Effect of Salicylhydroxamic Acid on Relative Levels of Catalase, Peroxidase and Ascorbic Acid Peroxidase in Bold and Small Grains of Wheat

Alireza Houshmandfar, Davood Eradatmand Asli and Payam Moaveni

ABSTRACT

The effect of exogenous application of salicylhydroxamic acid (SHAM) on relative levels of catalase, peroxidase and ascorbic acid peroxidase were investigated within developing grains of wheat (*Triticum aestivum* L. var. *PBW-343*). A concentration of 10 ppm salicylhydroxamic acid was applied at anthesis stage in five replications with the help of cotton plugs, which remained on ears of mother shoots (MS) for 48 hours. The labeled spikes were sampled five times, seven-day intervals started from seventh day after anthesis (DAA) up to 28th DAA, and at maturity. The main spikes were divided into two grain types within each spikelet included basal (bold) and apical (small). The salient points emerging through the use of salicylhydroxamic acid were that (i) both bold and small grains showed a significant decrease in relative levels of catalase, peroxidase and ascorbic acid peroxidase from 14th, 28th and 28th DAA stages respectively and (ii) in spite of the aforementioned decline, they continued to exhibit the disparity between them and at maturity the smaller grains still showed higher catalase, peroxidase and ascorbic acid peroxidase than the bolder grains.

Key words: CN-resistant respiration; SHAM; inhibitor; spikelet; *Triticum aestivum* L.

Introduction

The potential upgradation of components constituting the total yield in wheat (number of productive tillers m⁻², grains per spike and 1000-grain weight), would help to raise the production substantially. Though, significant milestones have been achieved in the first two parameters the last component, the individual grain weight has eluded scientific investigations and rather paradoxically has declined with the advent of high yielding varieties. A study into the physiology of grain yield shows the existence of variation among different varieties or genotypes or even the grains developing in the same ear [3,25,20,2911,31]. It further discloses that the yield may be influenced by the availability of photosynthates to the developing sinks [30,21,23,9]. Various sugar responsive genes in plants potentially affect the partitioning (Geiger et al. 1996) and have been stressed to be key determinant of plant productivity [10]. Dry matter partitioning also plays a paramount role in growth rate of sink organs [15]. Working on the grain growth in wheat and buckwheat variation among varieties was traceable to endogenous hormone production in variety vis-à-vis that in the ear [8,7]. A few biochemical components as advocated by Abrol et al. [2], Hakaka [12] and Hasan and Kamal [13] might be of significance in determining sink efficiency and/or the grain yield. Since, the harvest index is the culmination of innumerable events, most of the view points on sink efficiency appears to be speculative and need a
holistic approach in isolating obligatory events to produce the net assimilates. The revelation that the electron transport chain, in operation during biological oxidation, might find an alternate route without performing the target aim of creating proctivity and may downgrade the overall impetus of meristems to grow by 10 to 25 percent [24]. Indeed, it has been reported that higher alternative respiration could be one of the reasons of lower growth of grains at distal position in a spikelet [26]. It is, therefore, advocated that any attempt to interrupt this process may prove beneficial in improving productivity. In the present study, it is proposed to analyse the relative levels of catalase, peroxidase and ascorbic acid peroxidase as affected by specific inhibitor of salicylhydroxamic acid in different grains growing in the same spikelet of wheat.

**Materials and methods**

**Crop Management and Sampling:**

The investigation was conducted with a common bread wheat (Triticum aestivum L. var. PBW-343), which was sown in circular earthenware pots (50x30x30 cm) containing 35 kg of soil mixed with farmyard manure (4:1). Eight seeds per pot were sown and after 15 days, seedlings were thinned to two. Hoagland’s nutrient solution [16] was supplied to the pots. The plants were grown in a screen covered hall under otherwise natural conditions. A concentration of 10 ppm salicylhydroxamic acid was applied at anthesis stage in five replications with the help of cotton plugs, which remained on ears of mother shoots (MS) for 48 hours. The labeled main spikes were sampled five times, seven-day intervals started from seventh day after anthesis (DAA) up to 28th DAA, and at maturity. Grains were usually taken from three different segments in the ear. The labeled samples of grains were brought to laboratory and separated to two types of grains (small and bold) and biochemical analysis included the relative levels of catalase, peroxidase and ascorbic acid peroxidase as affected by by specific inhibitor of salicylhydroxamic acid in different grains growing in the same spikelet of wheat.

The salient points emerging through the use of salicylhydroxamic acid were that (i) both bold and small grains showed a significant decrease in relative levels of catalase, peroxidase and ascorbic acid peroxidase from 14th, 28th and 28th DAA stages respectively (Figures 1, 2 and 3) and (ii) in spite of the aforementioned decline, they continued to exhibit the disparity between them and at maturity the smaller grains still showed higher catalase, peroxidase and ascorbic acid peroxidase than the bolder grains (Figure 4).

The data uncover that as the grains progressed towards maturity, the levels of catalase increased in both the types of grains (Figure 1). The pattern showed that there was an increase in the level of catalase in the bolder grains to the tune of 217.3, 9.5 and 71.25 percents from 7th to 14th, 14th to 21st and 21st to 28th DAA respectively, whereas from 28th DAA to maturity the increase was to the tune of 40.87 percent.

Similarly, the increase in small grains was 140.0, 4.1 and 55.2 percents at aforementioned stages with a final increase by 23.7 percent at maturity from 28th DAA.
Fig. 1: Relative levels of catalase (µ mol oxygen released g⁻¹ fresh weight) at different location within developing grains of wheat (*Triticum aestivum* L. var. *PBW-343*) as influenced by salicylhydroxamic acid; Values within parenthesis indicate percentage of increase (+) or decrease (-) in level of catalase over control.

Fig. 2: Relative levels of peroxidase (µ mol purpurogallin g⁻¹ fresh weight) at different location within developing grains of wheat (*Triticum aestivum* L. var. *PBW-343*) as influenced by salicylhydroxamic acid; Values within parenthesis indicate percentage of increase (+) or decrease (-) in level of peroxidase over control.

Fig. 3: Relative levels of ascorbic acid peroxidase (µ mol g⁻¹ fresh weight) at different location within developing grains of wheat (*Triticum aestivum* L. var. *PBW-343*) as influenced by salicylhydroxamic acid; Values within parenthesis indicate percentage of increase (+) or decrease (-) in level of ascorbic acid peroxidase over control.
Fig. 4: Percentage increase (+) in relative levels of catalase, peroxidase and ascorbic acid peroxidase in small grains over their counterparts bold grains

A further look into the levels of catalase, with regard to their distribution in bold and small grains, disclosed that smaller grains possessed a relatively higher levels of catalase at all stages of investigations. The analysis of data revealed that the higher quantum of distribution in small grains was maximum at 7th DAA (117.4 percent higher) and subsequent to that the difference was to the tune of 64.4, 56.2 and 41.6 percents more in small grains at 14th, 21st and 28th DAA stages. At harvest the smaller grains possessed relatively more (24.4 percent) of catalase than their co-developer bolder grains (Figure 4).

The scrutiny of the data of second hydrolytic enzyme (peroxidase) also offered some interesting lineaments (Figure 2). As apparent from the data the levels of peroxidase activity was comparatively higher in smaller grains than bolder grains at different stages of grain development. This disparity was more at 7th DAA as compared to other stages of grain development (166.7 percent). Smaller grains exhibited 136.8, 45.8, 28.1 and 9.2 percents higher peroxidase activity than bolder grains at 14th, 21st and 28th DAA and at maturity respectively.

Studies on the behavior of grains with regard to levels of ascorbic acid peroxidase unfolded certain interesting revelations. As apparent from data in Figures 3 and 4, the levels of ascorbic acid peroxidase were comparatively higher in smaller grains than bolder types at all the stages of grain development. Enzyme activity in both the types of grains was highest at 7th DAA which narrowed down towards maturity.

Smaller grains registered 113.8, 100.0, 81.0, 54.5 and 116.7 percents higher ascorbic acid peroxidase activity as compared to bolder grains at 7th, 14th, 21st and 28th DAA and at maturity respectively. A look into the data revealed that the rate of deduction in enzyme activity was more pronounced in smaller grains as compared to bold grains.

Discussion:

The results bring forth, in no uncertain terms, the findings that the ear of wheat is a developing place for a definite number of grains which intern are separate biological entities endowed with their inherent potentials. This axiom was advocated by Abolina [1] and is in line with the observations of innumerable workers [6,18,27,29]. Nevertheless, the sequence of events, piloting the yielding ability, is the metabolic profile and if augmented through the use of plant growth regulators [28,17] or by imposing a shift in metabolic events [7] promotery effects are achievable [19]. In present context, the central point which came to light in the present endeavor is that an unusual path of aerobic respiratory chain (CN-resistant respiration) plausibly switches-on during the grain filling stage and if checked, through the immaculate use of salicylhydroxamic acid, can decrease the relative levels of catalase, peroxidase and ascorbic acid peroxidase in the grains. Of course, SHAM or regulator of alternate oxidase pathway was not successful in eliminating the disparities between the two types of grains.

References


