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ORIGINAL PAPER

Elimination of gibberellin from *Kappaphycus alvarezii* seaweed sap foliar spray enhances corn stover production without compromising the grain yield advantage

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Abstract Sustainable intensification of agricultural productivity is a global challenge. The sap of the commercially important red seaweed, *Kappaphycus alvarezii*, has been of interest in this regard, and its application as foliar spray has had a profound impact on the yields of many crops. It has been shown to contain indole acetic acid, kinetin, zeatin and gibberellic acid (GA_3) but no study is yet reported on the interactions among these constituents, if any. In the present study, selective solvent extraction was undertaken to obtain GA_3-free and indole acetic acid-free sap compositions. Another composition was prepared by autoclaving the sap which resulted in degradation of all the above growth hormones. The sap variants, along with water spray (control) and pristine sap, were applied on *Zea mays* as foliar spray over three consecutive seasons in dilute form. The four sap treatments were at par with one another—and significantly superior to control treatment—in so far as grain yield and quality were concerned. Pristine sap was subsequently shown to also contain choline and glycine betaine, and these were detected in similar amounts in all the sap variants, apparently indicating their profound influence on grain yield. Another important observation was that GA_3-free sap led to heightened photosynthetic activity which translated into 26 % increase in corn stover yield compared to pristine sap. This is hypothesized to be on account of prevention of negative interactions between GA_3 and other hormones. The study constitutes the first report of enhancement of performance of a natural seaweed plant stimulant towards increasing plant growth through simplification of its composition.

Keywords *Kappaphycus alvarezii* sap · Gibberellin removal · Effect on maize · Enhanced photosynthesis · Grain and corn stover yield

Introduction

The world population is expected to grow to 9.2 billion by 2050 and therefore the availability of plant-derived products has to increase dramatically to meet the demand of food, feed, fiber, bioenergy and other industrial products (Borlaug 2007). Maize is an important crop grown in many parts of the world. The grain is an important cereal, which also finds industrial utility, while the residual above ground biomass (corn stover) is employed both as animal feed and energy feedstock (Tyndall et al. 2011; Godina et al. 2013). Raising the grain and biomass yields of this crop is therefore of profound importance. A more formidable challenge is to achieve such intensification sustainably, i.e., without substantially increasing fertilizer and fresh water inputs, and without damaging the soil and environment (Kerckhoffs and Renquist 2013). Seaweed-based plant

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