The effect of de-lamination of wheat during grain-filling

W.M. Blacklow, P. Rheloung and S.J. Hearn

School of Agriculture, Dniversity of Western Australia, Nedlands. W.A. 6009

Total crop-requirements of nitrogen applied as inorganic fertilizer at seeding can promote excessive vegetative growth that depletes the soil-water before crop maturity and can also be wasted when leached from sandy soils by winter rains. Farmers, therefore, are interested in split applications of nitrogen-fertilizer but our ability to predict a yield-increase is low. In this paper we report on whether a yield-increase from a late application of nitrogen was due to sustained rates of photosynthesis, through a delay in senescence, or due to higher levels of photosynthesis early in grain-filling that could cause an increase in the level of non-structural carbohydrates of the inter- nodes and act as a reserve for grain-filling.

Methods

Wheat (cv. Jacup) was grown under two levels of nitrogen-nutrition on a sandy soil in Perth in 1983 where the growing-season rainfall was 440 mm. Plots of the low (L) and high (H) levels of nutrition were split at anthesis and half of the split-plots received additional applications of 17 and 50 kg/ha of N to the L and H treatments, L+ and H+ respectively, followed by a light irrigation to move the ammonium nitrate into the root zone. Selected plants of the four nitrogen treatments were de-tillered at anthesis and main culms were de-eared (50 or 100%) three days later or de-laminated eighteen days after anthesis. There were six replicates of each treatment and samples for yield and carbohydrates were taken seven-times during grain-filling. Photosynthesis of flag-leaves was measured with $^{14}CO_2$. Total ethanol (70%) soluble carbohydrates of the peduncles were assayed by the anthrone-method and separation and identification of the soluble carbohydrates were made by high performance liquid chromatography.

Results and Discussion

Crain-yields for the 1. and II treatments were 3.7 and 5.4 t/ha and were increased by 33 and 18% by the L+ and 11+ treatments respectively. Increases in yield were due to increases in grain number per ear and mass per grain of about 12 to 15%. De-lamination of the L and 11 treatments had an insignificant effect on yield and the yield-responses of the L+ and 11+ treatments. However, the reason for the yield-increase of the de-laminated L+ and H+ treatments was due mainly to an increase in the number of grains per ear. Late applications of nitrogen increased the nitrogen and chlorophyll contents of flag-leaves and their rates of photosynthesis during the early phases of grain filling. However, the higher rates of photosynthesis did not increase the peak levels of non-structural carbohydrates that accumulated in the peducles (mainly fructans of 5 to 9 hexose units). De-lamination eighteen days after anthesis and removal of the ears of the L treatment decreased the peak levels of peduncle-carbohydrates twenty-three days after anthesis by 307. The lack of an effect of de-lamination during grain-filling on grain yield appeared to be due to the supply of photosynthate from the remaining green parts of the plant (glumes, awns, leaf sheathes). Applications of nitrogen at anthesis enhanced this supply and the increase in the number of grains per ear implicated the subtending glumes in providing photosynthate to grains that were not filled

in ears of culms that retained their leaf-lamina. If this was so then methods for improving the results from foliar nutrition during grain-filling should be directed to ensuring uptake of nitrogen by the glumes which are known to be the last parts of the culm to senesce.