Effects of Water and Nutrition on Photoassimilates Partitioning Coefficient Variation*

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Abstract. Photoassimilates partitioning was studied using the experimental data of winter wheat in 2008-2009 at irrigation experimental station of Tianjin Agriculture University.The Research showed that when relative development stage (RDS) was greater than 0.35 fr(root) ,fr（stem and sheath）and fr(leaf) decreased ,fr(Ear) increased with the increase of RDS,and turned into negative When RDS were 0.59,0.67,0.7 respectively.It was due to the existence of repartitioning of photoassimilates, and photoassimilates storaged in root , stem and sheath and leaf began to transport to ear.Water and nutrition had a certain influence on the partitioning of photoassimilates among organs.Excessive water and nutrition were unfavourable for the transportation of photoassimilates to the growth center.

Keywords: winter wheat, photoassimilates, partitioning coefficient.

1 Introduction

Photoassimilates partitioning, known as dry matter partitioning, mainly refers to the partitioning of organic matter producted through photosynthesis among organs[1]. The status of water and nutrient in soil have great influence on photoassimilates accumulation and partitioning[2]. Variation of photoassimilate partitioning coefficient and the effects of diffrent water and nutrition treatment on winter wheat photoassimilate partitioning were discussed ,which will provide a theoretical basis for determining the amount of water and nutrition of the high yield for winter wheat.

2 Experiments and Methods

2.1 Experimental Design

The experiment were conducted at irrigation experimental station of Tianjin Agriculture University in winter wheat growing season, 2008-2009, located in Xiqing district, Tianjin,longitude $116^0 57$ ', latitude $39^o 08$ ', height of 5.49 m above sea level.

* Tianjin Nature Science Foundation（10JCBJC09400）.

D. Li and Y. Chen (Eds.): CCTA 2013, Part II, IFIP AICT 420, pp. 309–315, 2014.

Xiqing district belongs to the warm temperate semi-humid continental monsoon climate zone. The soil of 0-2.7m was medium loam;The level of NO_3-N, NH_4-N of 0-0.6m were 3.87g/kg ,3.05g/kg respectively. Winter wheat varieties was 6001. Winter wheat were sowed in October 7, 2008, harvested in June 15, 2009.

The test consisted of 5 treatments,2 of which were choosen for analysis in this paper, high water and nutrition ,medium water and nutrition(on behalf of the local normal water and nutrition level).Base manure of high nutrition treatment was compound fertilizer 750kg/hm^2.After manuring was urea 225 kg/hm^2. Base manure of medium water and nutrition was compound fertilizer 450kg/hm^2,After manuring was urea 150 kg/hm^2. Irrigation times of high water treatment (the whole growth period) were 4, winter water(December 2, 2008), jointing water(April 9, 2009), esring water(May 7, 2009) , filling water (May 18, 2009) respectively; Irrigation times of medium water treatment was 3, winter water(December 2, 2008), jointing water(April 9, 2009), filling water (May 18, 2009) respectively;Irrigation quota was 60mm for all treatments.Each treatment contained 3 replicates, the area of a plot was 40m^2.the total area of two treatment was 240m^2.There was no isolation zone between replicates, .Three plots of one treatment were adjacent. There was protection zone in test area,with width of more than 3m.

2.2 Test Items and Methods

The test index included dry matter, soil moisture,nutrition, plant height, leaf area, temperature, wind speed, radiation,etc. The measuring of dry matter: 10 representative plant samples were chosed and cut against ground.The root were got through a stratified sampling method with root drill, 10cm a layers,washed with tap water, dived into several groups according to plant organ subsequently.Each groups dryed to constant weight under the conditions of 80℃ after fixxing 30 minute under the conditions of 105℃, then weighted.

Soil moisture was determined by neutron instrument, with measuring depth was 160cm and testing one time each 20cm .

Temperature, wind speed and radiation, etc meteorological data were from meteorological station of Xiqing , Tianjin city.

2.3 Data Analysis

Dry matter of Every organs were measured for 8 times from March 27,2009 to June 15,2009.The data were analyzed by Excel2003 .The variation of dry matter of every organs with time were simulated to determine every organs daily dry matter . The difference between daily dry matter weight and the previous day's was the dry matter increment.the ratio of dry matter increment to the total of each organ was definded as partitioning coefficient of an organ.

3 Results and Analysis

3.1 The Photoassimilates Partitioning Coefficient of Organ of Medium Water and Nutrition

Photoassimilates from the plant photosynthetic organ is distributed to each organ.Plant organs(root,stem,leaves and storage organs) receive photoassimilates for the maintenance of their physiological activity and growth.The rate of photoassimilates partitioning to each organ is in connection with RDS, the amount of which depends on photoassimilates partitioning coefficient. The photoassimilates partitioning coefficient is as follows:

$$fr(org) = {GAA(org)}\big/{Fgass}$$

Where org is the plant organ, $fr(org)$ is photoassimilates partitioning coefficient, $GAA(org)$ is the rate of photoassimilates partitioning to various organs $(kg/ha^{-1} \cdot d^{-1})$, $Fgass$ is the total rate of assimilation of the field-crop plants $(kg/ha^{-1} \cdot d^{-1})$。

photoassimilates partitioning coefficient of medium water and nutrition was shown in figure 1.It can be seen from Figure 1 that fr(root) ,fr（stem and sheath） and fr(leaf) decreased ,fr(Ear) increased with the increase of RDS when RDS was greater than 0.35. It was the reason that the absorption and using process of sinks had significant effects on the partitioning of assimilates. The photoassimilates partitioning of each sink dependde on the competition ability of each sink mainly.The stronger the competition ability was,the more photoassimilates.Competition ability have two meanings, strength and priority.Strength is defined as the potential demand or potential capacity to photoassimilates of sink[2]. Priority refers to the order of meet the need to photoassimilates of sinks when photoassimilates supply is not sufficient.According to the previous studies, the priority order of plant organs from strong to weak were seed, fruit (stem and leaves), cambium layer, root and storage structure[3-4].Fr(ear) was the bigest because the ear competitiveness to photoassimilate was greater than root, stem and sheath, leaf when RDS was greater than 0.59, and increased with increasing RDS.

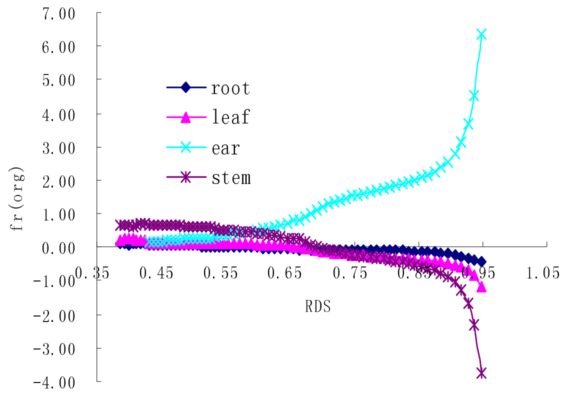
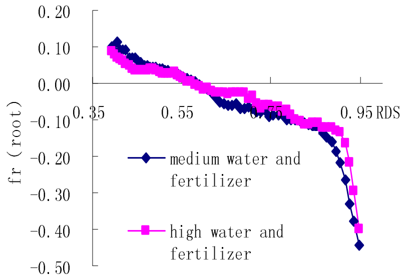


Fig. 1. Photoassimilates partitioning coefficient of winter wheat of medium water and nutrition

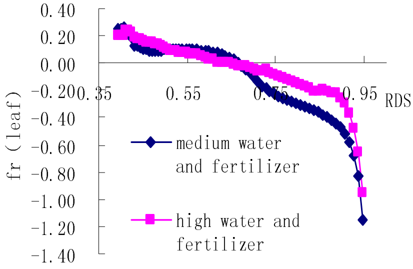
It can be seen from Figure 1 that fr(root) ,fr(stem and sheath) and fr(leaf) turned into negative When RDS were 0.59,0.67,0.7 respectively . It was due to the existence of repartitioning of photoassimilates.Component of plant body with the exception of cell walls ,even the inorganic substance, can be redistributed to other organs.For example, when the leaf senescence, most of the sugar and N, P, K etc evacuated and redistribute to new organs nearby.When RDS was greater than 0.59 ear become the growth center of winter wheat,so photoassimilates storaged in root , stem and sheath and leaf began to transport to ear. The amount of photoassimilates of root , stem and sheath and leaf decreased with time,so the corresponding photoassimilates partitioning coefficient were negative.Photoassimilates supply to ear mainly,so fr(ear) was the maximum.when RDS=0.95, partitioning coefficient of ear reached 6.35.The ratio of photoassimilates transported from stemandsheath was the largest,followed by leaves and roots.

3.2 Effects of Water and Nutrient on Photoassimilates Partitioning Coefficient

The data of high water and nutrition ,medium water and nutrition treatments were analysized to detect whether the nutrition and water had influence on the partitioning coefficient.It can be seen from Figure 2 that photoassimilates partitioning coefficient of root,stem and sheath, leaf of high water and nutrition treatment were greater than that of medium water and nutrition. That was, vegetative growth of high water and nutrition was luxuriantly than that of medium water and nutrition.When RDS was 0.90 fr(root) ,fr（stem and sheath）, fr(leaf), fr(ear) of medium water and nutrition were -0.18,-0.47,-0.89,2.54 respectively . Fr（stem and sheath）, fr(leaf), fr(ear) of medium water and nutrition were -0.13,-0.25,-0.45,1.83 respectively.It showed that excessive water and nutrition made against the transportation of photoassimilates to the growth center.The ratio of photoassimilates transported to ear from root , stem and sheath and leaf of high water and nutrition treatment was lower than that of medium water and nutrition treatment.So water and nutrition should be controled appropriately in later growth period in order to realize high yield of winter wheat.



(a)



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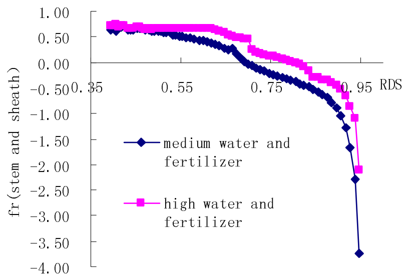

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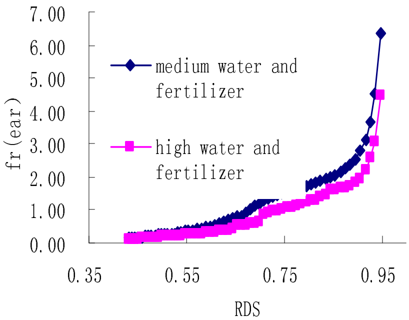

(d)

Fig. 2. Photoassimilates partitioning coefficient among organs

3.3 Data Comparison

Photoassimilates partitioning coefficient of all organs measured by P.M.Driessen[5] were shown in Table 1.It can be seen that fr(root) fr(stem) and fr(leaf) were 0.00, and fr(ear) was 1.00 when RDS was greater than 0.56. In his study, the minimum and maximum of Photoassimilates partitioning coefficient of all organs were 0.00 and 1.0 without the consideration of the transportation of photoassimilates among organs.However fr(root) ,fr（stem and sheath）and fr(leaf) turned into negative When RDS were 0.59,0.67,0.7 respectively, fr(ear) was 6.35 when RDS=0.95 in the paper.It was due to the existence of repartitioning of photoassimilates, and photoassimilates storaged in root , stem and sheath and leaf began to transport to ear.

Table 1. Photoassimilates partitioning coefficient of all organs of winter wheat

RDS	0	0.11	0.20	0.35	0.47	>0.56
fr(leaf)	0.50	0.66	0.56	0.34	0.10	0.00
fr(root)	0.50	0.34	0.23	0.09	0.04	0.00
fr(stem)	0.00	0.00	0.21	0.57	0.86	0.00
fr(s.o.)	0.00	0.00	0.00	0.10	0.00	1.00

4 Conclution

When RDS was greater than 0.35 fr(root) ,fr（stem and sheath）and fr(leaf) decreased, fr(Ear) increased with the increase of RDS.When RDS were 0.59,0.67,0.7 fr(root), fr（stem and sheath） and fr(leaf) turned into negative respectively .It was due to the existence of repartitioning of photoassimilates,and photoassimilates storaged in root , stem and sheath and leaf began to transport to ear. It showed that water and nutrition had a certain influence on the photoassimilates partitioning coefficient among organs, and excessive water and nutrition were unfavourable for the transportation of photoassimilates to the growth center.The ratio of photoassimilates transported to ear from root , stem and sheath and leaf of high water and nutrition treatment was lower than that of medium water and nutrition treatment .

In future research photoassimilates partitioning in the conditions of limited water and nutrition should be studied , in order to provide theoretical basis for the determination of high yield and high efficiency water and ferlilizer utilization of winter wheat.

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