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Canopy Index and Productivity of Broadcasted Hybrid Rice (*Oryza sativa L.*) Influenced by Nitrogen Splitting Application

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ABSTRACT

A filed experiment was layout in split plot design with three replications in two consecutive summer seasons of 2014 and 2015 in the Experimental farm of rice research section located at Sakha station, Kafr EL-Sheikh Governorate and Laboratory of Agric botany department of Faculty of Agriculture Assuit Al-Azhar university. Two Nitrogen fertilization doses in form of urea viz; 165 and 220 Kg N/ ha., were investigated under 6 schedules of nitrogen splitting application along with physiological life span of Egyptian hybrid rice one (EHR1) under broadcast seeded rice as following T1:1/2 basal(B) +1/2panicleinitiation (PI)., T2:1/3B+ 1/3ET+ 1/3PI., T3:., T5:1/4B +1/4ET +1/4PI +Mid-booting(MB)and T6:1/4B+1/4ETS+1/4PFS+1/4 panicle emergence (PE). Analysis of variance indicated that highly significant differences in all studied vegetative characters such as leaf area index, nitrogen concentration in flag leaf at flowering, vegetative dry weight at maturity under 220kg N/ha with multiple ways schedules of nitrogen application. yield and its attributes with high nitrogen dose 220kgN/ha with all schedules of nitrogen splitting application showed highly significant superiority in dry matter accumulation, chlorophyll content, nitrogen content, vegetative dry matter at maturity, leaf area index, canopy index as well as grain yield and its attributes. Four or three nitrogen doses one of them at late growth stage surpassed two way-schedule of nitrogen application in all abovementioned characters**.** It could be summarized that 220 Kg N/ha four equal premiums which jointed both of vegetative and reproductive growth stages with the vital premium at panicle emergence or mid-booting is considered the pertinent schedule to enhance and reach the ceiling productivity of Egyptian rice hybrid. Direct seeded for hybrid rice (DSHR) is considered the future avenue for rice cultivation in Egypt and all over the rice countries. Under DSHR improvement of canopy index is considered analeptic matrix for corresponding rice parameters which physiologically effect directly throughout raise up the contribution of post-anthesis assimilates (Current Photosynthesis) which resulted in maintaining rice grain yield and the nutritional value of rice grains and indirectly throughout increase the translocation of pre-anthesis assimilates (stored assimilates) which reflected on augmentation of harvest index.

Keywords: Canopy index, Nitrogen % in flag leaf, yield, hybrid Rice , N splitting

INTRODUCTION

Rice (*Oryza sativa L.*) is a major food of the world and more than half of the population subsists on it. It is the main livelihood of rural population living in subtropical and tropical Asia and hundreds of millions people living in Africa and Latin America. Rice is most prominent crop in Egypt and is the staple food of the Egyptian. Transplanting of rice seedlings into flooded fields gives the crop a major competitive suppressed by the standing water. Rising costs of labour, high water use and energy required for nursery establishment, puddling of fields and transplanting, coupled with labour scarcity during the peak period of activity are the compelling factors to seek an alternative to transplanting of rice. At the time being it becomes an urgent circumstances to shift rice cultivation from transplanting(TPR) to direct seeded rice(DSR) because of several reasons. Firstly, water scarcity in rice countries is considered the most important detrimental factor in rice production**.** Secondly, high cost of labour under transplanting rice. Thirdly, water consumption under DSR is less by approximately 25-30% compared by transplanted rice system. Fourthly, a lot of agricultural process such as raising of seedlings in a nursery, puddling, transplanting are completely eliminated under DSR. Direct seeding is an alternative rice cultivation technology that can reduce the labour and energy requirements for crop establishment and the demand for irrigation water. It offers faster and easier planting, reduces labour requirement, earlier crop maturity by7– 10 days, more efficient water use and higher tolerance of water deficit, less methane emission and often higher profit in areas with an assured water supply. Direct-seeded rice (DSR) offers the advantage of faster and easier planting, ensure proper plant population, reduce labor and hence less drudgery, 10-12 days earlier crop maturity, more efficient water use and higher tolerance to water-deficit, and often high profit in areas with assured water supply. Nitrogen nutrient is considered the major element determined the productivity of rice crop due to mobility inside plant. A plenty of variability in case of nitrogen exhibited viz: mineralization, leaching, denitrification and uptake rice plant. Therefore, this study aimed to optimize the utilization of nitrogen applied in the field throughout the pertinent schedule of nitrogen application which meet the growth demand along with life span under broadcasted seeded rice.

MATRIRIALS AND METHODS

A filed experiment was conducted at the Farm of Sakha agriculture research station, Sakha, Kafr El-Sheikh, Egypt during the two seasons of 2014 and 2015. The current study aimed to investigate the suitable schedules of nitrogen application along with physiological growth stages under two pertinent nitrogen doses as a technique to reduce nitrogen loses and increase the utilization by rice plant. Split plot design with three replications was used where the two nitrogen levels were allocated in the main plots whereas schedules of nitrogen application assigned in sub plots with plot size 3x4 m^2. Two nitrogen doses were used 165 and 220 kg/ha each under six nitrogen split schedules as follows:T1: 1/2 basal(B) +1/2 panicle initiation (PI).; T2:1/3 B+1/3 Early-tillering(ET)

+1/3PI,; T3: 1/2B+1/4ET+1/4PI,; T4: 1/3B+1/3PI+1/3 Early booting (EB).; T5: 1/4B+1/4 ET+1/4PI+1/4 Mid booting(MB) and T6: 1/4B+1/4ET+1/4PI+1/4 panicle emergence (PE ,30 DAPI). Soil samples were taken from the experimental site at 0-30cm depth then air-dried, ground to pass through a two mm sieve and well mixed then physical and chemical analysis reported according to the methods of Black *et al.*(1965)as presented in Table 1.

A/ Field preparation and Fertilizer applied.

Phosphate in form of Calcium super phosphate (15.5% P_2O_5) incorporated at the rate of 220Kg/ha with the soil before plough. The experimental site was well prepared by ploughing twice then disk harrowed then water submergence. Commercial Zinc sulphate $(Zn)_2SO_4 6H_2O$ was added immediately after puddling at a rate of 24kg/ha. Potassium sulfate (48% K_2O) was added at a rate of 120Kg/ha into dry soil and incorporated during soil preparation. In case of nitrogen fertilizer with each dose in form of Urea $(NH_2)_2C=O$ (46.5% N) were applied according to the treatments.

Table 1. Some chemical properties of the experimental site during 2014and 2015 seasons.

Characters	2014	2015
Texture	Clayey	Clayey
pH(1:2.5 soil extract)	8.25	8.15
EC dSm^{-1} (soil paste)	2.30	2.55
OM %	1.60	1.51%
N %	0.055	0.052
P (available) ppm	18.8 0	14.20
K (available) ppm	480.00	520.00
Zn (available) ppm	1.40	1.58

B/ Broadcasting and weed control.

Egyptian Hybrid rice one was uniformity broadcasted on May18th at the rate of 25kg seeds/ha in the two studied seasons. Rice weeds were chemically controlled by using Saturn 50% mixed with sand to homogenous distribution at a rate of 7.14 liters/ ha one week after broadcasting according the recommendation of its application.

C/ Flowering Measurements.

Seven days from the last nitrogen premium, a steel frame (25 x 25 cm) was used to determine dry matter production. The fresh samples separated green into leaf blades and stem with leaf sheath then oven dried at 70 C^o for 72 hours then converted into m^2. Chlorophyll content of flag leaf (SPAD values) was estimated by chlorophyll meter Model 502. Vegetative growth rate at maturity(g/m^2/day) was measured according to Pantnaik *et al.*(1994) using the following formula:

$$\mathbf{VGRM} = \frac{\textbf{Vegetative dry weight at flowering } (g/m^2)}{\textbf{Days to 50\% heading}}$$

Nitrogen content in flag leaf was measured according to Hafez and Mikkelson(1981). Canopy Index was estimated according to Jiang *et al.*(1993) formula as follows CI = (LAI x Leaf nitrogen content %) at flowering. Based on LAI and leaf nitrogen content, canopy index (CI) has been early proposed as a prime quantitative parameter for the healthy rice canopy.

D/ Yield and it attributes.

At harvest a steel frame (25x25 cm) was used to estimate number of tillers and number of panicles then converted per m^2. Ten panicle were chosen randomly to estimate panicle length, number of primary branches/panicle, filled grains/panicle, chaffy grains/panicle, sterility%, panicle weight as well as 1000 grain weight. A central area $5m^2$(2x2.5) from each plot was harvested, dried, estimated as biological yield, mechanically threshed, weighted and recorded the yield then converted into (ton/ha). Nitrogen content % was estimated according to Hafez and Mikkelson(1981) then times with 5.95 to estimate protein content in rice grains. All data were statically analyzed by using CO-Stat program then the differences among treatments were analyzed by using (Duncan's Multiple Range Test, DMRT) at 0.05 P-Levels (Gomez and Gomez,1984).

RESULTS AND DISSCUSION

A/ Flowering Measurements.

Leaves dry weight, Stem dry weight and Total dry weight(g/m^2).

Leaf, stem and total dry weights of Egyptian hybrid rice one significantly affected by nitrogen levels and different schedules of nitrogen applied as stated in Table 3. High nitrogen dose 220kgN/ha surpassed the other dose in leaf dry weight at flowering, stem dry weight at flowering, total dry weight and recorded 625.1,629.4,1057.25,1047.03,1676.32 and 1675.55 g/m^2 in both seasons of study, respectively. When nitrogen levels increased both of leaf and stem dry weights at anthesis were significantly increased. These might be attributed to the role of nitrogen in growth, tillering, photosynthesis which reflected in carbohydrate accumulation in plant organs. These data are confirmed also by Salem *et al.* (2011), Husan *et al.*(2014) and Gomaa *et al.*(2015).

With regards to various nitrogen application on leaf dry weight, stem dry weight and total dry weight data obtained indicated that, split application of urea significantly influenced leaf, stem and total dry weights as showed in Table 2. There were a highly significant differences among all schedules of nitrogen applied, where multiple way- schedules of nitrogen application surpassed two way schedules of nitrogen applied in leaf, stem and total dry weights g/m^2 in both seasons of study. Among multiple way of nitrogen applied the schedules which jointed both vegetative and reproductive growth stages of plant life span showed a marked superiority in leaf, stem and total dry weights and produced the highest values in both seasons. Both of T5 and T6 of nitrogen application that applied nitrogen in four equal premium through plant life span jointed both vegetative and reproductive growth stages statistically recorded the highest and par values of leaf dry weight 627.5, 636.7, 647.5 and 659.2 g/m^2., stem dry weight 1120.46, 1115.3, 1121.8 and 1111.7 g/m^2., total dry weight 1750.6,1770.8,1747.6 and 1749.2 g/m^2 in both seasons of study as mentioned before. These results are in a good harmony with finding obtained by El-Kallawy(2008).

Table 2. Leaf, Stem dry, Total dry weights g/m^2 and chlorophyll content of EHR1Cultivar at 1st flowering as affected by nitrogen levels and splitting of nitrogen application in 2014 and 2015 seasons.

Characters Treatments	Leaf dry weight (g/m^2)		Stem dry weight (g/m^2)		Total dry weight (g/m^2)		Chlorophyll content (SPAD values)	
	2014	2015	2014	2015	2014	2015	2014	2015
N-Levels Kg N/ ha.								
165	573.9b	575.1b	964.6b	960.7b	1535.2b	1535.8a	39.0b	38.3b
220	625.1a	629.4a	1057.3a	1047.0a	1676.3a	1675.6b	42.0a	40.6a
F. Test	**	**	**	**	**	**	**	**
N-Splitting								
T1	573.9c	561.1e	867.5c	877.5d	1425.6e	1438.5d	37.0e	36.1d
T2	575.5c	569.2e	917.6c	888.8d	1498.1d	1457.9d	38.0d	36.7d
T3	575.1c	585.6d	998.8b	992.5c	1575.4c	1576.7c	37.9d	36.1d
T4	597.4b	602.6c	1039.6b	1037.6b	1637.4b	1640.8b	41.5c	39.9c
T5	627.5a	636.7b	1121.8a	1111.7a	1747.6a	1749.2a	43.3b	42.8b
T6	647.5a	659.2a	1120.5a	1115.3a	1750.6a	1770.8a	45.3a	45.0a
F. Test	**	**	**	**	**	**	**	**
Interaction	**	**	**	**	**	**	**	**

***, ** and NS indicate $P < 0.05$, $P < 0.01$ and not significant, respectively. Means of each factor designated by the same latter are not significantly different at 5% level using DMRT.**

T1: 1/2 basal(B) +1/2 panicle initiation, PI.; T2: 1/3 B+1/3 Early-tillering, ET+1/3PI.; T3: 1/2B+1/4ET+1/4PI.; T4: 1/3B+1/3PI+1/4 Early booting, EB,; T5: 1/4B+1/4 ET 1/4PI+ Mid booting, MB, and T6: 1/4B+1/4ET+1/4PI+1/4 panicle emergence, PE.

With refers to the interaction effect between nitrogen doses and schedules of nitrogen application under study as shown in figure1, it could noticed that the best combinations to get the ceiling leaf, stem and total dry weights was 220kgN/ha with four equal premium 1/4 dose at basal+1/4 dose at early tillering+1/4dose at panicle initiation+1/4dose at panicle emergence which recorded the peak leaf dry weight values 654.66,670.00,1200,1200,1820 and 1830 g/m^2 in both seasons. High nitrogen dose 220 Kg N with T5 which applied nitrogen in four equal premium 1/4 dose at basal+1/4dose at early tillering+1/4dose at panicle initiation+1/4dose at mid booting came in the following rank in producing leaf, stem and total dry weight in the two seasons. These Data are in a similarity with that reported by Gobi *et al.* (2006), El-Kallawy (2008), Mahajan *et al.* (2012) and Tsedalu *et al.(*2015). Therefore, the pertinent schemes T6 and T5 for Egyptian Hybrid rice one under direct seeded rice (DSR) which increase leaf, stem and total dry weights per unit area have to not only meet the plant demand in critical time of plant needs but also reach the ceiling of nitrogen utilization applied.

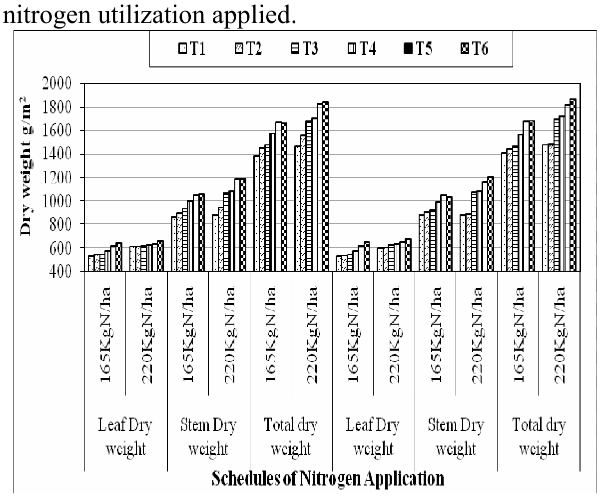

Fig. 1. Leaf dry weight g/m^2, stem dry weight g/m^2 and total dry weight g/m^2 of EHR1 cultivar at 1st flowering as affected by interaction between N-levels and N-splitting application at 2014and 2015 seasons.

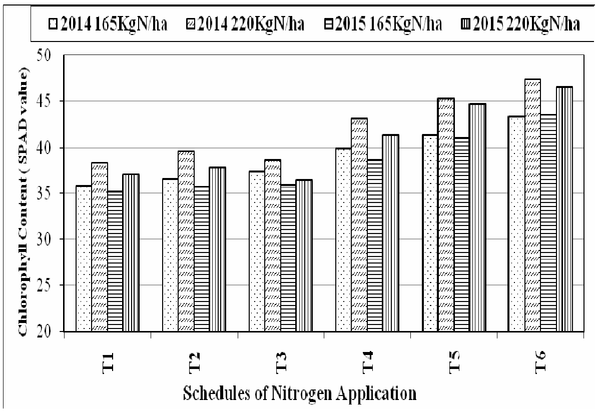

Fig. 2. Chlorophyll Content (SPAD value) of EHR1 cultivar at 1st flowering as affected by interaction between N- levels and N-splitting application at 2014and 2015seasons.

Chlorophyll Content (SPAD values and Days to 50% heading.

As well known the role of nitrogen function is that increase the greenish of the plant leaves due to highly absorption of nitrogen applied, data shown in Table 2 and 3 indicated that a significant superiority of 220kgN/ha in chlorophyll content in flag leaf in soil plant analysis development (SPAD) values and recorded 42.0 and 40.6 in both studied seasons. Highly nitrogen dose applied also delayed days to 50% heading of Egyptian rice one and recorded 105.4 and 105.3 in both seasons of study. At the highest rate of N, the anthesis (flowering) was delayed by three to four days as compared with the other treatments. These finding are completely in harmony with similar obtained by El-Kallawy (2008), Young Li *et al.(*2010), Yoseftabar (2013a),Yoseftabar (2013b), Yu Qiao-Yang *et al.(*2013), Wang Yuan *et al.*(2014) and Singh *et al*.(2015).

Multiple way schemes of nitrogen application significantly surpassed two way schemes of nitrogen application in both chlorophyll content and days to 50 % heading in both seasons as listed in Table 3 and 4. Among multiple way-schemes of nitrogen application T5 and T6 that jointed both vegetative and reproductive stages in nitrogen premiums applied were superior in both chlorophyll content in flag leaf and days to 50% heading compared with T3 that ended in nitrogen premiums at panicle initiation. Four equal premium of nitrogen application 1/4basal +1/4early tillering +1/4 panicle intiation+1/4 panicle emergence is considered the pertinent schedule of nitrogen application which recorded the peak chlorophyll content 45.3and 45.0 in both seasons of study. These findings lead to the fact that under DSR system of Egyptian hybrid rice cultivation the suitable timing and real one to meet hybrid rice requirements of nitrogen should to receive the amount of nitrogen before and after anthesis to maintain the chlorophyll content in flag leaf as the active and most effective rice leaf in current photosynthesis which contributes more that 65% of rice grain yield.

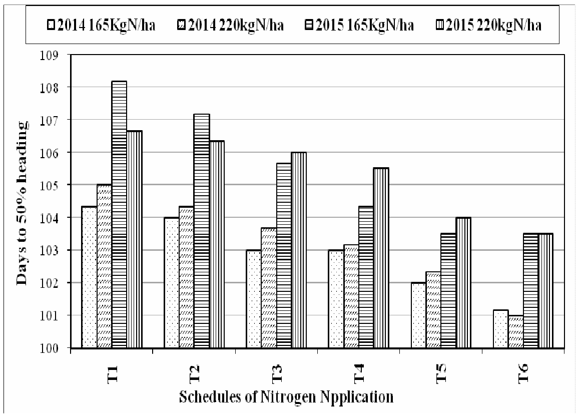

Fig. 3. Days to 50% heading of EHR1 cultivar at 1st flowering as affected by interaction between N- levels and N-splitting application at 2014and 2015 seasons.

Table 4. Days to 50% heading, vegetative growth rate at maturity, Leaf area index and nitrogen content% in flag leaf of EHR1 cultivar at 1st of flowering as affected by nitrogen levels and splitting of nitrogen application in 2014and 2015 seasons.

Characters	Days to 50% heading		VGRM		Leaf Area Index		N content (%) In Flag Leaf	
Treatments	2014	2015	2014	2015	2014	2015	2014	2015
N-Levels Kg N/ ha.								
165	102.9b	103.3b	14.9b	14.9b	5.7b	5.5b	1.5b	1.4b
220	105.4a	105.3a	15.9a	15.9a	6.4a	6.1a	1.6a	1.6a
F. Test	**	**	**	**	**	**	**	**
N-Splitting								
T1	102.3e	102.3e	13.4e	13.6d	5.4d	5.2de	1.3e	1.3e
T2	102.8e	103.2d	14.2d	13.8d	5.5d	5.4d	1.4d	1.4d
T3	103. 7d	104.3c	15.1c	15.0c	5.5d	4.9e	1.4d	1.4d
T4	104.3c	104.8bc	15.8b	15.0c	6.0c	5.9c	1.6c	1.5c
T5	105.6b	105.3ab	17.0a	17.0a	6.6b	6.6b	1.7b	1.7b
T6	106.3a	105.8a	17.1a	17.3a	7.1a	6.9a	1.9a	1.8a
F. Test	**	**	**	**	**	**	**	**
Interaction	**	**	**	**	**	**	**	**

***, ** and Ns indicate P < 0.05, P < 0.01 and not significant, respectively. Means of each factor designated by the same latter are not significantly different at 5% level using DMRT.**

T1: 1/2 basal(B) +1/2 panicle initiation, PI.; T2: 1/3 B+1/3 Early-tillering, ET+1/3PI.; T3: 1/2B+1/4ET+1/4PI.; T4: 1/3B+1/3PI+1/4 Early booting, EB,; T5: 1/4B+1/4 ET 1/4PI+ Mid booting, MB, and T6: 1/4B+1/4ET+1/4PI+1/4 panicle emergence, PE.

Vegetative growth rate at maturity (VGRM) (g/m^2/day) and Leaf area index.

vegetative growth rate at maturity of hybrid rice under DSR, is considered a very important growth parameter that reflects the plant weight increase per unit area per day at flowering. Data in Table 4 illustrated that highly significant differences among nitrogen doses in vegetative growth rate at maturity and leaf area index where, the highest nitrogen dose 220kgN/ha recorded the highest dry weight per day and leaf area index 15.9, 15.9, 6.4 and 6.1 in both seasons of study, respectively. With high nitrogen dose applied, Egyptian hybrid rice one showed edacity of nitrogen absorption which resulted in higher dry matter production. Among schedules of nitrogen application data in Table 4 revealed that by increasing premiums of nitrogen applied dry matter production per day and leaf area index improved. Multiple way schedules of nitrogen application surpassed two way scheme of nitrogen application in dry matter produced per day and leaf area index. The schemes of nitrogen applied in both vegetative and reproductive growth stages T6 and T5 significantly recorded the highest dry matter per day and leaf area index. Four equal nitrogen doses 1/4 at basal,1/4 at early tillering, 1/4 at panicle initiation and 1/4 at panicle emergence is considered the suitable scheme of nitrogen application which came in the first rank in dry matter production per day 17.1and 17.3 and leaf area index 7.1 and 6.9 in both studied seasons. The similar results were reported by El-Kallawy (2008), Sathiya and Ramesh 2009, Yong Li *et al.*(2010), Hafeez *et al.*(2013) and Forough Kamyab *et al*.(2014). Under DSR it could be maintain dry matter production per unit area to meet hybrid rice requirements throughout doses of nitrogen and increase its splitting gathering both vegetative and a sensitive reproductive growth stages. Timely and split application of N allows for more efficient use of N throughout the growing season as it provides specific amounts of nutrients to the crop during peak periods of growth. The best combination of vegetative growth rate at maturity g/m2/day and leaf area index were produced by 220kgN/ha with four equal nitrogen premiums ended at reproductive stage neither panicle emergence or mid booting.

N content in flag leaf (%) and Canopy index.

Nitrogen concentration in flag leaf of hybrid rice is considered the most important factor in rice leaf due to its active monitor for current photosynthesis which contribute more than 70% of rice grain yield. Both of nitrogen concentration in flag leaf and leaf area index are the two wings of canopy index formula. Nitrogen concentration in flag leaf % and canopy index as affected by nitrogen doses and schedules of nitrogen application are presented in Tables 4 and 5. The obtained results revealed that there were a highly significant difference between nitrogen doses on nitrogen% in flag leaf and canopy index where, the high nitrogen dose applied the high nitrogen concentration in flag leaf obtained the high canopy index produced in both studied seasons. recorded The highest values of nitrogen content% and canopy index recorded with 220kgN/ha 1.6,1.6,10.6 and 9.9 in both seasons of study, respectively. As mentioned in the aforementioned characters with regards to various of schedules of nitrogen application effects on nitrogen content concentration in flag leaf and canopy index data stated in Tables 4 and 5 revealed that the split application of fertilizer N remains an essential component of ceiling of N % in flag leaf and maintain the leaf area index at flowering. Hence, both of maintenance N % in flag leaf and leaf area index resulted in improvement of canopy index. Application of N during critical stages may optimize leaf N distribution, thereby maintaining high canopy photosynthesis, especially during grain filling stage Qi Jing *et al.*(2007) and EL-Kallawy (2008).

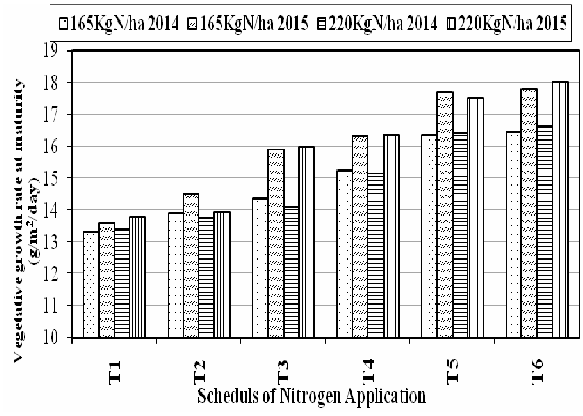

Fig. 4. Vegetative growth rate at maturity (VGRM g/m²/day)of EHR1 cultivar at 1st flowering as affected by interaction between N- levels and N-splitting application at 2014and 2015 seasons.

Therefore, applying nitrogen premiums along with rice growth stages keep the N % in hybrid rice leaves at the optimal ranges which reflect later on indirectly on pre assimilates photosynthesis and directly on post anthesis photosynthesis(Current Photosynthesis) thorough improvement the canopy index, EL-Kallawy (2008).

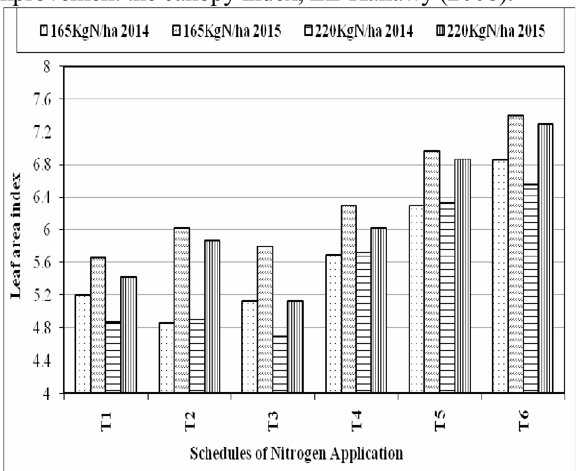

Fig. 5. Leaf area index of EHR1 cultivar at 1st flowering as affected by interaction between N- levels and N-splitting application at 2014and 2015 seasons.

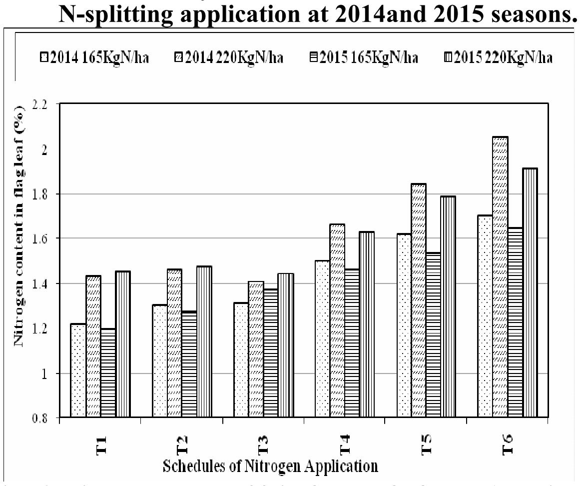

Fig. 6. Nitrogen content% in flag leaf of EHR1 cultivar at 1st flowering as affected by interaction between N- levels and N-splitting application at 2014and 2015 seasons.

Table 5. Canopy index, plant height, number of panicles/m2 and panicle length of EHR1 cultivar at 1st of flowering as affected by Nitrogen levels and Splitting of Nitrogen application in 2014and 2015 seasons.

Characters	Canopy Index		Plant height Cm		No of Panicles/ m²		Panicle length cm	
Treatments	2014	2015	2014	2015	2014	2015	2014	2015
N-Levels Kg N/ ha.								
165	8.4b	7. 9b	97.3b	97.8b	542.7b	542.4b	22.5b	22.8b
220	10.6a	9. 9a	100.3a	102.0a	590.8a	586. 7a	24.2a	23.9a
F. Test	**	**	*	*	**	**	**	**
N-Splitting								
T1	7.2e	6.8d	95.3c	97.6cd	525.8e	525. 7e	22.5c	22. 7c
T2	7.7d	7.4d	98.3b	99.5ab	545.2d	546.5d	22.8bc	22.9bc
T3	7.7d	6.9d	100.6a	102.5a	546.8d	544.7d	22.9bc	22.5c
T4	9.4c	9.1c	100.2a	101.3a	557.3c	557.5c	23.4b	23.3b
T5	11.6b	10.7b	98.2b	98.4bc	597.7b	597.3b	24.2a	24.2a
T6	13.4a	12.4a	100.1a	100.0ab	627.8a	615. 7a	24.3a	24.6a
F. Test	**	**	*	*	**	**	*	*
Interaction	**	*	NS	NS	**	**	NS	NS

***, ** and Ns indicate P < 0.05, P < 0.01 and not significant, respectively. Means of each factor designated by the same latter are not significantly different at 5% level using DMRT.**

T1: 1/2 basal(B) +1/2 panicle initiation, PI.; T2: 1/3 B+1/3 Early-tillering, ET+1/3PI.; T3: 1/2B+1/4ET+1/4PI.; T4: 1/3B+1/3PI+1/4 Early booting, EB,; T5: 1/4B+1/4 ET 1/4PI+ Mid booting, MB, and T6: 1/4B+1/4ET+1/4PI+1/4 panicle emergence, PE.

Both of T6 and T5 that applying nitrogen doses in for equal premiums in both vegetative and reproductive growth stages reached the peak of N% in flag leaf and canopy index 1.9, 1.8, 1.7, 1.7, 13.4, 12.4, 11.6 and 10.7 in both seasons under study, respectively. After all mentioned discussion for the vegetative growth characters it could summarized that canopy index could be used as a pertinent indicator growth parameter for forecasting of post-anthesis photosynthesis assimilates contribution in rice grain yield.

The best combination was 220kgN/ha applied in four equal premiums 1/4 at basal+1/4 at early tillering +1/4 at panicle initiation +1/4 at panicle emergence which produced the peak values of N% in flag leaf and canopy index followed by the four equal nitrogen premiums ended at mid- booting stage with the same nitrogen dose.

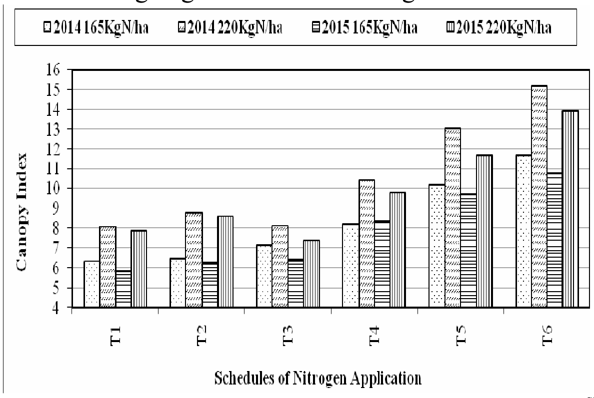

Fig. 7. Canopy Index of EHR1 cultivar at 1st flowering as affected by interaction between N- levels and N-splitting application at 2014and 2015seasons.

B. Yield and its attributes as affected by N-doses and schedules of N- application .

Number of panicle /m^2, Plant height cm, and Panicle length cm.

Data listed in Table 5 revealed that a highly significant differences were recorded in plant height, number of panicles/m^2 and panicle length as affected by nitrogen doses and schedules of nitrogen application where, the height nitrogen dose applied 220kgN/ha the tallest plants obtained 100.3cm and 102.0cm the highest number of panicles /m^2 recorded 590.8and 586. 7 and the tallest panicle length obtained 24.2cm and 23.9cm in both seasons of study, respectively. These results are in coincidence with that reported by Muhammad Maqsood *et al.*(2013). On the other hand, more splitting of nitrogen along with life growth span of hybrid rice especially that jointed both of vegetative and reproductive stages showed superiority in the above-mentioned characters where, T6 and T5 which contained one premium of applied nitrogen in sensitive reproductive stage either at panicle emergence or mid booting recorded the peak values of that characters in both growing seasons. These results of the superiority of T6 and T5 in case of number of panicles/m^2 could be due to reducing the mortality percentage along with plant duration. The supremacy of T6 and T5 in panicle length due to the role of nitrogen at these stages which might be speed up the formation of growth regulators such as auxins which increased the panicle exertion throughout increasing internode elongation located below the panicle. These findings are in congruent with that recorded Abd El-Maksoud (2008), El-Kallawy (2008), Muhammed Tahir *et al.*(2008), Bah *et al.* (2009) and Li Hong Xue *et al.*(2013). As shown in fig. 8 dividing nitrogen amount applied in multi ways according to plant growth stages improved panicles /m^2. The pertinent combinations regards to number of panicles/m^2 were reported when 220kg/ha applied in four equal premiums ended at panicle emergence followed by the scheme ended at mid booting with the same nitrogen dose in both following seasons. Similar results were founded by Hung *et al.*(2008) and Tsedalu *et al.(*2015).

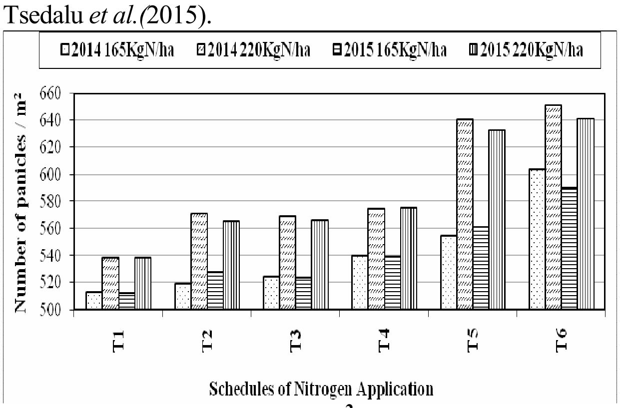

Fig. 8. Number of panicles / m^2 at harvest affected by interaction between N- levels and N-splitting application at 2014and 2015seasons.

Panicle characteristics.

With regards to panicle characteristics including panicle weight, filled grains/panicle, chaffy grains/ panicle, sterility % and 1000- grain weight as affected by doses and schedules of nitrogen application data listed in Table 6 revealed that nitrogen doses affected significantly all the mentioned panicle characteristics where the highest dose of nitrogen applied, 220kgN/ha the heaviest panicle recorded, the highest filled grains per panicle obtained, the highest chaffy grains per panicle produced, the highest sterility percentage recorded and the highest 1000- grain produced. These results might be due to the role of nitrogen in improvement of sink capacity parameters which characterized rice hybrids. These finding are in harmony with that recorded by Mirza *et al.* (2009), Li Hong Xue *et al.*(2013) and Mahjoobeh *et al.*(2013). With respect to the schedules of nitrogen application as presented in Table 6 data illustrated that increasing nitrogen premiums surpassed two premiums in the mentioned panicle characters in both studied seasons. Among the schedules of nitrogen applied T5 and T6 statistically recorded the ceiling values of all panicle characters where, four equal of nitrogen 1/4 at basal+1/4 at early tillering+1/4 at panicle initation+1/4 at panicle emergence along with plant growth ended at panicle emergence is considered the fitted one which improved all panicle characters. In the same trend data reported by El-Kallawy(2008), Farough Kamyab *et al.(*2014) and Tsedalu *et al.(* 2015) were confirmed.

With respect to the interaction effects between nitrogen doses and schedules of nitrogen application on panicle characters data shown in Fig.9 to Fig.13 shown that panicle weight improved when number of nitrogen splitting increased with both nitrogen doses fig.9. where the best combinations were four equal nitrogen premiums ended at either panicle emergence or mid booting which produced the peak panicle weight in both seasons of study. These results mainly due to the vital effect of the last premium of nitrogen applied at sensitive reproductive stage which increased N concentration in flag leaf and the two concurrent leaves and that resulted in improvement of Rubisco(Ribulose 1-5 bisphosphate carboxylase oxygenase) content in flag leaf which reflected on increasing the current photosynthesis Pantnaik *et al.*(1994) and El-Kallawy (2008). The same trend were reported in case the filled grains/ panicle Fig.10 where multiple way schemes of nitrogen application with the high nitrogen dose 220kgN/ha. Applying 220KgN/ha in terms of four equal premiums ended at panicle emergence recorded the peak values of filled grains/ panicle. These data could be refers to that hybrid rice plants are classified as limiting source type with vigor sink size which is considered the main factor affect its higher yield El-Kallawy (2008). That continuous translocation and higher amount of post anthesis contribution to panicle of hybrid rice reduced the chaffy grains as shown in Fig.11 and thus, reduced the sterility percentage Fig.12 and increase 1000- grain weight Fig.13.

Table 6. PanicleWeight, filled grains/panicle, chaffy grains/panicle, sterility % and 1000- grain weight /g of EHR1 at harvest as affected by nitrogen levels and splitting of nitrogen application in 2014 and 2015 seasons.

Characters	Panicle Weight/ g		Filled grains/panicle		Chaffy grains/panicle		Sterility %		1000- grain weight /g	
Treatment	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
N-Levels Kg N/ ha										
165	4.0b	3. 9b	163.0b	162.7b	17.7b	18.2b	9.31b	10.0a	24.3b	23.9b
220	4.4a	4.3a	173.8a	171.1a	17.9a	19.0a	9.94a	10.1a	25.3a	25.5a
F. Test	**	**	**	*	**	**	**	NS	*	**
N-Splitting										
T1	3.9e	3.8e	158.9c	157.0d	21.9a	22.3a	12.1a	12.4a	24.4c	23.8c
T2	4.0d	3.9d	161.6c	161.2d	22.0a	22.3a	12.0a	12.2a	24.6bc	24.5b
T3	4.1cd	4.0d	161.2c	160.1d	21.4a	21.9a	11.7a	12.0a	24.8bc	24.6b
T4	4.1c	4.1c	170.8b	167.2c	16.5b	17.4b	8.8b	9.4b	24.2c	24.4bc
T5	4.5b	4.4b	177.2a	174.4b	12.6c	15.3c	6.7c	8.1c	25.1ab	25.4a
T6	4.6a	4.6a	180.9a	181.4a	12.5c	12.4d	6.5c	6.4d	25.6a	25.4a
F. Test	**	**	**	**	**	**	**	**	**	**
Interaction	**	**	*	*	**	**	**	**	**	**

***, ** and Ns indicate $P < 0.05$, $P < 0.01$ and not significant, respectively. Means of each factor designated by the same latter are not significantly different at 5% level using DMRT.**

T1: 1/2 basal(B) +1/2 panicle initiation, PI.; T2: 1/3 B+1/3 Early-tillering, ET+1/3PI.; T3: 1/2B+1/4ET+1/4PI.; T4: 1/3B+1/3PI+1/4 Early booting, EB,; T5: 1/4B+1/4 ET 1/4PI+ Mid booting, MB, and T6: 1/4B+1/4ET+1/4PI+1/4 panicle emergence, PE.

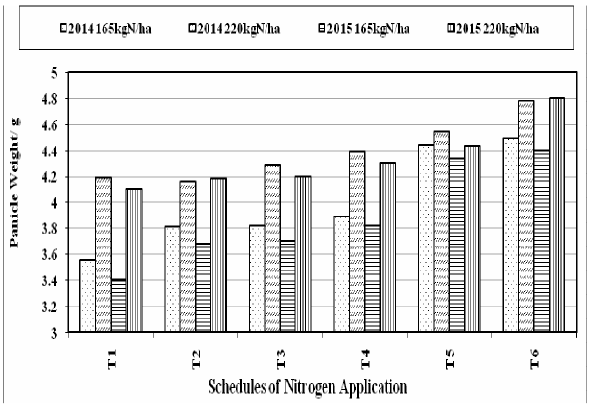

Fig. 9. Panicle Weight/g of EHR1 cultivar at harvest as affected by interaction between N- levels and N-splitting application at 2014and 2015 seasons.

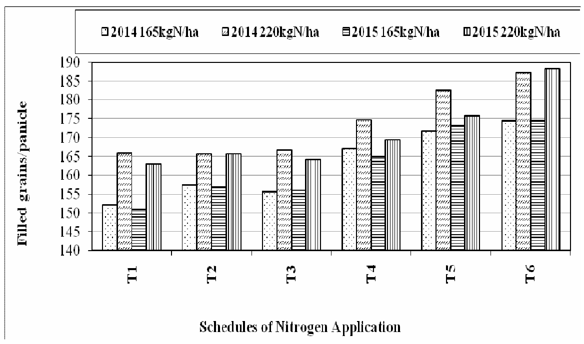

Fig. 10. Filled grains/panicle of EHR1 cultivar at harvest as affected by interaction between N-levels and N-splitting application at 2014and 2015 seasons.

Grain, straw yields t/ha and harvest index.

Grain rice yield is considered the last final target of all circumstances and conditions happened throughout all plant life span. Data stated in Table 7 regards grain yield, straw yield and harvest index as affected by nitrogen doses and schedules of nitrogen application revealed that the high nitrogen dose applied 220kgN/ha the highest grain yield obtained 11.24 and 11.19 tons/ha, straw yield 16.94 and 16.93tons/ha, harvest index 40.02 and 39.79 in both seasons of study. The profuse superiority hybrid rice under high nitrogen dose could be mainly due to vigorous root system, highly photosynthetic rate, high sink capacity, higher leaf area index and higher canopy index which all complementary going to raise rice grain yield.

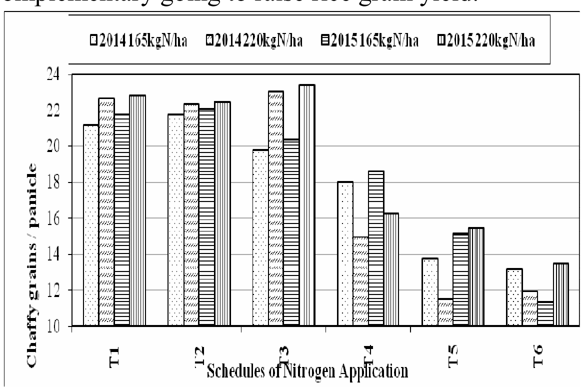

Fig. 11. Chaffy grains/panicle of EHR1 cultivar at harvest as affected by interaction between N-levels and N-splitting application at 2014and 2015 seasons.

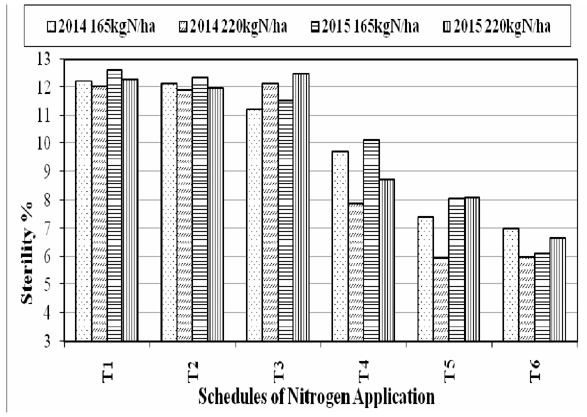

Fig. 12. Sterility % of EHR1 cultivar at harvest as affected by interaction between N- levels and N-splitting application at 2014and 2015 seasons.

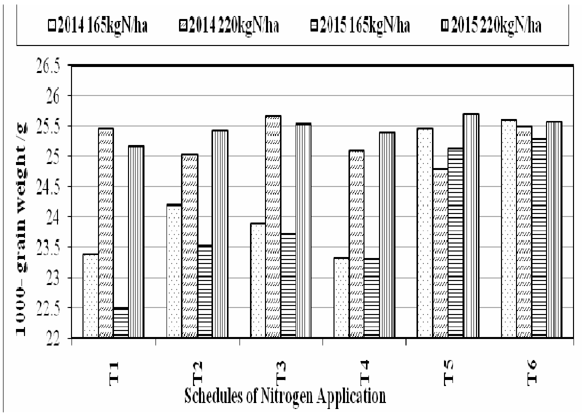

Fig. 13. 1000- grain weight /g of EHR1 cultivar at harvest as affected by interaction between N-levels and N-splitting application at 2014and 2015 seasons.

Table 7. Grain yield, straw yield, harvest index, nitrogen concentration% and protein content% in rice grains of EHRI at harvest as affected by Nitrogen levels and Splitting of Nitrogen application in 2014 and 2015 seasons.

Characters Treatments	Grain yield t/ ha		Straw yield t/ha		Harvest index		N- Content% in grain		Protein Content % in grains	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
N-Levels Kg N/ ha										
165	10.8b	10.9a	16.0b	16.1b	40.4a	40.6a	1.2a	1.2a	7.0a	7.1b
220	11.2a	11.2a	16.9a	16.9a	40.0a	39.8b	1.2a	1.2a	7.1a	7.2a
F. Test	**	*	*	**	NS	*	NS	NS	NS	*
N-Splitting										
T1	10.5d	10.6c	17.7a	17.7a	37.7d	37.4e	1.10e	1.13d	6.5e	6.7e
T2	10.6d	10.6c	18.0a	17.7a	37.1d	37.6de	1.14d	1.16c	6.8d	6.9cd
T3	10.6d	10.8c	17.8a	17.5a	37.3d	38.2d	1.15d	1.14d	6.8d	6.8de
T4	11.0c	11.1b	15.4b	16.0b	41.7c	41.0c	1.18c	1.16c	7.0c	7.0c
T5	11.4b	11.3b	15.0b	15.4c	43.2b	42.1b	1.25b	1.17b	7.42b	7.5b
T6	12.0a	12.0a	14.9b	14. 8d	44.6a	44.9a	1.30a	1.30a	7.71a	7.8a
F. Test	**	**	*	**	*	**	**	**	**	**
Interaction										
F. Test	*	*	*	*	*	*	*	*	*	*

***, ** and Ns indicate P < 0.05, P < 0.01 and not significant, respectively. Means of each factor designated by the same latter are not significantly different at 5% level using DMRT.**

T1: 1/2 basal(B) +1/2 panicle initiation, PI.; T2: 1/3 B+1/3 Early-tillering, ET+1/3PI.; T3: 1/2B+1/4ET+1/4PI.; T4: 1/3B+1/3PI+1/4 Early booting, EB,; T5: 1/4B+1/4 ET 1/4PI+ Mid booting, MB, and T6: 1/4B+1/4ET+1/4PI+1/4 panicle emergence, PE.

These findings are in a good compatibility with that recorded by Abd El-Maksoud(2008), Bah *et al.*(2009), Mirza *et al.*(2009), Li Hong Xue *et at*.(2013) and Mahjoobeh *et al.(*2013). Whereas, Multiple way schemes of nitrogen application showed a marked superiority in grain yield compared with two way schemes of nitrogen application as presented in Table 7. Among multiple nitrogen schedules, both of T6 and T5 recorded significantly the highest rice grain values 12.0, 12.0,11.4 and 11.3 tons/ha in both seasons, respectively. The superiority of T6 and T5 which included the last nitrogen premium at the analeptic reproductive growth stages panicle emergence or mid booting might be due to occurrence of nitrogenous fertilizer near root proliferating which indicated that NH_3 is still present in the growing medium. These facts could be related to the C investment of plant into N metabolism which needs C skeletons, reducing power and energy and all satisfied through afflux of photosynthetic products from leaves and the C investment in N assimilation is likely to be at its maximum when roots surrounded by the fertilizer if it was present in growth solution and able to draw the ammonical N form. These results are in pertinence with those reported by El-Kallawy (2008), Hafeez *et al.(*2013),and Hafeez *et al.(*2016). The best combinations which significantly recorded the par values of grain yield is that 1/4 at basal+1/4 at early tillering+1/4 at panicle initiation+1/4 at panicle emergence under 220kgN/ha followed by nitrogen scheme ended at mid booting with the same nitrogen dose as shown in Fig 14. The superiority of nitrogen schemes that including the last nitrogen premium at late reproductive stage such as panicle emergence or mid booting had a analeptic power through two mechanisms Firstly, increasing the translocation of pre- assimilates which stored in plant organs before anthesis. Secondly, throughout delayed leaf senescence and prolonging the products of current photosynthesis during grain filling period El-Kallawy(2008) and Amina Khatuni *et al.*(2015). These results are completely in coincidence with that reported by Pattniak *et al.*(1994) and Amina Khatuni *et al.*(2015).

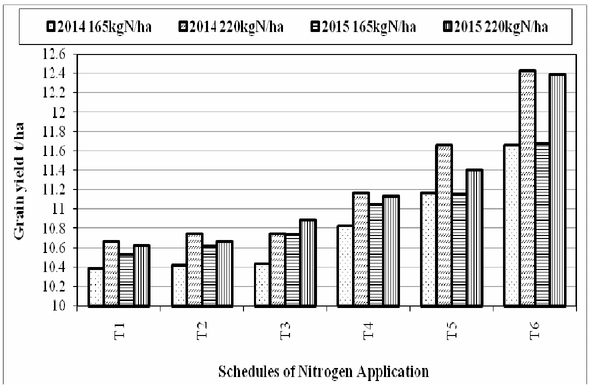

Fig. 14. Grain yield t/ha of EHR1 cultivar as affected by interaction between N- levels and N-splitting application at 2014and 2015 seasons.

In case of straw yield t/ha as affected by nitrogen doses and schedules of nitrogen application, as shown in Fig.15 with increasing nitrogen application premiums straw yield t/ha significantly decreased. Therefore, four equal nitrogen premiums under T5 and T6 with 165kgN/ha produced the lowest straw yield in both studied seasons because of increasing the pre anthesis assimilates of carbohydrates stored in plant organs before anthesis and finally resulted in maintain harvest index.

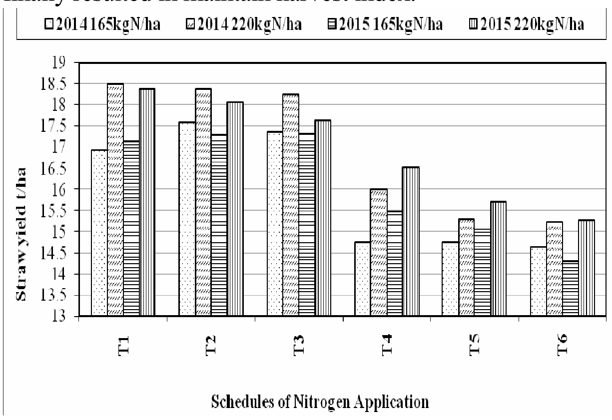

Fig. 15. Straw yield t/ha of EHR1 cultivar at harvest as affected by interaction between N- levels and N-splitting application at 2014and 2015 seasons.

N% and protein content in rice grains.

Nitrogen doses did not affect nitrogen concentration in rice grains or protein content except in the second season as listed in Table7. Meanwhile, There were a highly significant differences between all schedules of nitrogen application on both N concentration and protein content in rice grains in both seasons of study. Multiple way schemes of nitrogen application surpassed two way schemes in N concentration and protein content in rice grains.

Data in Table7 revealed that four equal nitrogen premiums which had the last dose at panicle emergence or mid booting recorded the highest nitrogen concentration and protein content values1.3, 1.303, 1.25, 1.17, 7.7, 7.8, 7.4 and 7.5 in both studied seasons, respectively. These results might be attributed to the fact that Egyptian rice hybrid had a high density of root distribution which responsible for higher N absorption potential. These finding are in harmony with that reported by Consuelo *et al.*(1996) and El-Kallawy (2008). The best combinations regards N-concentration and protein% in rice grains were 220KgN/ha applied in terms of four equal premiums ended either at panicle emergence or at mid-booting which recorded the peak N-concentration and protein % in rice grains in both studied seasons.

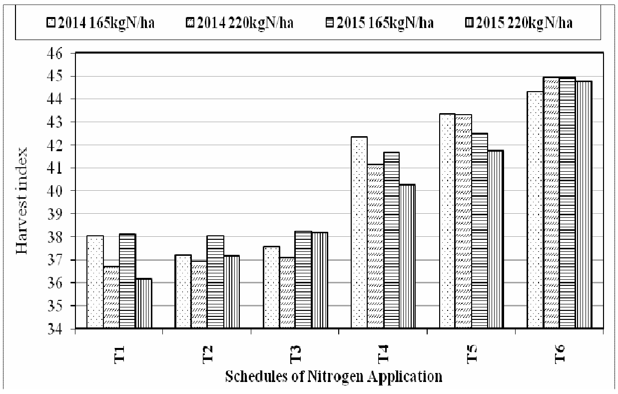

Fig. 16. Harvest index of EHR1 cultivar at harvest as affected by interaction between N- levels and N-splitting application at 2014and 2015 seasons.

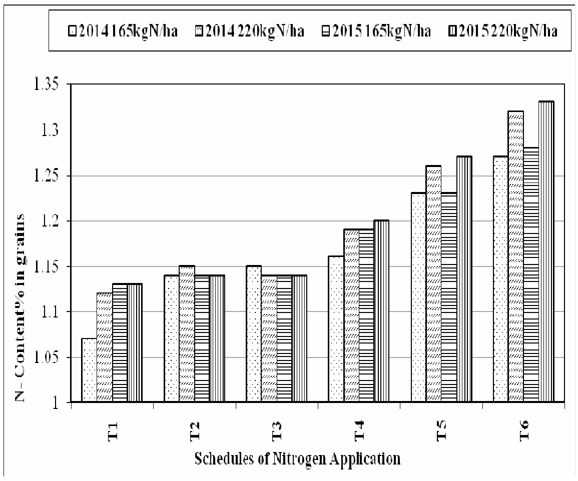

Fig. 17. N- Content% in grains of EHR1 cultivar as affected by interaction between N- levels and N-splitting application at 2014and 2015 seasons.

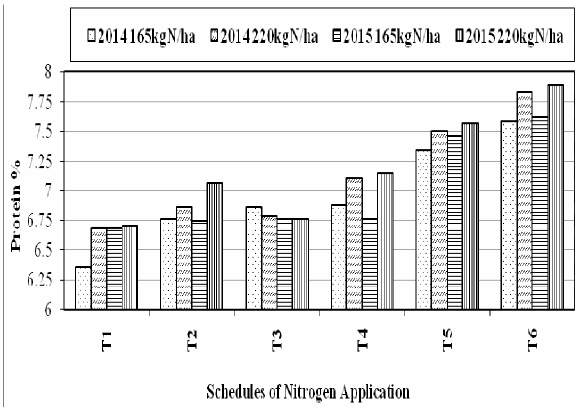

Fig. 18. Protein% in grains of EHR1 cultivar at harvest as affected by interaction between N- levels and N-splitting application at 2014and 2015 seasons.

Finally, it could be summarized that 220 Kg N/ha in four equal premiums which jointed both of vegetative and reproductive growth stages with the vital premium at panicle emergence or mid-booting is considered the pertinent schedule to enhance and reach the ceiling productivity of Egyptian rice hybrid. Direct seeded for hybrid rice(DSHR) is considered the future avenue for rice cultivation in Egypt and all over the rice countries. Under DSHR improvement of canopy index is considered analeptic matrix for corresponding rice parameters which physiologically effect directly throughout raise up post-anthesis assimilates (Current Photosynthesis)which resulted in maintain rice grain yield and the nutritional values of rice grains and indirectly throughout increase the translocation of pre-anthesis assimilates(stored assimilates) which reflected on augmentation of harvest index. Farther studies are needed in that concern.

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دليل الغطاء النباتي وإنتاجيه الأرز الهجين البدار المتأثر باضافه جرعات النيتروجين

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[2] قسم النبات الزراعي – زراعه أسيوط – جامعه الأزهر- مصر

أجريت تجربه حقليه في تصميم القطع المنشقة مره واحده في ثلاث مكررات في موسمي زراعه متتاليين 2014، 2015 في المزرعة البحثية لقسم بحوث الأرز بسخا-محطة بحوث سخا- محافظه كفر الشيخ وكذا معمل قسم النبات الزراعي بكلية الزراعة بأسيوط جامعه الأزهر- مصر. تم استخدام معدلين من السماد النيتروجينى 165 ،220 كجم نيتروجين/ هكتار تحت 6 من انظمه الاضافه حسب مراحل النمو المختلفة من حياه الأرز الهجين تحت طريقه الزراعة البدار وهى كما يلي: (1) 1/2 الكميه على الشراقى + 1/2 الكميه عند بداية تكوين السنبلة. (2) 1/3 الكميه على الشراقى + 1/3 الكميه عند التفريع المبكر+ 1/3 الكميه عند بداية تكوين السنبلة. (3) 1/2الكميه على الشراقى + 1/4 الكميه عند التفريع المبكر + 1/4 الكميه عند بداية تكوين السنبلة.(4) 1/3 الكميه على الشراقى + 1/3 الكميه عند بداية تكوين السنبلة + 1/3 الكميه عند مرحله الحبلانه المبكر. (5) 1/4 الكميه على الشراقى + 1/4 الكميه عند التفريع المبكر + 1/4 الكميه عند بداية تكوين السنبلة + 1/4 الكميه عند منتصف مرحله الحبلانه. (6) 1/4 الكميه على الشراقى + 1/4الكميه عند مرحله التفريع المبكر + 1/4 الكميه عند بداية تكوين السنبلة+1/4 الكميه عند بداية طرد السنابل . أظهرت بيانات تحليل التباين وجود اختلافات معنوية عاليه في كل الصفات المدروسة على النمو الخضري كوزن الأوراق الجاف بالجم/ م2، وزن السيقان كجم/ م2،الوزن الكلى الجاف / م2،دليل مساحه الأوراق، محتوى النيتروجين في ورقه العلم عند تمام التزهير، المعدل اليومي لتكوين المادة الجافة عند تمام التزهير جم/م2/يوم، وذلك تحت معدل 220 كجم نيتروجين/ هكتار مع نظم الاضافه المتعدد الجرعات من السماد النيتروجينى. أظهرت نظم الاضافه متعدد الجرعات من النيتروجين لمعدل التسميد 220كجم نيتروجين/ هكتار تفوقا معنويا في تراكم المادة الجافة ، محتوى الكلوروفيل في ورقه العلم ، تركيز النيتروجين في ورقه العلم، المعدل اليومي لتكوين المادة الجافة، دليل مساحه الأوراق ، دليل الغطاء النباتي بالاضافه إلى المحصول ومكوناته . كذلك تفوقت نظم اضافه السماد الازوتى على جرعات تفوقا واضحا عن نظم اضافه السماد الازوتى على جرعتين في كل الصفات المدروسة السابقة الذكر. وأخيرا يمكن تلخيص ما يلي: يعتبر 220كجم نيتروجين/ هكتار تحت نظم الاضافه على 4 جرعات متساوية والتي تربط بين مرحله النمو الخضري ومرحله النمو الثمرى مع الجرعة الأخيرة الحيوية عند مرحله خروج السنبلة أو منتصف فتره الحبلانه أفضل نظم الاضافه والمناسبة لزيادة ورفع إنتاجيه الأرز الهجين أقصاها. كذلك تعتبر الزراعة البدار للأرز الهجين هي الاتجاه المستقبلي لزراعه الأرز في مصر وكذا دول الأرز الأخرى. تحت نظام الزراعة البدار للأرز الهجين يعبر تحسين دليل الغطاء النباتي هوا المنظومة الفعالة والمؤثرة على صفات الأرز والتي تؤثر فسيولوجيا بطريق مباشر من خلال زيادة مساهمه ناتج التمثيل الضوئي بعد الطرد (التمثيل الضوئي المباشر) والذي يؤدى إلى معظمه محصول الحبوب وكذا القيمة الغذائية لحبوب الأرز كما يؤثر بطريق غير مباشر من خلال زيادة انتقال نواتج التمثيل الضوئي (الكربوهيدرات المخزنة) والتي تنعكس على زيادة دليل الحصاد.