	5.13	5.2	5.33	8.44	8.5	8.74	6.19	6.2	6.19	3.44	3.46	3.45
F1	5.42	5.46	5.42	8.93	8.98	8.95	6.63	7.64	6.63	3.60	3..63	3.62
F1	5.17	5.24	5.20	8.48	8.53	8.5	6.25	6.23	6.36	3.46	3.49	3.47
F1	4.68	4.75	4.72	8.02	8.06	8.04	5.57	6.66	5.71	3.21	3.26	3.23
F-test	S	S	S	S	S	S	S	S	S	S	S	S
SEd ±	0.073	0.049	0.034	0.117	0.113	0.122	0.137	0.122	0.103	0.024	0.019	0.024
CD (P=0.05)	0.15	0.10	0.07	0.24	0.23	0.25	0.28	0.25	0.21	0.05	0.04	0.05
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

F_1 = 2% DAP + 1% KCl, N_1 = 30 Kg ha^{-1} F_2 = 2% DAP + 1% KCl + Nutrient mixture*, N_2 = 60 Kg ha^{-1} F_3 = 2% DAP + 1% KCl + 100 ppm Salicylic acid, N_3 = 90 Kg ha^{-1}; F_4 = 2% DAP + 1% KCl + 100ppm Maleic hydrazide,N_4 = 120 Kg ha^{-1} * Nutrient mixture prepared by 0.5% $MgSO_4$, 0.25% MnSO4, 0.25% $ZnSO_4$ and 0.1% Boric acid.

with foliar spray of F_2 treatment (9.45) at 60 DAS and thereafter tillers plant^{-1} declined gradually up to 120 DAS due to senescence of lower leaves by shading. The maximum number of tillers recorded at 120 DAS by F_2 treatment was 3.62 followed by 3.47 with F_3 and 3.45 with F_1. The least number of tillers plant^{-1} at 120 DAS were recorded with F_4 treatment (3.23). Significant increase in the tiller number per plant as recorded with F_2 treatment could be due to better nutrition to the crop with macro and micronutrients, especially P which is known to promote tiller production. F_3 treatment also produced significantly more tillers plant^{-1} than F_4 treatment. This might be due to the application of Salicylic acid spray as it plays important role in the ion uptake and transport (Kaydan and Yagmur , 2007).

Number of spikes plant^{-1}

Spikes plant^{-1} was significantly influenced by different levels of N and foliar spray of nutrient mixture during both the years (Table 4). Pooled data of two years shows that, spikes plant^{-1} were significantly more over application of 30 kg Nha^{-1} due to the application of 120 kg Nha^{-1} but the spikes plant^{-1} did not vary significantly among 120, 90, and 60 Kg Nha^{-1} application. Among different N levels, maximum number of spikes plant^{-1} (3.42) were recorded with application of 120 kg Nha^{-1}, followed by application of 90 kg Nha^{-1} (3.24), 60 kg Nha^{-1} (3.21) and the least number of spikes plant^{-1} was observed with the application of 30 kg Nha^{-1}. The higher N nutrition to the crop reflected in increased number of spikes plant^{-1}. Earlier Singh et al. (1995) also reported the significant improvement in the effective tillers plant^{-1} with N application up to 120 kgN ha^{-1}.

Significant increase in spikes plant^{-1} was observed with application of foliar spray of 2% DAP + 1% KCl + nutrient mixture (F_2) over 2% DAP + 1% KCl + 100 ppm Maleic hydrazide (F_4) but the spikes per plant did not vary significantly amongst F_2, F_3 (2% DAP + 1% KCl + 100 ppm Salicylic acid) and F_1 (2% DAP + 1% KCl) treatments (Table 4). It was also found that, the spikes plant^{-1} did not vary significantly amongst

Table 4. Response of wheat (*Triticum aestivum* L.) to different levels of N and foliar spray of nutrient mixture on number of spikes plant^{-1}.

Nitrogen levels (Kg ha^{-1})	Foliar spray of nutrient mixture														
	2007-08					2008-09					Pooled				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
N_{30}	3.14	3.32	3.16	3.02	**3.16**	3.07	3.32	3.19	3.05	**3.16**	3.10	3.32	3.17	3.02	**3.15**
N_{60}	3.18	3.36	3.20	3.07	3.20	3.22	3.37	3.24	3.10	3.23	3.20	3.36	3.22	3.08	3.21
N_{90}	3.32	3.50	3.34	3.21	3.34	3.33	3.49	3.36	3.22	3.35	3.32	3.49	3.35	3.21	3.34
N_{120}	3.39	3.55	3.41	3.28	3.41	3.42	3.55	3.44	3.30	3.43	3.40	3.55	3.42	3.29	3.42
Mean	3.26	3.44	3.28	3.14		3.26	3.44	3.31	3.17		3.25	3.41	3.29	3.15	
		F-test	SEd ±	CD (P=0.05)			F-test	SEd ±	CD (P=0.05)			F-test	SEd ±	CD (P=0.05)	
Nitrogen levels		S	0.132	0.27			S	0.127	0.26			S	0.127	0.26	
Foliar pray of nutrient mixture		S	0.132	0.27			S	0.127	0.26			S	0.127	0.26	
Interaction effect		NS	0.264	-			NS	0.254	-			NS	0.254	-	

F_1 = 2% DAP + 1% KCl: N_1 = 30 Kg ha^{-1}, F_2 = 2% DAP + 1% KCl + Nutrient mixture *:N_2 = 60 Kg ha^{-1}, F_3 = 2% DAP + 1% KCl + 100 ppm Salicylic acid:N_3 = 90 Kg ha^{-1}, F_4 = 2% DAP + 1% KCl + 100 ppm Maleic hydrazide:N_4 = 120 Kg ha^{-1}, * nutrient mixture prepared by 0.5% $MgSO_4$, 0.25% MnSO4, 0.25% $ZnSO_4$ and 0.1 % Boric acid.

F_3, F_1, and F_4 treatments. Maximum number of spikes (3.41) were recorded with F_2 treatment followed by F_3 (3.29) and F_1 (3.25) and the leastnumber of spikes plant^{-1} (3.15) was found in F_4 treatment. The significant increase in the spikes plant^{-1} recorded by F_2 treatment could be attributed to better growth and development attained by the crop due to additional application of micronutrients, known to be involved in photosynthesis, protein metabolism and energy transfer reactions. Earlier, Mohamed (1994) also reported the improvement in the number of spikes in wheat with foliar spray of Zinc, Iron and other micronutrients.

Grain yield (qha^{-1})

Grain yield as presented in Table 5 shows, reported by Akthar (2001), Naeem (2001) and increased significantly with the application of N and foliar spray of nutrient mixture and the interactions between them during two years. Pooled data over two years indicates that, grain increased significantly with N application at 120 kg N ha^{-1} over 90, 60, and 30 kg Nha^{-1}. N_{120} level marked grains yield superiority of 2.18, 6.12, and 14.9% over N_{90}, N_{60} and N_{30} levels, respectively.

Different N levels increased the nutrient content in the plants that lead to increase in vegetative growth. Besides, N is an essential constituent of plant tissue and thus is involved in cell division and cell elongation. The increase in vegetative growth is evident from the plant height, tiller production and dry matter accumulation and the increase in different yield contributing characters viz., spikes per plant, spike length, grains per spike thereby consequently improving the straw and grain yield of crop. The increase in grain and straw yield with application of N has also been Jatoi (2003). Comparatively lower grain and straw yield obtained with 30 Kg Nha^{-1} could be attributed to poor nutrition to the crop because of insufficient N uptake.

Maximum grain yield of 46.9 qha^{-1} was realized with application of F_2 treatment followed by F_3 treatment recording 44.5 qha^{-1} of grain whereas, the lowest grain yield of 43.4 qha^{-1}was recorded with F_4 treatment. F_2 treatment marked grain yield superiority of 5.39, 6.10, and 8.06, over F_3, F_1 and F_4 treatments, respectively. Comparatively higher grain yield recorded with F_3 treatment over F_1 and F_4 treatments could be due to the fact that, salicylic acid plays role in growth and development, photosynthesis, ion uptake and transport. Seed treatment/foliar spray of salicylic acid induces reduction in sodium absorption and toxicity which is further reflected in low membrane injury, high water content and high dry matter production (El-Tayeeb, 2005). Significantly lowest yield obtained with F_4 treatment even at lower concentration could be due to the fact that, Maleic hydrazide may have limited the growth anddevelopment of the crop due to its inhibitory effect (Henry and Cathey, 2009).The interaction effect for grain and straw yield between N levels and foliar spray of

Table 5. Response of wheat (*Triticum aestivum* L.) to different levels of nitrogen and foliar spray of nutrient mixture on grain yield (qha^{-1}).

Nitrogen levels ($Kg\ ha^{-1}$)	Foliar spray of nutrient mixture														
	2007-2008					2008-2009					Pooled				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
N_{30}	41.6	44.2	41.8	40.8	42.1	41.4	44.2	41.7	40.6	42.0	41.5	44.2	41.7	40.6	42.0
N_{60}	43.7	46.3	43.9	42.9	44.2	43.6	46.4	43.9	42.8	44.2	43.6	46.3	43.9	42.8	44.1
N_{90}	45.3	47.9	45.5	44.5	45.8	45.3	48.0	45.6	44.4	45.8	45.3	47.9	45.5	44.4	45.8
N_{120}	46.5	49.1	46.7	45.7	47.0	46.6	49.3	46.9	45.7	47.1	46.5	49.2	46.8	45.7	46.8
Mean	44.3	46.9	44.5	43.5		44.2	47	44.5	43.4		44.2	46.9	44.5	43.4	
		F-test	SEd ±	CD (P=0.05)			F-test	SEd ±	CD (P=0.05)			F-test	SEd ±	CD (P=0.05)	
Nitrogen levels		S	0.534	1.09			S	0.603	1.23			S	0.441	0.9	
Foliar spray of nutrient mixture		S	0.534	1.09			S	0.603	1.23			S	0.441	0.9	
Interaction effect		S	1.068	2.18			S	1.206	2.46			S	0.882	1.8	

F_1 = 2% DAP + 1% KCl,N_1 = 30 Kg ha^{-1} ,F_2 = 2% DAP + 1% KCl + Nutrient mixture *, N_2 = 60 Kg ha^{-1} F_3 = 2% DAP + 1% KCl + 100 ppm Salicylic acid, N_3 = 90 Kg ha^{-1}; F_4 = 2% DAP + 1% KCl + 100ppm Maleic hydrazide, N_4 = 120 Kg ha^{-1} * Nutrient mixture prepared by 0.5% $MgSO_4$, 0.25% MnSO4, 0.25% $ZnSO_4$ and 0.1 % Boric acid.

nutrient mixture was found significant. The highest grain and straw yield of 49.2 and 78.1 qha^{-1}, respectively was recorded with the treatment combination N_4F_2.

Conclusion

Both grain yield and different growth attributing characters viz, periodic plant height, dry weight $plant^{-1}$, number of tillers $plant^{-1}$ and number of spikes $plant^{-1}$ were significantly maximum with the application of 120 kg Nha^{-1} and least with application of 30 kg Nha^{-1}. Foliar spray of 2% DAP + 1% KCl + nutrient mixture (F2) significantly increased the yield and growth attributes viz: periodic plant height, dry weight $plant^{-1}$, number of tillers $plant^{-1}$ and number of spikes $plant^{-1}$ over 2% DAP + 1% KCl + 100 ppm maleic hydrazide (F_4). Foliar spray of 2% DAP + 1% KCl + 100 ppm salicylic acid 100 ppm (F_3) and 2% DAP + 1% KCl (F_1) also recorded significantly higher values of growth characters over F_4 treatments. The interaction effect between N and foliar spray of nutrient mixture was found significant for grain yield. The treatment combination N_{120} × 2% DAP + 1% KCl + 100 ppm nutrient mixture (F_2) produced the highest values for these characters.

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