EFFICIENCY OF WHEAT CROP IN FIXING SOLAR RADIATION UNDER DIFFERENT LEVELS OF NITROGENOUS FERTILIZERS

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A C K N O W L E D G M E N T

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INTRODUCTION

Wheat is one of the most important cereal crop grown in Egypt. It thrives well in winter during which the clouds some days decrease the light intensity. In addition, mutual shading of leaves of the same plant and the neihbouring plants.

The wheat yield is a function of many factors among which light intensity, nitrogenous fertilizers and some other factors are the most important.

The increase in wheat yield could be achieved by increasing the capacity of the crop in utilizing the light energy.

The aim of this work is to investigate the efficiency of wheat crop in fixing solar energy under different levels of shading and nitrogen fertilizers. Due consideration was given to the association of solar energy conversion of wheat plant with some morphological and physiological characters.

REVIEW OF LITERATURE

The harmony between root nutrition and solar utilization by plant leaves initiated the interest of several investigators. The reports concerning the individual effects of light intensity, nitrogen fertilization as well as their interaction on plant productivity are reviewed separately

Effect of Light Intensity :

Effect on growth :

The height of wheat plants increased with shading (68). Similarly, growing Hindi wheat varieties under artificial light conditions resulted in a decrease in plant height with increase in light intensity (53). Reducing light intensity to 64 and 34% of normal light during the 7 weeks pre ripe period caused increase in height of wheat plants; further reduction depressed the plant height (49).

The leaf characters is governed by light intensity. The number of leaves decreased (32, 33, 53, 57, 68) and the leaf area increased (34, 57, 64) with shading or reduction of light intensity. Gyloiv et al. (40) growing wheat and corn in the field, found that coefficient of decreasing photosynthetic active radiation (PAR) depends to a great extent upon the leaf area of the plants. They added that such coefficient was similar for wheat and corn plants having the same leaf area.

Both the rate of tillering and the number of tillers per wheat plant are regulated by light intensity. The rate of tillering decreased by reduction in light intensity(32) and the number of tillers also decreased with shading or reduction of light intensity (16, 17, 23, 53, 68).

The spike characters is affected by light intensity. The number of spikes (68) and the length of spike (31) decreased with shading or reduction light intensity.

The response of the dry matter content of wheat to shading or reduction in light intensity is similar with the number of tillers. The dry matter content of entire plant (53), or different parts of plants (68) and the above ground part (91) decreased with shading or reduction in light intensity. The most conspicious effect of shading was found at the critical stage 10 - 12 days before heading (107). A decrease of light intensity of 29 or 40% for 7 days from the beginning of the appearance of the pollen mother cells caused a considerable delay in the accumulation of the total dry matter (56). The greatest decrease in dry matter content was recorded for the spike and the stem and a smaller decrease was noticed for the leaves especially the lower ones.

Increase of light intensity reaching the plants decreased leaf area ratio (LAR), and increased relative growth rate (RGR), (16, 35).

Decreasing light intensity tended to slow down the growth phases,i.e. increased the number of days from planting to maturity (107).

Effect on photosynthetic apparatus :

The photosynthetic activity of green plants is known to be dependent on both the genetical factors as well as the prevailing environmental conditions. Light intensity is considered to be one of the most important external factors controlling the intensity of this vital process.

The compensation point, and light saturation of the leaves of sun plants were at higher light intensity than that in those of shade plants (10, 15, 59, 60, 80, 99). The adaptation of plants to light conditions was found to be existed not only through their evolution but also during their antogenesis (short time of growing). Thus, different leaves on the same plant which received various light intensity may have the characters of sun and shade plants according to the light conditions (14, 43, 70, 71). Therefore, growing the plants under different light intensity (artificial and natural) also induced changes in the photosynthetic apparatus. The leaves of plants grown under high light intensity showed photosynthetic light curves much similar to those of sun plants. Meanwhile, the photosynthetic light curves of shade plants were being similar to those of shade plants (10, 15, 47, 75, 99).

It is known that light plays an important role in chlorophyll biosynthesis. However, up till now there is no clear picture concerning the effect of light intensity on chlorophyll content. However, there are two types of plants with regard to the sensitivity of chlorophyll to light intensity (65). The first type is the photostable plants, where increasing light intensity leads to increases in its chlorophyll content. The second type of plants is the photosensitive, where chlorophyll content decreased with increasing light intensity. The higher the light intensity, the lower was the chlorophyll content in the leaves of Pseudoplantanus plant (99) such plants are photosensitive "according to Montfort (65)". The chlorophyll content in the leaves of cucumber and radish plants increased with increasing light intensity up to 20.10^3 erg/cm^2, after which further increase in light intensity did not induce more chlorophyll accumulation, yet in other plant species, a decrease in pigment content was reported (51). There was no clear correlation between the accumulation of chlorophyll and carotenoids under different light intensities (51). The content of chlorophyll as well as carotenoids was a function of the amount of the energy exposed to barley plants (12). About 20-30 mg chlorophyll were accumulated per 100 gm dry weight of leaves per unit light energy ($erg/cm^2 \cdot sec$) (12). The amount of chlorophyll a + b in the leaves of onion plants increased with increasing light intensity up to $20 \times 10^3 - 25 \times 10^3$ $erg/cm^2 \cdot sec$ (51). The chlorophyll content in the leaves of Solidago virgaurea plants tended to increase with increasing light intensity, yet the chlorophyll a were more sensitive than chlorophyll b (10).

The existance correlation between the chlorophyll content and the intensity of photosynthesis is still up till now an open question. Willstatter and Stoll(105) studied the leaves of different plants from a several ecological groups and concluded that at saturation light intensity there was no correlation between the assimilation of CO_2 and chlorophyll content. These authors introduced the concept of assimilation number, i.e. the amount of assimilated CO_2/hour/unit chlorophyll content. Gabrielsen(36) showed that even at low light intensities the rate of photosynthesis per unit leaf area was independent on the concentration of chlorophyll, if the latter was higher than about 6 mg $a+b/dm^2$. Only if the concentration was below 1 mg/dm^2, i.e. extremely chlorophyll poor leaves. a direct correlation may be found between the rate of photosynthesis and the concentration of chlorophyll. The net photosynthetic rate was linearly proportional to the amount of chlorophyll (referred to unit leaf area). The higher net photosynthetic rate and the highest chlorophyll content were recorded for the young Nicotiana leaves (85). Ashour (3), on the other hand did not obtain clear correlation between the content of chlorophyll and the maximum rate of photosynthesis in the leaves of corn, bean and cucumber plants.

It is interesting to show that Osipova and Ashour (75) found a correlation between the intensity of photosynthesis and the stability of chlorophyll. The higher the percentage of stable chlorophyll, the higher was the intensity of photosynthesis. Thus Ashour (3) as well as Ashour and Thalooth (5) concluded that such correlation may be existed between the maximum rate of photosynthesis and the amount of photosynthetic active forms of chlorophyll (a), but not its total content.

Effect on yield :

Shading decreased the grain yield (2, 16, 75, 10?), straw yield (2. 16, 108), the number of head-bearing tillers (104), filled grain number per spike (45) , grain weight per spike (45) and weight of spike/weight of vegetative growth (68).

The developmental stage during which wheat plants are exposed to shading had a marked effect on yield. The lowest yield was obtained by shading plants during the period from spike emergence (92). Shading during maturing grains also tended to decrease the yield of grains(92). Pendleton and Weibel (76), showed that light was a critical factor during the heading stage of winter wheat. Wheat was most susceptible to shading at 10 - 12 days before heading (107), shading at certain other period had no marked harmfull effect.

Effect on nitrogen content :

The regulating effect of light intensity on the uptake of nutritive elements by plant roots was reported by several investigators (4, 38, 74, 90). Moreover, light intensity was found not only to affect the uptake of nitrogen but also the reduction and utilization of nitrate within the plant tissues (1, 50, 95, 96). Shading wheat plants grown in nutrient solution caused a reduction in nitrogen absorption (92). The reduction in nitrogen uptake was in proportion to the degree of shading.

Shading treatments during the critical period from spike primordia differentiation to spikelet development increased the content of N compounds in the shoot of wheat plant (73). Although shading had no statistical significant effect on nitrogen concentration in different parts of wheat plant in some experiments.yet its absolute content was depressed (68).

A decrease in light intensity of 29 or 40% for 7 days from the beginning of the appearance of the pollen mother cells of wheat plants caused some decreases in the amount of proteins in the leaves (56).

At weak light intensity amino acid synthesis in leaves was relatively more rapid, whereas at stronger intensities carbohydrate synthesis became more significant(69). This emphasis the direct involvement of light in protein synthesis. In accordance,Campell and Read(17)and Wislocka (107) demonstrated that the percentage of total nitrogen in wheat grains was raised due to shading treatments.

Effect of Nitrogen Fertilization :

Effect on growth :

Nitrogen increased plant height (30, 53, 62, 101, 109), number of leaves (53), enhanced tillering (7, 52, 53, 61, 97), increased number of spikes (30, 52, 61) and dry weight (11, 42, 79), of wheat plants.

Effect on photosynthetic apparatus :

Nitrogen as well as carbon are the most important components which participate in biosynthesis of different