

Regulation Effects of Nitrogen on Light Adapted State of Wheat (*Triticum aestivum* L.) in Nutrient Cycling and Nitrogen Management

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Abstract This study means effects of nitrogen (N) on photosynthetic energy conversion efficiency, and photosynthetic performance of winter wheat. The average P_N , g_s and E of hole nitrogen rate N150 were the highest, reaching $4.71 \mu\text{mol}(\text{CO}_2) \text{mol}^{-1}$, $20.69 \mu\text{mol m}^{-2} \text{s}^{-1}$, respectively. Methods, The eastern part of the Shanxi Taigu was used to set four nitrogen application levels of 0 (N0), 120 (N120), 150 (N150), and 210 (N210) kg ha^{-1} before sowing. Two variety, (Variety Yunhan-20410, Yuhan-618). Result. The results from different parameters of research were showed, that the organic manure partial substitution for chemical fertilizer increased post-anthesis N uptake by 81.4 and 16.4% thus increasing the post-anthesis photosynthetic capacity and delaying leaf senescence. grain number per spikes by 11.5, 12.2%, and 1000-grain weight by 7.3 and 3.6%, respectively. The grain yield under organic manure partial substitution for chemical fertilizer treatment increased by 23, and 15%, respectively. Conclusion, The N120 at all stages of growth had significant effects on the C_i winter wheat flag leaf. The number of ears and grain number per spike were increased and the maximum values were achieved at N150, and nitrogen yield significant differences with the variety YH-20410, respectively.

Keywords: Chlorophyll fluorescence, Photosynthetic characteristics, wheat, water stress, yield components

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1. Introduction

Rain-fed agriculture in Asian, and Pacific regions accounts for approximately 70% of the region's arable land, and 60-80% of global food supply comes from these rainfed lands [1]. The successful cultivation and promotion of superior varieties which are the basis for the continuous increase of wheat yield and grain quality [2]. Under drought conditions, the plant stomata rates closed due to which the plant's absorption of CO_2 reduces, and the rate of photosynthesis, growth, and yield of the plant affected badly [3]. High planting density has been adopted in sprouts production systems. Which improved the photosynthesis, influences plant height, architecture and synthesis of chlorophyll. Commonly, single density planting adopted, which does not effectively yield of with high quality. Seeds consume a lot of energy and resources during germination. High amount of antioxidant substances are synthesized during germination [3,4]. Leaf senescence comprises a series of biochemical and physiological events from the fully expanded state until death. The leaf duration after full expansion depends

strongly on the water conditions and crop species; some researchers have reported that the post-anthesis senescence in cereals affects the whole plant, with organs closest to the developing grains i.e, flag leaves generally senescence last [5]. Nitrogen which is the material basis for the synthesis of wheat protein. Within a certain range, with the increase of nitrogen application level, the protein content of wheat grains increases, but excessive or insufficient nitrogen application will reduce the transport of accumulated nitrogen before anthesis to grains, and affect the protein content of grains [6,7]. The premature photosynthetic nitrogen transport in wheat results in premature canopy leaf senescence, and grain yield reduction [8,9]. P_N , g_s as well as increasing the substomatal CO_2 concentraion (C_i) in wheat. Therefore, increasing the N content, the P_N , g_s , and E are considered as the value of wheat stomatal restriction in different plant populations. It was reported that N also improved yield and components in wheat [10]. However, the process of nitrogen transport from wheat organs to grains is extremely complex in physiology. greenhouse-scale studies have no way to determine which photosynthetic nitrogen, and stored nitrogen transport starts first, or even synchronously, but the transport ratio of photosynthetic

nitrogen, and stored nitrogen can be calculated [11]. The heterosis effects on the net photosynthetic rate (PN) vary in seed types and at different growth stages. Current scenario of climate change such as high temperature requires development of wheat with improved leaf gas-exchange parameters. Wheat PN which is not affected by high intensity of light, temperature, and low humidity [12]. The regulation of nitrogen utilization of wheat by replacing part of nitrogen fertilizer with organic fertilizer. At the vegetative growth stage, nitrogen distribution in the canopy was optimized, and nitrogen accumulation was promoted by replacing part of nitrogen fertilizer with organic fertilizer [13,14]. The other hand, replacing part of nitrogen fertilizer with organic fertilizer increased postanthesis nitrogen absorption, delayed the senescence of photosynthetic organs, and was beneficial to maintaining a high duration of photosynthetic capacity. Therefore, replacing part of nitrogen fertilizer with organic fertilizer promoted postanthesis dry matter accumulation, thus achieving a higher photosynthetic nitrogen use efficiency (PNUE). It is well known that grain filling is regulated by both source and sink [14]. Maintaining higher photosynthesis and reducing transpiration water loss are important for improving water use efficiency. The grain filling process mainly depends on three aspects of material supply. The direct transport of photosynthetic from leaves, and stem sheaths to grains during grain filling [15,16]. Therefore, dry matter accumulation and transport during wheat grain-filling stage are very important processes for yield formation and water use efficiency. However, there was little information on dry matter accumulation and transport during wheat filling stage. The effects of fertilizer on wheat yield, and water use efficiency. In general, the N application of chemical fertilizers can increase biomass accumulation and thus yield. However, excessive biomass accumulation leads to excessive canopy leaf area, resulting in excessive increase of transpiration and water loss, and ultimately excessive consumption of soil water [17]. In the long run, increased fertilizer application cannot continuously increase crop yield and water use efficiency [18]. Organic fertilizer utilization not only improved soil water retention capacity by improving soil aggregate components ($>0.25\text{mm}$), but also significantly increased soil nutrient (N, P, K and organic matter) contents in growth period, and ultimately significantly increased crop yield and water use efficiency [19,20]. Nitrogen fertilizer is a major component of proteins and nucleic acids, and its application regulates plant growth [20]. Nitrogen fertilizer inhibits the efficiency of photosynthesis and irradiation to reduce grain yield, while the optimal concentration of nitrogen application can increase grain yield [21]. The objective of this study were to reveal to effects of the combined N0, N120, N150, N210 t ha⁻¹. (i) The changes in the photosynthetic, jointing stage, booting stage, flowering stage, filling stage the same large-spike lines and the control cultivar. (ii) to study the response of N fertilizer to wheat water pressure from leaf relative water content (LRWC), membrane lipid peroxidation photosynthetic characteristics. Effects of organic fertilizer on accumulation and reuse of dry matter.

2. Materials and Methods

2.1. General Situation of the Test Site and Test Materials

The experiment was conducted in the wheat experimental base of Henan Xinlianxin Chemicals Group Co, Ltd. Xinxiang, China (E112°34' E, N37°25' N) from 2020 to 2021, which belongs to the temperate continental climate zone, with an average annual temperature of 10.4°C. Separated by concrete walls with a thickness of 20 cm, and an insulation layer of 10 cm added to the outer walls.

2.2. Experimental Design and Crop Management

The experiment was arranged in a split-plot design with the four N application rates N0, N120, N150, and N210 t ha⁻¹. A widely planted wheat variety (Yunhan-20410, Yunhan-618), were sown with the N application rate of 97.5 kg ha⁻¹ in early October each year. The plot size was 2m × 4 m=8 m². Before sowing, 150 kg P₂O₅ ha⁻¹, and 150 kg K₂O ha⁻¹ were evenly applied to the plots. respectively, the nitrogen fertilizer was applied to the base fertilizer. The seeds were sown on November, 9th, 2020, planted in a manual with row spacing of 20cm, and a sowing quantity of 225 kg ha⁻¹. Irrigation was applied using a drip irrigation system, with the application of 50 mm each time as measured with a water meter.

2.3. Photosynthetic Characteristics

Photosynthetic rate P_N , in the different stages of winter wheat (Jointing, Booting, Flowering, Filling) sunny, and cloudless weather. The field atmospheric CO₂ concentration (about 380 $\mu\text{mol L}^{-1}$), and artificial light source were used to set the optical quantum density. The photon flux density (PPFD) was 1200 $\mu\text{mol m}^{-2} \text{s}^{-1}$, the airflow rate was 500 $\mu\text{mol s}^{-1}$, and the leaf chamber temperature was 27.7 °C. Nine flag leaves with consistent growth, and a similar light direction was selected for each treatment. The diurnal variation of photosynthetic rate was measured every 4 hours from 8:00 to 12:00am under sunny weather.

2.4. Photosynthetic Pigment and Chlorophyll Fluorescence Parameters

The chlorophyll fluorescence characteristics of wheat flag leaves were measured on (booting stage, before well-watered). A portable modulated chlorophyll fluorimeter (PAM-2500, Walz, Germany) was used to determine the chlorophyll fluorescence induction

The wheat variety was kept in the dark for at least 20 minutes. After dark treatment, Chl a fluorescence induction curves were measured using PEA with red irradiance of 3,000 $\mu\text{mol (photon) m}^{-2} \text{s}^{-1}$. Measurements were performed at 12:00 and 17:00 h on the same day.

2.5. Yield Component

At maturity, 20 plants from each plot were randomly sampled from the inner rows to determine yield

components such as ear number, grain number per ear, and 1,000-grain weight. Grain yield was obtained by harvesting all plants in the plot. After the plants were mechanically dispelled, and the grains were air-dried, the moisture content of the grains was measured to 12.5%.

2.6. Statistical Analysis

The data were subjected to analysis of variance (ANOVA) using DPS and SAS 7.5 was used to study the main influence and interaction on yield. When there was a significant interaction effect between Photosynthesis, SPAD, and yield, the Least Significant Difference (LSD) method was used for variance analysis, and independence T-test and the significance level was set to $\alpha=0.05$. Differences were considered statistically significant when $p \leq 0.05$.

3. Results

3.1. Photosynthetic Characteristics

Net photosynthesis P_N reached the maximum value at the flowering stage, and began to decline after the flowering stage (Table 1). The maximum P_N value of 20-30d was 20.06, which was increased by 15.37%, 6.97%, and 5.88% compared to of nitrogen rate respectively, indicating that nitrogen application could significantly improve the photosynthetic rate of wheat leaves, among which, medium nitrogen treatment had the most significant promoting effect. However, the high nitrogen application rate did not improve the net photosynthetic rate of wheat leaves but inhibited it to some extent. The appropriate demographic structure was useful for accumulating net photosynthetic rates, and N150 significantly enhanced the P_N increase in winter wheat flag leaves, whereas excessive nitrogen use had a particular inhibitory effect. While there was a significant difference between them in N0, and N120 a significant difference between the treatments in the flowering stage. According to the different significance test (F value), the effects of nitrogen application rate on P_N of winter wheat were extremely significant at all growth stages, indicating that changing population distribution mode, and nitrogen level could effectively improve leaf photosynthetic performance N150 level was the best, respectively [14].

Effects of different N rate comparison of stomatal conductance g_s (Table 2). The 20-30d, N150 was the highest, reaching 0.45 followed by 20-30d, N210, and 10-20d N150. The g_s value was highest in the N150 compared to others treatment, and there was a significant difference between N0, and N120 treatments. However, the data shown that there was no significant difference between N0 treatments in the booting, and flowering stages. There was a significant difference between treatments N120, and N150. However, there was a significant difference between N210. N150 had a very significant effect on g_s at each growth stage, but they only N150 had a very significant interaction at the booting stage, and a significant interaction at the filling stage.

Effects of different nitrogen applications (Table 3). The transpiration rate (E) $\text{mmol (H}_2\text{O) m}^{-2} \text{ s}^{-1}$ of each

treatment overall trend of first increasing, and then decreasing. E leaves were increased slowly from the jointing stage to the booting stage, average value increased of 78% reaching the maximum value at the flowering stage. The average growth from booting to flowering was $4.30 \text{ mmol m}^{-2} \text{ s}^{-1}$. The E value of N120 and N150 at the booting stage was greater than that of N0 and N210, and there was no significant difference between N0, and N120. The E value of 10-20d, and 20-30d treatment was significantly higher than that of nitrogen treatment at the filling stage, and reached the maximum value at N150, and N210. Except that nitrogen application N0 had no significant effect on E $\text{mmol (H}_2\text{O) m}^{-2} \text{ s}^{-1}$, Filling stage the nitrogen application. The difference was that nitrogen application did not have a significant effect on E $\text{mmol (H}_2\text{O) m}^{-2} \text{ s}^{-1}$, but the nitrogen filling stage, and their interaction on E $\text{mmol (H}_2\text{O) m}^{-2} \text{ s}^{-1}$ had a significant effects on all growth stages. The interaction effect of nitrogen application rate on E was the largest at the flowering stage, so optimizing the combination of nitrogen application rate could enhance the leaf function of wheat at the late stage.

Effects of different nitrogen applications (Table 4) the influence of different nitrogen applications on the C_i winter wheat flag leaves. The maximum C_i value of days was $505.28 \text{ C}_i [\mu\text{mol (CO}_2\text{) mol}^{-1}]$ with the increased in nitrogen application rate, the C_i value decreased significantly. The C_i value of 10-20d, N120 treatment at the filling stage, and N120 treatment at booting, might be due to the that high nitrogen level. Environmental Stress on the flag leaf causes the stomata to close on the wheat flag leaf, resulting in an increase in C_i . The N120 at all stages of growth had significant effects on the C_i winter wheat flag leaf, and the interaction between these two interactions was extremely significant at all stages of growth except the booting stage.

3.2. Effects of Partial Replacement on Nitrogen Fertilizer by Organic Fertilizer

The root dry weight, root nitrogen concentration, and root nitrogen content at the filling stage root, as a part of the plant, was an important organ for water nutrient absorption metabolic activities are closely related to the growth, and development of the shoot (Figure 1. A,B). N120 treatment was the highest. However, due to the difficulty, and inaccuracy of sampling, little literature have reported the variation of root dry weight nitrogen content with time during the filling stage, especially under different fertilizer application, and water condition. N150 treatment was the highest (Figure 1 C,D). The dynamic changes of root dry matter, and nitrogen with time at the filling stage were analyzed in detail under different fertilizer applications, variety, and water treatments. The variety YH-20410, under WW condition, the root dry weight of YH-20410 treatment increased gradually from 0 to 21 days after flowering, and gradually decreased after 21 days, while the root dry weight of YH-618 treatment changed little from 0 to 14 days, and the weight was relatively stable. However, the dry weight began to decrease sharply after 14 days (Figure 1. E,F). For variety YH-618, under WW condition, root N content under YH-618 treatment increased gradually from 0 to 14 days and

began to decrease gradually after 14 days. N210 treatment was the highest.

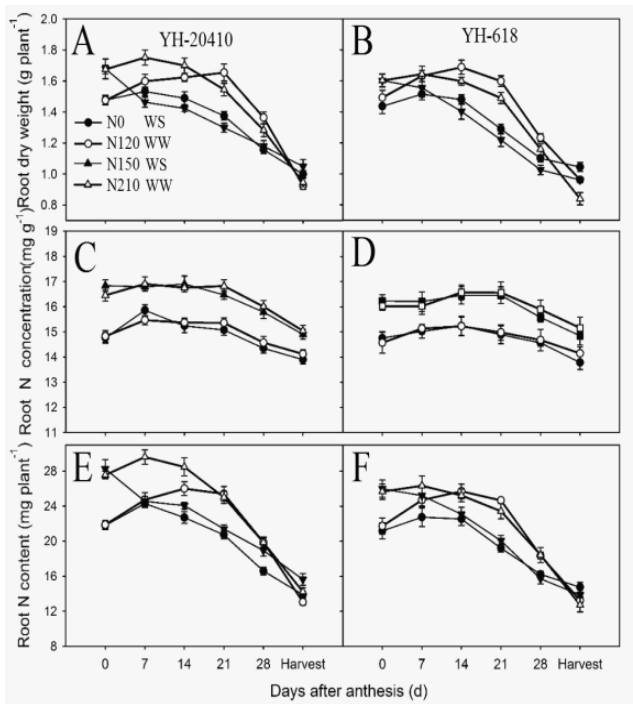


Figure 1. Changes in (A, D) root dry weight, (B, E) root N concentration, and (C, F) root N content during the days after anthesis stage of two cultivars, YH-20410 (A-C) and YH-618 (D-F), manure partial substitution for chemical fertilizer; WS: water stress; WW: well-watered. Values with different letters on the same sampling day indicate significant differences at $P < 0.05$

3.3. Effects of Yield Components

The grain number per spike N150 treatment were the highest (Table 5). The number of seeds was 26.60, followed by variety YH-20410. The grain number per spike of N120, N150, and N210 increased by 32.17%, 46.64%, and 43.29%, respectively. The effects of variety on grain number per spike were as follows variety YH-20410 and YH-618 were 3.49% and 7.87% higher than variety YH-20410, respectively. The number of spikes was one of the main factors affecting the yield of winter wheat, and its value was increased with the increase in nitrogen application rate. The number of harvested spikes under N150 treatment was the highest, while N150 was 1.64%, and 4.34% higher than variety YH-20410 and N150, respectively. The 1000-grain weight was mainly affected by the growth environment, and individual leaf function in the later stage of wheat, which was closely related to grain filling characteristics. The 1000-grain weight of the N150 treatment was the largest (48.18g), followed by that of variety YH-20410, N120 treatment 47.79g.

Nitrogen fertilizer treatment significantly impacted nitrogen accumulation in all organs at the maturity stage, while zinc fertilizer treatment had notable effects on nitrogen accumulation in all organs at the same stage. There was significant difference observed between the effects of nitrogen and zinc fertilizer treatments as described in (Table 6). When comparing nitrogen application rates of 0 and N150 nitrogen accumulation in leaves, spike + glume, and grain at maturity increased by 15% to 60%.

Table 1. Effects of nitrogen rate comparison of Net photosynthesis PN of winter wheat

Treatment	Growth stage				
		Jointing stage	Booting stage	Flowering stage	Filling stage
YH-20410	N0	18.0 c	28.0 c	31.0 b	32.0 b
	N120	21.0 c	32.0 b	34.0 b	32.0 b
	N150	25.0 a	34.0 a	41.0 a	35.0 a
	N210	22.0 b	34.0 a	40.0 a	31.0 b
	Mean	0.22	0.32	0.37	0.32
YH-618	N0	22.0 d	30.0 b	37.0 b	31.0 b
	N120	25.0 c	32.0 b	40.0 b	33.0 b
	N150	28.0 a	36.0 a	44.0 a	37.0 a
	N210	27.0 b	35.0 a	42.0 ab	32.0 b
	Mean	0.26	0.33	0.41	0.33
ANOVA <i>F</i>					
V		**	**	**	**
N		**	**	**	**
V×N		ns	**	ns	*

Table 2. Different nitrogen application stomatal conductance gs of winter wheat

Treatment	Growth stages				
		Jointing Stage	Booting stage	Flowering stage	Filling stage
YH-20410	N0	0.19 c	0.27 c	0.32 b	0.30 b
	N120	0.20 c	0.31 b	0.35 b	0.31 b
	N150	0.26 a	0.35 a	0.42 a	0.36 a
	N210	0.22 b	0.34 a	0.40 a	0.31 b
	Mean	0.22	0.32	0.37	0.32
YH-618	N0	0.22 d	0.30 b	0.37 b	0.31 b
	N120	0.25 c	0.32 b	0.40 b	0.33 b
	N150	0.29 a	0.37 a	0.45 a	0.38 a

	N210	0.27 b	0.35 a	0.42 ab	0.32 b
	Mean	0.26	0.33	0.41	0.33
ANOVA <i>F</i>					
V		**	**	**	**
N		**	**	**	**
V×N		Ns	**	Ns	*

Variety (V), and Nitrogen (N). Values are means ± SD, n = 3. Different lowercase letters indicate significant differences at $P < 0.05$.

Table 3. Effects of nitrogen application on transpiration rate *E* winter wheat

Treatment		Growth stages			
		Jointing stage	Booting stage	Flowering stage	Filling stage
YH-20410	N0	1.64 ab	2.00 c	5.31 b	4.63 b
	N120	1.96 a	2.97 b	5.56 b	5.20 ab
	N150	1.91 a	3.15 a	8.07 a	5.04 ab
	N210	1.55 b	2.94 b	5.96 b	5.60 a
	Mean	1.76	2.77	6.22	5.12
YH-618	N0	2.05 b	2.30 b	6.28 c	5.85 a
	N120	2.07 b	2.72 a	7.52 ab	5.91 a
	N150	2.30 ab	2.64 a	8.37 a	6.26 a
	N210	1.52 c	2.42 ab	7.30 b	6.00 a
	Mean	2.12	2.52	7.37	6.01
ANOVA <i>F</i>					
V		**	**	**	**
N		**	**	**	ns
V × N		**	**	**	*

Table 4. Effects of different nitrogen application on substomatal CO₂ concentraion *C_i*

Treatment		Growth stages			
		Jointing stage	Booting stage	Flowering stage	Filling stage
YH-20410	N0	309.00 b	310.00 c	456.12 a	234.00 b
	N120	327.33 a	387.67 a	520.14 a	242.17 a
	N150	312.67 b	354.00 ab	500.20 a	221.74 c
	N210	298.00 c	332.00 bc	494.16 a	252.04 a
	Mean	311.75	350.56	492.66	229.99
YH-618	N0	313.67 b	300.00 b	409.03 b	212.00 ab
	N120	317.67 a	403.00 a	528.33 a	237.53 a
	N150	305.67 c	380.00 a	513.00 a	231.32 ab
	N210	307.00 c	321.33 b	442.00 b	198.46 b
	Mean	311.00	351.08	473.09	219.83
ANOVA <i>F</i>					
V		**	**	*	*
N		**	**	**	**
V×N		**	ns	**	**

Table 5. Effects of nitrogen application on yield components of Winter Wheat

Treatment		Grains per spike	Number of spike (×10 ⁴ ha ⁻¹)	1000-grain weight (g)	Yield (kg ha ⁻¹)
YH-20410	N0	16.70 d	628.67 c	37.73 d	3221.57 d
	N120	24.34 c	655.67 b	42.03 c	4503.64 c
	N150	27.41 a	709.67 a	46.66 a	6715.89 a
	N210	26.61 b	636.67 b	43.38 b	5059.95 b
YH-618	N0	19.71 c	642.06 d	39.19 d	3680.44 d
	N120	25.91 b	672.33 c	43.52 c	4581.61 c
	N150	28.88 a	721.33 a	47.79 a	6144.75 a
	N210	27.86 a	694.03 b	44.62 b	5240.95 b
ANOVA <i>F</i>					
V		**	**	**	**
N		**	**	**	**
V×N		ns	ns	ns	ns

Table 6. Effects of nitrogen application on nitrogen accumulation in various organs of winter wheat

Treatment		Stalk	Grain	Leaf	Spike + Glumes	Above ground plant
YH-20410	N0	54.97 d	160.51 d	21.357 c	10.217d	247.05 d
	N120	91.42 c	208.06 c	31.343 b	18.837 c	349.66 c
	N150	123.75 a	258.59 a	42.148 a	30.805 a	455.29 a
	N210	113.28 b	243.98 b	39.827 a	27.043 b	424.12 b
YH-618	N0	46.45 d	142.18 c	17.500 c	8.360 d	214.49 d
	N120	66.47 c	176.53 d	24.295 b	13.385 c	280.69 c
	N150	99.29 a	218.38 a	32.285 a	20.225 a	370.17 a
	N210	88.08 b	214.94 b	32.350 a	18.230 b	353.61 b
YH-20410	N0	54.42 d	162.38 d	21.560 d	10.060 d	248.42 d
	N120	95.75 c	206.25 c	31.570 c	17.065 c	350.64 c
	N150	124.31 b	250.58 a	42.065 b	28.745 a	445.69 a
	N210	110.32 a	232.94 b	37.035 b	24.205 b	404.50 b
YH-618	N0	64.03 c	176.97 d	25.010 c	12.230 d	278.24 d
	N120	112.05 b	241.38 c	38.165 b	26.060 c	417.67 c
	N150	147.67 a	306.82 a	52.095 a	43.445 a	550.02 a
	N210	141.43 a	284.05 b	50.095 a	38.695 b	514.27 b
ANOVA						
V	**	***	**	***	***	
N	***	***	***	***	***	
N+V	ns	ns	ns	ns	ns	

4. Discussion

The growth stage of the tiller in light energy utilization efficiency of wheat, and the population structure was more reasonable, which played a significant role in the effective utilization of light energy, and the improvement of grain yield. Photosynthetic rate of wheat planted with variety YH-20410 were higher, yield components were more reasonable, and yield was significantly higher than other varieties [22,23]. Nitrogen application of 150 t ha⁻¹ could significantly enhance the photosynthetic efficiency of wheat, improve the problems of greenhouse diseases, and insect pests at the later growth stage, photosynthetic rate the further improvement of wheat yield [23]. Some interesting results were obtained in this study including nitrogen application of 150 t ha⁻¹ could significantly improve the area of single stem leaf and light energy utilization efficiency of wheat. Also, it could increase wheat grain weight at the later growth stage compared to N0, N90 t ha⁻¹ [24]. The leaf area index of winter wheat increased under N150, especially in the middle, and late growth stages. The differences in leaf area under the different nitrogen applications could be attributed to the differences in the wheat distribution. Wheat with N150 intercepts light more properly with a higher photosynthesis rate, and leaf area index [24,25]. The results showed that the stored nitrogen of all dryland wheat varieties could not meet the requirements of nitrogen transport of crops, and photosynthetic nitrogen transport was carried out the average photosynthetic nitrogen transport rate was 87.5%, which was significantly higher than that of Yunhan-20410 (69.5%). The average storage nitrogen transport rate of Yunhan-618 was 97.5%, which was higher than that of Yunhan-618 [26]. The Photosynthesis photosynthetic characteristics, and photosynthesis characteristics were higher than those of the N120, which were consistent with the results of previous studies. Optimize doses of nitrogen to increase

the yield of the winter wheat crops. Thus, we used four nitrogen application concentrations set as N120, and 150 respectively to analyze the photosynthetic characteristics, and yield-related traits in winter wheat. Therefore, N120 t ha⁻¹ would be a valuable management practice to improve wheat yield [26,27]. The nitrogen uptake ratio of different special types of wheat was different in each growth period, and the nitrogen uptake, and nitrogen uptake ratio of wheat were the largest from jointing to flowering [28]. Nitrogen application contributed to the simultaneous improvement of carbon and nitrogen metabolism in wheat plants. With the increase of nitrogen application rate, P_N in the leaf of winter wheat increased first and then decreased with the increase of nitrogen application rate. When the nitrogen application rate was N150 which was similar to that of the leaf is an important component of wheat at the later growth stage [29]. The main channel for the diffusion of CO₂ and water vapor inside and outside leaves plays an important role in regulating the transpiration and photosynthetic physiological process of leaves, and the growth stage [30]. A good understanding of the response of photosynthesis rate (P_N) and transpiration rate (T_r) to stomatal alteration during the diurnal variations is important to cumulative photosynthetic production and water loss of crops. Stomatal conductance and intercellular CO₂ concentration of winter wheat in the late flowering stage were always higher than those in the early flowering period. Believed that with increasing nitrogen application rate, transpiration rate (E) of wheat in the parietal leaf showed a trend of first increasing and then decreasing [13,31]. The results showed that different N rates, the effects of nitrogen application rate on Photosynthesis characteristics, and growth N150 t ha⁻¹ nitrogen application rate higher N210, and the improved photosynthesis efficiency growth reached a significant level. The protein content of Yunhan-20410 (14.1%) was significantly lower than that of Yunhan-618 (15.2%), respectively. The grain protein content of Yunhan-618 could meet the standard of high quality strong gluten, and

the yield performance of Yunhan-20410, N_{150} $t\ ha^{-1}$ was significantly different from that of high yield variety.

The growth of plants above and below ground is a whole, relatively independent, and interdependent. The roots absorb water nutrients to meet the growth, and development of the shoot, while the photosynthates of the shoot are transported to the underground part through the stem, providing energy for root activities and meeting the material requirements of root activities. Under drought stress, plant roots tend to grow, and become an active assimilate pool in order to meet water, and nutrient absorption. However, each additional unit of root weight consumes twice as much photosynthate as aboveground, so a larger root system is detrimental to yield formation [32]. Many studies have founded, that root cutting reduces root redundancy, and energy consumption of the root system, therefore. It promotes yield formation [32,33]. Increasing the amount of nitrogen fertilizer increased the distribution of dry matter in stem leaf, and ear, thus increasing the yield. In this study it was founded that comparison promoted the distribution of photocontractual compounds to spike and leaf organs, and significantly increased the dry matter distribution index of leaf, and spike. Since more photosynthates were allocated to leaf and spike organs, produced a significantly higher ratio. Increased wheat-to-root ratio means fewer root system redundancy is beneficial to yield formation [32,34]. In addition, more dry matter accumulation in leaves and spike also promoted light interception and photosynthate accumulation, which was beneficial to yield formation. Generally, grain number has been used as a key factor in determining wheat yield [35]. This study also found that leaf nitrogen transport efficiency was the highest, reaching 79%, followed by stem sheath (75%) and glume (58%), and root nitrogen transport efficiency was the lowest, only 51%, which was consistent with literature results. Transshipment, and transshipment efficiency of nitrogen generally depend on soil available nitrogen content and other environmental factors [36]. The increase of nitrogen uptake after anthesis delayed the senescence of photosynthetic organs, and improved photosynthetic capacity at the grain filling stage, thus increasing the accumulation of photosynthetic compounds after anthesis, and ultimately improving grain yield [37]. Studies in wheat showed that nitrogen application combined with organic fertilizer increased nitrogen uptake and biomass accumulation, thus increasing grain yield [38,39]. In treatment compared to N treatment ($150\ t\ ha^{-1}$), organic fertilizer application ($240\ kg\ organic\ N\ ha^{-1}$) significantly increased dry matter and nitrogen accumulation after anthesis, but decreased biomass and nitrogen accumulation at anthesis, thus reducing the amount of nitrogen stored before anthesis to grain transport [40]. It is necessary to further studies the differences in the photosynthesis characteristics of N_{150} improves photosynthesis related to nitrogen accumulation and transport, and the leaf expression characteristics among wheat with different nitrogen. Therefore, quantitative analysis of structural nitrogen, photosynthetic nitrogen, and storage nitrogen is of great significance for determining nitrogen accumulation and translocation in wheat plants. In this experimental work the results were showed that compared to other dryland wheat varieties,

Yunhan-20410 had higher structural nitrogen ($53.42\ t\ ha^{-1}$ on average), and Yunhan-618 had higher structural nitrogen ($150\ t\ ha^{-1}$), indicating that Yunhan-20410 had higher structural nitrogen than other wheat varieties.

5. Conclusion

In this study title of “Physiological photosynthetic characteristics of variable fluorescence yield of the light-adapted state of wheat (*Triticum aestivum* L.) in response to nitrogen application levels” analyzed that, Relative air humidity played an important role in affecting the correlation between g_s with P_N and T_r of wheat during the diurnal variation and suggested that values of F_v/F_o increased with the increased nitrogen and the highest values were obtained at N_{150} . The number of ears and grain number per spike were increased and the maximum values were achieved at N_{150} , and nitrogen yield significant differences with the variety YH-20410. Substituting part of nitrogen fertilizer for organic fertilizer increased photosynthetic capacity at the filling stage, delayed leaf senescence, and increased dry matter accumulation after anthesis. These changes ultimately reduced water consumption, increased grain number, grain weight, and grain yield. The difference in nitrogen rate $N_{150}\ t\ ha^{-1}$ was significant on 1000-grain mass, spike number and grain number per spike, intercellular CO_2 , yield were the highest under Nitrogen application $150\ t\ ha^{-1}$.

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Disclosure Statement

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