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Effect of different NPK levels, splitting of soil application and foliar feeding of NPK (19:19:19) fertilizer on growth and yield of wheat (*Triticum aestivum* L.)

Paramjeet Singh, Shrikant Chitale, Rajendra Lakpale and Alka Singh

Abstract
The experiment was carried out at Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) during *Rabi* season of 2017-18 and 2018-19 to study the "Effect of different levels, splitting and foliar feeding of NPK fertilizer on growth and yield of wheat (*Triticum aestivum* L.)". The soil of experimental field was clayey in texture (*Vertisols*) locally known as Kanhar. The experiments were laid out in randomized block design with three replication, 12 treatments *viz.* T_1-50% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_2-100% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_3- 150% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_4-50% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_5-100% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_6-150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_7-T_4+ foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_8-T_5+ foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_9- T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_{10}-T_4 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_{11}-T_5+ foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_{12}-T_6+ foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage were studied the results revealed that all growth parameters and yield *viz*., plant height, number of tillers m^{-2}, number of leaves m^{-2}, leaf area, leaf area index, dry matter accumulation m^{-2}, crop growth rate, relative growth rate and SPAD value, grain yield (39.87 and 40.87 q ha^{-1}), straw yield and harvest index by the crop were significantly highest under the treatments T_{12}: T_6+ foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage as compared to other but it was found at par with T_9, T_6, T_3, and T_8 during 2017-18 and 2018-19.

Keywords: Different doses of NPK fertilizer, splitting of fertilizer, foliar spray NPK 19:19:19

Introduction
Cultivation of wheat has been a symbol of green revolution and self-sufficiency in food grain production in India. Wheat production in the year 2016-17 was recorded as 97.44 million tonnes covering an area of 30.23 million hectare the country (Anonymous, 2017a) [2]. In Chhattisgarh, major wheat growing districts are Raipur, Rajnandgaon, Durg, Bemetara, Dhamtari, Janjgir-Champa and Bilaspur. Wheat occupies an area of 1337 thousand ha with the production of 1.53 mt and productivity of 1145 kg ha^{-1} in the state (Anonymous, 2017b) [3]. The country further requires about 100 million tonnes of wheat by the year 2030 to fulfill the demands of the growing population. The main emphasis would be on increasing the productivity of wheat by adopting the improved cultivation practices through the effective and efficient management of nutrients.
Balanced nutrition of plants is the second most important factor determining ultimate crop productivity. Soil application is most common method to supply essential nutrients to plant. However, foliar spray of one or more nutrients to supplement soil application of fertilizers has gaining more attention in recent years to overcome the problem of low fertilizer nutrient supply from soil to plant (Reena *et al*., 2018, Rajesh and Paulpandi, 2013) [20, 18]. Nutrients applied through the fertilizers at the time of sowing are not fully utilized by the crop and are lost through leaching, fixation etc. and the crop may suffer nutrients deficiency at the later stage.
Nitrogen is one of the major nutrients which reduce the yield of wheat if not applied in proper amount as it is needed for fast growth of plants and to get high production per hectare. Nitrogen play important role in all the metabolic processes of plants.

Nitrogen is the main component and major constituent of plants especially in living tissues formation. Nitrogen insufficiency influences biomass synthesis and use of sun energy for productivity of the plant, with an extraordinary effect on grain yield and yield contributing parameters (Heinemann *et al*., 2006) [11]. The inconsistency in soil and climatic conditions related with farms that influence nitrogen elements in the root zone and their association with the plant may prompt variation in nitrogen accessibility and its necessity to plant (Simili *et al*., 2008 and Espindula *et al*., 2010) [23, 6]. It should be kept in mind that the optimized level of nitrogen application should be low for the cultivar less responsive to its application and the rate of nitrogen should be high for the variety that is more responsive to its application otherwise yield potential of the varieties would be decreased.

Phosphorus, is linked with a plant's ability to use and store energy, including the process of photosynthesis. It's also needed to help plants growth and develop normally. Phosphorus in commercial fertilizers comes from phosphate rock.

Potassium is the third key nutrient of commercial fertilizers. It helps to strengthen the plants' abilities to resist disease and plays an important role in increasing crop yields and overall quality. Potassium also protects the plant when the weather is cold or dry, strengthening its root system and preventing wilt.

Fertilizer is the important source to increase wheat yield. Among fertilizer application methods, apart from split and band placement, one of the most important methods of application is foliar nutrition through leaves. It is an efficient technique of fertilizer which enhances the availability of nutrients. Foliar nutrients facilitate easy and quick consumption of nutrients by penetrating the stomata or leaf cuticle and inter the cells. It is determined that during crop growth, supplementary foliar fertilizer increases plants mineral status and improve crop yields. Foliar feeding of mineral nutrients at Crown Root Initiation (CRI), tillering, jointing, booting and various stages of wheat crop in utilization of nutrients is much effective to increase the yield.

Among the different management practices, role of macro nutrients is crucial in crop nutrition for achieving higher yields (Raun & Johnson, 1999) [19]. Nitrogenous fertilizers play a vital role in modern farm technology, however only 20-50% of the soil applied nitrogen is recovered by the annual crops. The leftover nitrogen is lost from the soil system through denitrification, volatilization and leaching. In this situation, the partial and in-efficient use of nitrogen results in lower crop harvests. Thus efforts are needed to minimize its losses and to enhance its economic use. It has been observed that utilization of fertilizers especially, urea applied through soil is not as effective as when it is supplied to the plant through foliage along with soil application. Foliar application of water soluble fertilizers may be a very good option under this situation to promotes the rate of tillering, branching, flowering, increases the yield and ensures timely maturity of cereals crops under reduced cost of cultivation. Foliar fertilizers can provide the plant nutrient at critical stages of plant growth when the nutrient requirement of plant exceeds the normal uptake for certain nutrients (Fageria *et al*., 2009) [7]. Supplemental foliar nutrition of nutrients is more advantageous than soil application due to better translocation from the leaves to the developing seeds and efficient utilization of nutrients (Manonmani and Srimathi, 2009) [13]. Recently, new generation water soluble fertilizers have been introduced specially for foliar sprays. NPK 19:19:19 fertilizer is available as hundred per cent water soluble complete fertilizer containing nitrogen, phosphorus and potassium each 19% with low salt index. Foliar feeding also ensures the ample availability of nutrients to crops for obtaining higher yield (Arif *et al*., 2006) [4]. Several researchers justified the idea that nutrients (like N) may be taken up through roots and leaves and may spread within the plant (Ahmed & Ahmed, 2005, Hassanein, 2001) [1, 10]. The efficiency of N assimilation through foliage, however, depends upon several factors including varieties or genotypes.

Material and Methods

The soil was neutral (pH 7.04-7.21) in reaction with medium in fertility having 0.45-0.48% soil organic carbon, low nitrogen (182-185 kg ha^{-1}), medium phosphorus (16.23-18.15 kg ha^{-1}) and high potassium (312-314 kg ha^{-1}) content. The experiments were laid out in randomized block design with three replication, 12 treatments *viz.* T_1-50% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_2-100% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_3-150% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_4-50% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_5-100% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_6-150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_7-T_4+ foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_8-T_5+ foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_9-T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_{10}-T_4 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_{11}-T_5+ foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_{12}-T_6+ foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage. Sowing of seeds was done manually at a depth of 5 cm keeping inter row spacing of 20 cm using recommended seed rate of 120 kg ha^{-1}. The wheat variety 'GW-366' was sown as test crop on 28th November 2017 and 19th November 2018 in the experiments. Harvesting was done on 30th march 2018 in the first year and 18th march 2019 in the second year.

Result and Discussion

Plant population (m^{-2})

It is evident from the data presented in Table 1 that plant population (m^{-2}) at 30 DAS and at harvest did not vary statistically due to different treatments of wheat nutrition at variable levels and timing of nutrient application.

Plant height (cm)

The data pertaining to plant height at different growth stages are embodied in Table 2. It is obvious from the data that plant height increased progressively upto harvest of the crop under all treatments. The height increased rapidly upto 40 days and thereafter rate of increase declined slightly upto 60 DAS. After this point the rate of increase in plant height was very slow.

At 30 DAS, no significant difference was observed in plant height due to various treatment. Foliar nutrition of wheat at variable nutrient levels and timing of nitrogen application exerted their significance on plant height at 60 DAS, 90 DAS and at harvest stage during year 2017-18 and 2018-19. It increased at various nutrient levels and timing of nitrogen application. Treatment-150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage) + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and

5 DA late jointing stage (T_{12}) brought significant higher in plant height at 60 DAS, 90 DAS and at harvest however, it was found at par to T_9-T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_6-150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_3-150% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_{11}-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_8-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, and T_5-100% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage). These results are in agreement with the findings of Samadiyan *et al.* (2013) [21], Shirazi *et al.* (2014) [22] and Suryawanshi *et al.* (2014) [26].

Number of tillers (m^{-2})

Data on the number of tillers (m^{-2}) at 30, 60, 90 DAS and at harvest as influenced by foliar nutrition on wheat at different nutrient levels and timing of nitrogen application are presented in Table 3.

Table 1: Plant population as influenced by foliar nutrition on wheat at variable nutrient levels and timing of nitrogen application

Treatment		Plant population (m^{-2})					
		30 DAS			At harvest		
		2017-18	2018-19	Mean	2017-18	2018-19	Mean
T_1	50% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage)	122.0	123.6	122.8	112.1	107.3	109.7
T_2	100% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage)	136.0	143.6	139.8	125.4	127.4	126.4
T_3	150% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage)	139.3	146.9	143.1	128.7	132.0	130.3
T_4	50% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage)	127.3	129.9	128.6	114.7	111.3	113.0
T_5	100% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage)	134.1	141.7	137.9	123.5	128.0	125.8
T_6	150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage)	139.8	147.4	143.6	131.9	137.8	134.8
T_7	T_4 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage	129.3	133.6	131.5	116.7	118.6	117.7
T_8	T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage	136.4	144.0	140.2	124.4	129.0	126.7
T_9	T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage	142.0	149.6	145.8	134.1	142.6	138.3
T_{10}	T_4 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage	131.3	135.6	133.5	117.4	122.0	119.7
T_{11}	T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage	137.3	144.9	141.1	126.7	129.9	128.3
T_{12}	T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage	148.0	158.9	153.5	138.1	146.0	142.0
SEm±		7.69	6.67	5.74	6.23	7.89	6.57
CD (P=0.05)		NS	NS	NS	NS	NS	NS

Table 2: Plant height (cm) as influenced by foliar nutrition on wheat at variable nutrient levels and timing of nitrogen application

Treatment	Plant height (cm)											
	30 DAS			60DAS			90 DAS			At harvest		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean
T1	29.7	31.1	30.4	67.6	70.1	68.8	77.8	79.3	78.5	92.0	93.0	92.5
T2	31.4	31.7	31.6	71.4	72.4	71.9	80.5	81.9	81.2	95.0	96.3	95.7
T3	34.1	34.8	34.4	75.2	76.3	75.8	88.8	90.6	89.7	98.2	99.5	98.8
T4	31.1	31.1	31.1	68.5	69.2	68.8	78.0	78.8	78.4	92.3	94.0	93.2
T5	31.5	32.3	31.9	72.9	74.5	73.7	85.0	86.8	85.9	95.5	96.8	96.2
T6	34.3	35.9	35.1	76.5	77.4	76.9	89.4	91.2	90.3	100.2	102.2	101.2
T7	31.2	33.2	32.2	70.1	71.2	70.6	79.1	80.1	79.6	93.3	93.7	93.5
T8	31.5	33.2	32.3	74.5	75.6	75.0	86.2	88.0	87.1	96.5	97.8	97.2
T9	34.4	36.2	35.3	77.3	78.7	78.0	90.0	91.1	90.6	101.8	104.2	103.0
T10	31.4	31.7	31.5	70.1	71.6	70.8	82.0	82.4	82.2	94.0	96.0	95.0
T11	33.2	34.4	33.8	74.7	76.2	75.4	87.5	89.3	88.4	97.5	101.2	99.3
T12	34.2	37.0	35.6	79.5	81.6	80.6	92.6	93.1	92.8	102.2	104.2	103.2
SEm±	1.30	2.45	1.60	2.46	2.46	1.83	3.26	3.46	3.26	2.31	2.54	2.19
CD (P=0.05)	NS	NS	NS	7.24	7.24	5.37	9.60	10.18	9.59	6.79	7.48	6.46

*T_1-50% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_2-100% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_3-150% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_4-50% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_5-100% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_6-150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_7-T_4 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_8-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_9-T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_{10}-T_4 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_{11}-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_{12}-T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage.

The data indicated that the foliar nutrition of wheat at different nutrient levels and timing of nitrogen application had significant influence on number of tillers m^{-2} at all the stages except at 30 DAS during both the year. Significantly highest number of tillers m^{-2} was obtained under treatment T_{12}-(T_6) 150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage) + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage being at par with the number of tillers recorded under treatment T_9-T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_6-150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_3-150% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_{11}-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_8-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage and T_5-100% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage) and was significantly superior to the rest of treatment. Increased level of nutrient resulted in production of more tillers from the main stem. The number of tillers plant^{-1} increased significantly with exalted in nitrogen level up to 150 kg N ha^{-1} due to increased values of growth parameters and promoted vegetative growth. All fertilizer levels significantly affected the vegetative growth of the plant depending upon the availability of needed nutrition which led to proportional increase in tillers m^{-2}. These results are confirmatory to those revealed by Suryawanshi *et al*. (2014) [26] and Balwan *et al*. (2017) [5].

Dry matter accumulation m^{-2}

Results exhibited in Table 4 revealed that different treatments under study have caused significant variation in dry matter accumulation of wheat at 60, 90 DAS and at harvest stages during years 2017-18 and 2018-19. Foliar nutrition at variable nutrient levels and timing of nitrogen application significantly influenced the dry matter accumulation at 60 DAS and onwards. Highest dry matter accumulation at all the growth stages was recorded under the treatment T_{12}-150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage) + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage being at par with treatment T_9, T_6, T_3, T_{11}, T_8 & T_5 and found to be significantly superior to rest of the treatments. Similar trend was noticed during both the years. Increased dry matter accumulation per meter square due to adequate and continuous supply of major nutrients through split dose of soil applied nutrients under T_5, T_8 & T_{11} and liquid foliar application of NPK fertilizers adjoined with higher dose of NPK at different timing in T_3, T_6 & T_9 might be responsible for increased dry matter production. These results are in agreement with the findings of Nehra *et al*. (2001) [16] and Samadiyan *et al*. (2013) [21].

Crop growth rate (g day^{-1} m^{-2})

Crop growth rate was computed between 0-30, 30-60, 60-90 DAS and 90 DAS-at harvest and depicted through Fig 1. CGR was lowest between 0-30 DAS and increased progressively with the increasing crop age and reached to the highest between 60-90 DAS and declined sharply at maturity due to the completion of vegetative phase of wheat plants. This pattern of CGR in wheat was agreement with the observation of Balwan *et al*. (2017) [5] who stated that CGR is normally low in the early growth stage and increases with time, reaching a maximum value at flowering.

Foliar nutrition on wheat at variable nutrient levels and timing of nitrogen application significantly influenced the CGR at 30-60 DAS and 60-90 DAS only. At 60-90 DAS, highest CGR value was recorded under the treatment T_{12}-(T_6) 150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage) + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and late jointing stage remained statistically at par with the treatments T_9-T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_6-150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_3-150% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_{11}-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_8-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage and T_5-100% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage) and found to be significantly superior to rest of the treatments during both the years. Application of higher dose of nutrients might have facilitated plants for better utilization of resources. This advantage of extra nutrients enhanced the CGR. Similar results have also been reported by Singh and Kushawaha (2013) [25] and Balwan *et al.* (2017) [5].

Table 3: Number of tillers (m^{-2}) as influenced by foliar nutrition on wheat at variable nutrient levels and timing of nitrogen application

Treatment	Number of tillers (m^{-2})											
	30 DAS			60DAS			90 DAS			At harvest		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean
T1	153	163	158	214	230	222	267	288	277	327	354	341
T2	181	189	185	249	258	253	312	330	321	391	408	400
T3	184	194	189	259	273	266	323	342	333	407	423	415
T4	159	166	163	221	235	228	282	294	288	345	362	354
T5	177	187	182	249	262	256	317	334	325	397	413	405
T6	184	194	189	261	274	268	325	343	334	407	425	416
T7	168	176	172	234	248	241	294	312	303	367	384	375
T8	180	190	185	254	265	260	317	335	326	398	415	406
T9	188	197	192	265	278	272	335	348	342	415	431	423
T10	169	179	174	244	252	248	298	314	306	373	390	381
T11	181	191	186	255	269	262	321	337	329	401	417	409
T12	199	209	204	270	281	276	352	370	361	443	459	451
SEm±	8.50	9.25	8.80	6.77	6.85	6.22	12.22	12.80	12.24	17.00	17.01	16.76
CD (P=0.05)	NS	NS	NS	19.94	20.17	18.31	35.96	37.67	36.01	50.03	50.08	49.32

*T_1-50% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_2-100% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_3-150% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_4-50% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_5-100% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_6-150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_7-T_4 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_8-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_9-T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_{10}-T_4 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_{11}-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_{12}-T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage.

Table 4: Dry matter accumulation (g m^{-2}) as influenced by foliar nutrition on wheat at variable nutrient levels and timing of nitrogen application

Treatment	Dry matter accumulation (g m^{-2})											
	30 DAS			60DAS			90 DAS			At harvest		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean
T1	47.89	62.06	54.97	173.83	181.07	177.45	630.74	666.92	648.83	882.77	961.00	921.88
T2	54.44	75.46	64.95	225.70	243.54	234.62	826.79	900.50	863.64	1066.01	1154.58	1110.29
T3	58.78	76.66	67.72	280.63	277.64	279.14	977.19	1026.56	1001.88	1192.08	1280.64	1236.36
T4	49.67	66.96	58.31	179.27	182.41	180.84	642.43	725.81	684.12	972.32	1029.89	1001.11
T5	55.22	75.86	65.54	243.70	271.17	257.43	936.80	1003.84	970.32	1128.36	1206.59	1167.47
T6	60.22	76.46	68.34	284.70	280.50	282.60	1038.50	1067.21	1052.85	1232.72	1321.29	1277.01
T7	50.89	68.36	59.62	217.63	237.50	227.57	729.19	861.23	795.21	1026.75	1094.64	1060.69
T8	56.11	72.76	64.44	244.63	272.04	258.34	944.49	1001.20	972.84	1139.38	1227.94	1183.66
T9	62.11	78.16	70.14	287.73	289.86	288.80	1076.73	1072.38	1074.55	1279.22	1326.45	1302.84
T10	52.00	69.06	60.53	223.07	242.57	232.82	789.47	890.51	839.99	1076.69	1123.92	1100.31
T11	57.56	77.06	67.31	266.10	277.14	271.62	951.36	1000.73	976.04	1186.91	1254.81	1220.86
T12	65.78	78.46	72.12	296.60	298.76	297.68	1102.57	1089.94	1096.25	1317.46	1344.02	1330.74
SEm±	6.18	5.99	3.71	17.99	16.62	12.41	60.67	43.35	40.50	68.15	63.46	64.14
CD (P=0.05)	NS	NS	NS	52.94	48.91	36.51	178.56	127.58	119.21	200.56	186.77	188.76

*T_1- 50% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_2- 100% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_3- 150% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_4- 50% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_5- 100% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_6- 150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_7- T_4 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_8- T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_9- T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_{10}- T_4 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_{11}- T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_{12}- T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage.

Relative growth rate (g g^{-1} day^{-1})

The relative growth rate of wheat was computed at 0-30, 30-60, 60-90 DAS and 90 DAS-at harvest and the data are depicted through Fig 2. Foliar nutrition of wheat at variable nutrient levels and timing of nitrogen application did not significantly affect the relative growth rate throughout the crop growth during both the years. However, value during different periods of crop growth was found maximum under treatment T_{12}-(T_6) 150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage) + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and late jointing stage and minimum relative growth rate was found under the T_1-50% RDF (50% of N as basal + 25% at CRI + 25% late jointing) during 2017-18 and 2018-19 respectively. It is clear from the data that the relative growth progressively decreased with advancement of crop age. Similar finding was reported by Balwan *et al.* (2017) [5].

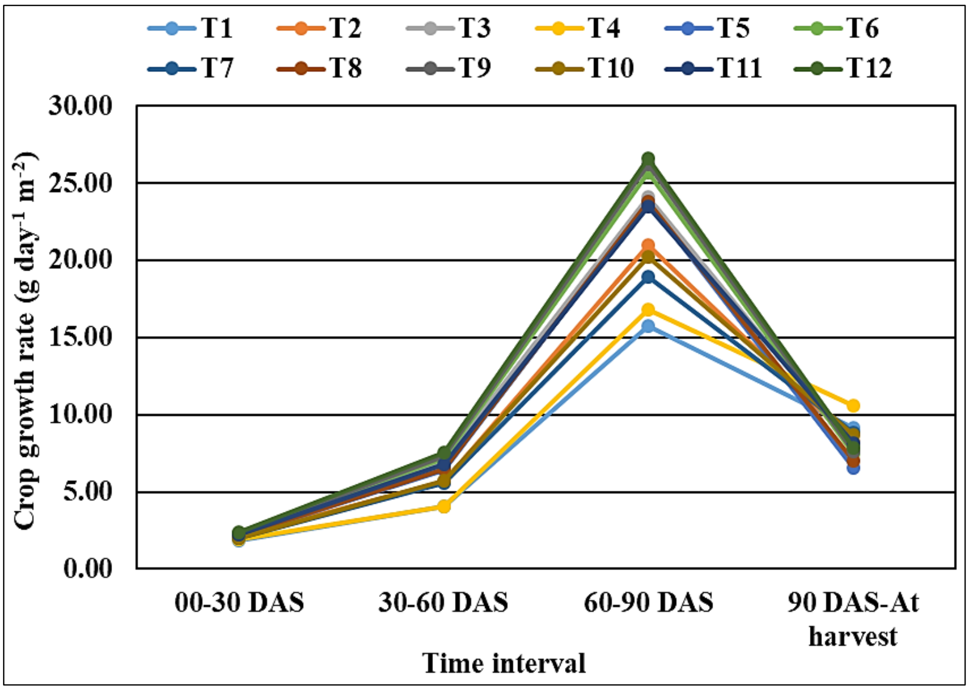

Fig 1: Crop growth rate (g day^{-1} m^{-2}) mean of 2017-18 and 2018-19

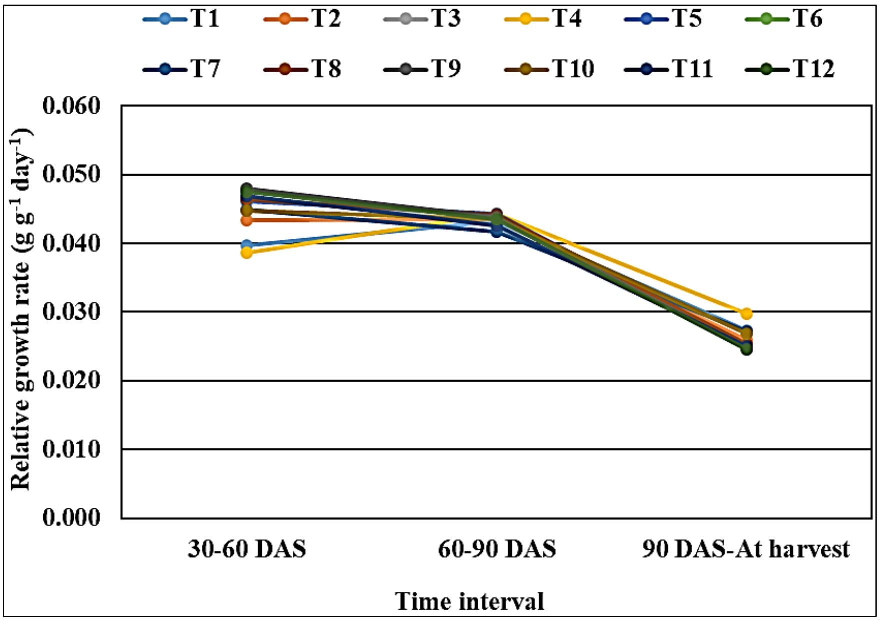

Fig 2: Relative growth rate (g g^{-1} day^{-1}) mean of 2017-18 and 2018-19

Number of leaves m^{-2}

Significant variation in the number of leaves m^{-2} of wheat due to foliar nutrition at variable nutrient levels and timings of nitrogen application was observed at 30, 60 and 90 DAS during year 2017-18 and 2018-19 (Table 5). No significant difference in number of leaves m^{-2} was observed at 30 DAS due to different treatments. Significantly maximum number of leaves m^{-2} was registered at 60 and 90 DAS in treatment T_{12}-(T_6) 150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage) + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and late jointing stage. Statistically at par number of leaves m^{-2} recorded under treatments T_9-T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_6-150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_3-150% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_{11}-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_8-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage and T_5-100% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage) to that of T_{12} and were significantly superior to rest of the treatments during both the years. Enhanced number of leaves per metre square due to adequate and continuous supply of major nutrients might be responsible for prolific leaf production, as nitrogen, being the main constituent of chlorophyll increased the photosynthetic efficiency of crop resulted in higher leaf counts. Similar result was observed by Nehra *et al*. (2001) [16] and Dhiman Mukherjee (2019) [15].

Table 5: Number of leaves m^{-2} as influenced by foliar nutrition on wheat at variable nutrient levels and timing of nitrogen application

Treatment	Number of leaves m^{-2}								
	30 DAS			60DAS			90 DAS		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean
T1	400.47	473.44	436.96	1619.81	1969.43	1794.62	2223.47	2599.09	2411.28
T2	526.96	639.90	583.43	2062.15	2403.17	2232.66	2772.48	3161.88	2967.18
T3	630.37	739.73	685.05	2373.42	2763.96	2568.69	3255.42	3696.87	3476.14
T4	419.61	503.22	461.42	1701.47	2044.43	1872.95	2413.14	2725.00	2569.07
T5	540.21	643.22	591.71	2146.36	2518.65	2332.50	3001.89	3396.71	3199.30
T6	653.65	764.39	709.02	2418.26	2816.40	2617.33	3329.45	3748.53	3538.99
T7	470.46	559.88	515.17	1859.14	2223.89	2041.52	2537.94	2913.37	2725.65
T8	566.02	666.51	616.26	2216.82	2576.32	2396.57	3106.56	3519.01	3312.78
T9	669.17	801.52	735.34	2498.11	2911.32	2704.71	3499.34	3880.16	3689.75
T10	482.41	577.87	530.14	1979.68	2298.24	2138.96	2603.05	2971.73	2787.39
T11	598.85	693.53	646.19	2282.76	2680.84	2481.80	3195.64	3600.56	3398.10
T12	714.30	855.38	784.84	2574.06	2960.77	2767.41	3722.15	4160.13	3941.14
SEm±	73.76	82.59	76.66	159.22	174.84	164.62	246.07	264.91	254.08
CD (P=0.05)	NS	NS	NS	468.60	514.57	484.48	724.21	779.66	747.78

*T_1-50% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_2-100% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_3-150% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_4-50% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_5-100% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_6-150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_7-T_4 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_8-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_9-T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_{10}- T_4 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_{11}-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_{12}- T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage.

Leaf area cm^2

Green leaf area is the source of food production of green plants and respond well to the nutrients. Significant variation was observed in respect to leaf area due to different treatments (Table 6). There was a general trend of declining leaf area as the age of the plant advanced. The leaf area was higher at booting stage (30-60 DAS) and then declined up to grain filling stage. The decline in leaf area in all the treatments at 90 DAS due to nutrient depletion from leaf at reproductive stage and transferred to the grains which caused leaf senescence. The main effect of foliar nutrition on wheat at different nutrient levels and timings of nitrogen application showed significant variations in leaf area across the crop growing period except 30 DAS during both the years. Application of treatment T_{12}-(T_6) 150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage) + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late on wheat was found to be significantly superior over the treatment for leaf area of wheat. The lowest leaves area of recorded under the application of treatment T_1-50% RDF (50% of N as basal + 25% at CRI + 25% late jointing) to wheat. Similar result was also recorded by Kaur *et al*. (2016) [12].

Leaf area index

The data on leaf area index (LAI) is an important parameter of the crop yield estimation, pests and diseases identification. LAI is also a good indicator for growth and energy exchange information of wheat estimated at different growth stages as influenced by foliar nutrition at variable nutrient levels and timings of nitrogen application (Table 7). The significant effect of foliar nutrition at variable nutrient levels and timing of nitrogen application on leaf area index (LAI) was found at 60 DAS and 90 DAS. Significantly maximum value of LAI was calculated in the treatment T_{12}-(T_6) 150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage) + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and late jointing stage during both the years of experimentation. Statistically at par value of leaf area recorded under treatments T_9-T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_6-150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_3-150% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_{11}-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_8-T_5 + foliar spray of NPK.
(19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage and T_5-100% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage) to that of T_{12} were significantly superior to the rest of treatments during both the years. The increase in LAI might be due to favourable synthesis of growth regulating constituents in plant system due to better supply of nitrogen which led to the increased number of leaves per unit area resulting in enlargement in leaf area. Alam (2013) also reported the highest leaf area index at the highest levels of nutrients application (160 kg N ha^{-1}) and minimum LAI was observed from control (0 kg N ha^{-1}) treatment during both years. The results are also in conformity with the finding of Kaur *et al*. (2016) [12].

SPAD Value

The SPAD value of wheat significantly influenced by foliar nutrition on wheat at variable nutrient levels and timing of nitrogen application at 30, 60 and 90 DAS. Significantly higher SPAD value (Table 8) was recorded in treatment T_{12}-T_6 + Foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage as compared to other however it was found at par with T_9, T_6, T_3, T_{11} and T_8 all the stages of observations during 2017-18 and 2018-19 and mean over the two years. The SPAD chlorophyll meter is useful for rapid analysis of chlorophyll and nitrogen status of crops. Wheat grown under different nutrient management practices where the plants received full amount of application timing and all fertilizer levels show consistently higher SPAD reading as compared to those received reduced all fertilizer levels.

Table 6: Leaf area cm^2 as influenced by foliar nutrition on wheat at variable nutrient levels and timing of nitrogen application

Treatment	Leaf area cm^2								
	30 DAS			60 DAS			90 DAS		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean
T1	478.73	585.00	531.86	5541.94	6815.43	6178.69	7856.34	9398.60	8627.47
T2	663.05	827.31	745.18	7175.24	8551.99	7863.62	10090.11	11796.23	10943.17
T3	854.03	1031.10	942.57	8740.08	10286.70	9513.39	12148.27	14103.79	13126.03
T4	501.93	622.55	562.24	5864.36	7082.56	6473.46	8561.54	9889.77	9225.66
T5	695.89	853.49	774.69	7696.29	9204.63	8450.46	11041.85	12731.67	11886.76
T6	891.67	1072.39	982.03	8913.95	10538.23	9726.09	12451.77	14332.63	13392.20
T7	570.26	699.84	635.05	6446.49	7761.75	7104.12	9372.24	10648.87	10010.56
T8	742.84	894.58	818.71	8032.88	9485.11	8759.00	11491.30	13297.57	12394.44
T9	920.88	1133.58	1027.23	9198.69	10879.90	10039.30	13169.31	14932.01	14050.66
T10	592.45	732.09	662.27	6837.87	8029.60	7433.73	9375.72	10989.10	10182.41
T11	797.19	962.00	879.59	8343.33	9935.53	9139.43	11860.71	13673.36	12767.04
T12	993.79	1226.65	1110.22	9534.62	11109.99	10322.30	13704.56	15835.21	14769.88
SEm±	130.73	153.93	140.84	704.01	731.10	709.17	995.05	1108.62	1045.60
CD $_{(P=0.05)}$	NS	NS	NS	2071.95	2151.70	2087.14	2928.53	3262.76	3077.30

*T_1-50% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_2-100% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_3-150% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_4-50% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_5-100% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_6-150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_7-T_4 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_8-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_9-T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_{10}-T_4 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_{11}-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_{12}-T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage.

Table 7: Leaf area index as influenced by foliar nutrition on wheat at variable nutrient levels and timing of nitrogen application

Treatment		Leaf area index					
		30 DAS		60DAS		90 DAS	
		2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
T_1	50% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage)	2.39	2.92	27.71	39.28	46.99	39.28
T_2	100% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage)	3.32	4.14	35.88	50.45	58.98	50.45
T_3	150% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage)	4.27	5.16	43.70	60.74	70.52	60.74
T_4	50% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage)	2.51	3.11	29.32	42.81	49.45	42.81
T_5	100% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage)	3.48	4.27	38.48	55.21	63.66	55.21
T_6	150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage)	4.46	5.36	44.57	62.26	71.66	62.26
T_7	T_4 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage	2.85	3.50	32.23	46.86	53.24	46.86
T_8	T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage	3.71	4.47	40.16	57.46	66.49	57.46
T_9	T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage	4.60	5.67	45.99	65.85	74.66	65.85
T_{10}	T_4 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage	2.96	3.66	34.19	46.88	54.95	46.88
T_{11}	T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage	3.99	4.81	41.72	59.30	68.37	59.30
T_{12}	T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage	4.97	6.13	47.67	68.52	79.18	68.52
SEm±		0.65	0.77	3.52	3.66	4.98	5.54
CD (P=0.05)		NS	NS	10.36	10.76	14.64	16.31

Grain yield (q ha^{-1})

The data on grain yield of wheat as influenced by foliar nutrition at variable nutrient levels and timing of nitrogen application are presented in Table 9. Twelve different treatments having 50%, 100% and 150% of RDF, splitting N for 3 (50% as basal + 25% at CRI + 25% late jointing stage) and 4 times (25% as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage) fortified with foliar spray of 19:19:19 NPK at tillering and/or late jointing stages were tested to find out the best combination for wheat. Study revealed that among the three fertility levels of 50%, 100% and 150% of RDF, the maximum grain yield of 39.87 q ha^{-1} and 40.87 q ha^{-1} was obtained from T_{12}-150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage) + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage during 2017-18 and 2018-19. Grain yield (38.21 and 39.51 q ha^{-1}) attained under treatment having 150% RDF and four split of N followed by one foliar spray of NPK (19:19:19) 5g l^{-1} of water at 5 DA late jointing stage (T_9) was found to be comparable to that of T_{12}. Treatment supplied with 150% RDF either with 3 N split *i.e.* 50% of N as basal + 25% at CRI + 25% late jointing stage (T_3) or 4 N split *i.e.* 25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage had also produced the statically similar grain yield to that of T_{12}. Yield increment was more in four split over three splits. Higher availability and less leaching losses and effective use of applied N could be responsible for yield advantage in 150% RDF over the other two levels. These results are in agreement with the findings of Mukherjee (2019) [15]. Singh *et al.* (2002) [24] also reported that the increased level of NPK upto 150% of recommended dose significantly increased the wheat yield over 100% of recommended dose. The increased grain and biological yield might be owing to the availability of N at various critical growth stages in optimal amount as supplied through different splits might have increased the yield attributes of wheat thus resulted in the increased grain yield (Mor *et al*., 2019) [14]. Among the all essential nutrients applied to the plants, nitrogen is the major one which has key role in the process of photosynthesis. Increased rate of photosynthesis by the high dose of nitrogen gave more yield because large amount of dry matter, more assimilates were produced and transported to fill the seeds as a result of more applied nitrogen. Further, fertility level of 100 and 150% of RDF during 2017-18 provided strong nutrient base and increased the N, P and K status in the soil for the crop during second year which performed better than the previous year under conducive environment of soil fertility during 2018-19. However, no significant difference in grain yield was found between 3 and 4 split of N at same level of nutrient.

Apart from split application, foliar nutrition through leaves is an efficient technique of fertilizer which enhances the availability of nutrients. Foliar nutrients facilitate easy and quick consumption of nutrients by penetrating the stomata or leaf cuticle and entered into the cells. It is established fact that during crop growth, supplementary foliar application of fertilizer increases plants minerals status and improve crop yields. Foliar feeding of mineral nutrients at tillering and jointing stages of wheat crop in utilization of nutrients has also shown effective increase in dry matter accumulation, the foliar nutrition through leaves is efficient technique which enhances the availability of nutrients and ultimately elevates the grain yield. This fact was clearly depicted from the study that the split application of N with foliar feeding of NPK liquid fertilizer at critical stages of wheat crop resulted in increased yield components, which ultimately reflected on grain yield. It is also beneficial when roots are unable to absorb the nutrient from soil due to the interference of various edaphic factors such as low soil moisture and loss of nutrients due to leaching (Patel *et al*., 2004) [17]. Effect of two foliar spray @ 5 g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage adjunct with four splits of N with 100% RDF as under T_{11} although produced 4.01 and 4.74 q lesser yield to that of T_{12} but was found to be statistically at par to that of 150% RDF as under T_{12}, T_9, T_6 and T_3. Non-significant but sizable difference (8-12%) was found between two foliar sprays and no foliar spray (T_4 and T_{10}, T_5 and T_{11}, T_6 and T_{12}) at same level of nutrient. Similar result was also reported by Gupta *et al*. (2007) [9]. In the light of above findings, it is obvious that soil and foliar application of nutrient were found to be effective and efficient method for nutrient supplementation to realizing the potentiality of wheat in terms of growth and yield attributing characters of crop.

Table 8: SPAD value influenced by foliar nutrition on wheat at variable nutrient levels and timing of nitrogen application during year 2017-18 and 2018-19

Treatment	SPAD value								
	30 DAS			60DAS			90 DAS		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean
T_1	19.89	21.14	20.52	38.25	39.76	39.01	25.65	26.51	26.08
T_2	22.42	22.89	22.66	40.78	42.18	41.48	29.18	30.26	29.72
T_3	28.35	29.67	29.01	47.71	49.63	48.67	36.11	37.37	36.74
T_4	20.19	21.78	20.99	38.55	40.40	39.48	25.95	27.15	26.55
T_5	23.79	24.48	24.14	44.49	45.10	44.80	31.21	32.52	31.86
T_6	31.31	32.31	31.81	49.00	50.93	49.97	37.06	39.35	38.20
T_7	20.35	21.98	21.17	38.71	40.60	39.66	26.11	27.35	26.73
T_8	25.89	27.43	26.66	47.25	48.05	47.65	33.98	35.80	34.89
T_9	31.76	32.85	32.31	51.46	52.47	51.97	38.52	40.55	39.53
T_{10}	21.47	22.56	22.02	39.83	41.18	40.51	27.89	28.60	28.24
T_{11}	27.38	28.79	28.09	47.41	49.41	48.41	34.47	36.49	35.48
T_{12}	33.82	34.79	34.31	53.19	54.41	53.80	40.25	42.16	41.20
SEm±	3.39	3.25	3.28	2.15	2.30	2.21	2.35	2.67	2.46
CD (P=0.05)	9.99	9.58	9.66	6.33	6.76	6.49	6.91	7.85	7.23

*T_1-50% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_2-100% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_3-150% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_4-50% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_5-100% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_6-150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_7- T_4 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_8-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_9-T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_{10}-T_4 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_{11}-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_{12}-T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage.

Although, having same nutrient level of 150% of RDF, treatment No. 6 (4 N splits) recorded higher grain yield, but it was at par to T_3 (3 N splits) which were significantly superior to T_1 (50% RDF) and T_2 (100% RDF). In that case, those farmers who could not afford an extra wage for going fourth split of N, can adopt T_3 treatment, as it is also giving the same grain yield as T_6 in lesser cost. Similarly with foliar application of liquid NPK 19:19:19, comparable grain yield was obtained under the treatment T_9 to that of T_{12} and one extra foliar spray at late jointing stage could be eliminated without any remarkable yield loss.

Straw yield (q ha^{-1})

The data on straw yield of wheat as influenced by foliar nutrition on wheat at variable nutrient levels and timing of nitrogen application revealed that the straw yield was significantly influenced by foliar nutrition on wheat at variable nutrient levels and timing of nitrogen application (Table 9). The maximum straw yield of 52.20 q ha^{-1} and 53.79 q ha^{-1} was obtained from the treatment T_{12}-(T_6) 150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage) + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage during 2017-18 and 2018-19 being at par with the straw yield recorded from treatment T_9-T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_6-150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_3-150% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_{11}-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage and T_8-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, which were significantly superior to the T_1-50% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage) treatments during both the years. More application of nitrogen gave tall plants, more grain yield, number of tillers per unit and total dry matter which collectively resulted in higher biological yield. There are many studies which revealed that with increasing the nitrogen rate biological yield also increased (Ghobadi *et al*., 2010) [8].

Harvest index

The ability of a crop to convert the total dry matter into economic yield is indicated by its harvest index value. Higher the harvest index value, greater is the physiological potential for converting the total dry matter into grain yield. The data presented in Table 9 revealed that harvest index was significantly affected by foliar nutrition on wheat at variable nutrient levels and timing of nitrogen application. The maximum harvest index (43.30 and 43.20%) was calculated under the treatment 150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage) + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage (T_{12}) during 2017-18 and 2018-19 respectively, being statistically at par with treatment T_9-T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_6 - 150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_3-150% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_{11}-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage and T_8-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, which were significantly superior to the T_1-50% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage). Suboptimal dose of fertilizers (50% of RDF) as in T_1 and 100% RDF as in T_2 both with three splits of N (50% of N as basal + 25% at CRI + 25% late jointing stage) without foliar spray nutrients produced the lesser harvest index to that of T_{12}. The results clearly showed that the effect of foliar spray combined with split application over only split application and two foliar sprays of NPK over single one.

Table 9: Grain yield, straw yield and harvest index as influenced by foliar nutrition on wheat at variable nutrient levels and timing of nitrogen application

Treatment	Grain yield, straw yield and harvest index								
	Grain yield (q ha^{-1})			Straw yield (q ha^{-1})			Harvest index		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean
T1	24.17	25.83	25.00	36.47	37.76	37.11	39.76	40.63	40.19
T2	31.34	32.31	31.83	44.61	44.90	44.76	41.32	41.85	41.58
T3	36.24	36.74	36.49	49.47	49.13	49.30	42.27	42.71	42.49
T4	25.94	27.78	26.86	38.61	40.37	39.49	40.17	40.71	40.44
T5	32.59	32.72	32.65	45.69	45.31	45.50	41.59	41.91	41.75
T6	37.06	38.19	37.63	49.80	50.92	50.36	42.69	42.93	42.81
T7	28.17	29.47	28.82	41.71	42.73	42.22	40.27	40.79	40.53
T8	34.36	35.76	35.06	47.19	48.68	47.94	42.11	42.34	42.23
T9	38.21	39.51	38.86	51.12	52.10	51.61	42.78	43.12	42.95
T10	30.92	31.51	31.21	43.92	44.43	44.18	41.22	41.47	41.35
T11	35.86	36.13	35.99	48.90	48.72	48.81	42.25	42.55	42.40
T12	39.87	40.87	40.37	52.20	53.79	53.00	43.30	43.20	43.25
SEm±	1.87	2.11	1.81	2.32	2.74	2.15	0.53	0.38	0.36
CD (P=0.05)	5.50	6.21	5.32	6.82	8.06	6.32	1.55	1.11	1.07

*T_1-50% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_2-100% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_3-150% RDF (50% of N as basal + 25% at CRI + 25% late jointing stage), T_4-50% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_5-100% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_6-150% RDF (25% of N as basal + 25% at CRI + 25% tillering stage + 25% late jointing stage), T_7- T_4 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_8-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_9-T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA late jointing stage, T_{10}-T_4 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_{11}-T_5 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage, T_{12}-T_6 + foliar spray of NPK (19:19:19) @ 5g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage.

Conclusion
On the basis of the above results, it was concluded that on the average of the two years. Effect of two foliar spray @ 5 g l^{-1} of water at 5 DA tillering and 5 DA late jointing stage adjunct with four splits of N with 100% RDF as under T_{11} although produced 4.01 and 4.74 q lesser seed yield to that of T_{12} but was found to be statistically at par to that of 150% RDF as under T_9, T_6 and T_3. Non-significant but sizable difference (8-12%) was found between two foliar sprays and no foliar spray (T_4 and T_{10}, T_5 and T_{11}, T_6 and T_{12}) at same level of nutrient.

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