EFFECT OF GROWTH REGULATORS ON YIELD AND FIBER QUALITY AND QUANTITY IN FLAX (*LINUM USITATISSIMUM* L.)

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ABSTRACT

Growth regulators have an important role in the biosynthesis of fiber in different crops, affecting both the quality and elongation. In research on various fiber plants, Gibberellic acid ($GA_{3)}$ and indole-3-acetic acid (IAA) promoted growth in hemp, jute and kenaf and in cotton, especially -fiber production and elongation. Application of IAA increased fiber elongation and lint yield in cotton. GA_3 causes stem elongation and flowering inhibition in a variety of plants. Little information, however, is available on the effect of these growth promoters on flax. Flax in an important crop worldwide for fiber and seed (linseed). Flax for linen is a very important export commodity in Western Europe, while linseed is a major product from Canada, China, and Germany. Important fiber properties for commercial use are fiber length, strength, chemical composition and diameter. Consequently, the potential effects of plant growth regulators such as GA_3 and IAA on the growth, development, yield, quality, and quantity of flax fibers make it a significant subject of study for this research.

The experiment was conducted from November 2002 to May 2003 at the USDA-ARS, J. Phil Campbell Sr. Natural Resource Conservation Center, Watkinsville, GA. The cultivars 'Opaline' and 'Hermes' were seeded at a rate of 110 lbs/acre. Plants were harvested by hand-pulling 20 weeks later and left in the field for approximately two weeks for dew retting.

Growth regulators were diluted in a 10% ethanol solution to produce final working concentrations of 1.0 and 3.0 ppm for IAA and 125 and 250 ppm for GA_3 , each containing 0.2% Tween-80. Control plants were sprayed with 10% ethanol solution. Plants were sprayed to the drip point with the growth regulator treatments and again 15 days after the initial application. Leaves from the top portion of the shoot were sampled after each growth regulator application to determine chlorophyll content. Approximately two kg of dew retted plants were processed (carded) through the USDA Flax Pilot Plant (Clemson, S.C.), then 400 g of fiber were passed through a Shirley Analyzer to separate fine fibers from coarse fibers and trash. The yield of fine fiber, as an assessment of retting efficiency, was calculated as a percent of the amount of carded fiber and of the initial amount of flax straw. Test fibers were conditioned for a minimum of 12 h at 20°C and 65% relative humidity. Shirley-cleaned fibers were analyzed in triplicate for tensile strength, elongation and fineness. To determine stem height and stem diameter, 25 stems of each cultivar and replicate (stems pulled by hand) were randomly chosen from among the stems harvested. Stem height was measured from shoot tip to soil surface and stem diameter was measured using a digital caliper at the mid-point of the stem. Data were also collected on chlorophyll content, yield, and flowering. Data were statistically analyzed using SAS procedures and reported at the 0.05 level of significance.

GA_3 treatment increased fine fiber yield by 13-14% and improved fiber fineness by 12-16% and decreased chlorophyll content, stem diameter, flowering and boll production over untreated controls. IAA increased fine fiber yield, chlorophyll content, and stem diameter, but

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decreased fiber strength, and fineness over untreated controls **(Not strength – see below).** GA_3 increased plant height and decreased stem diameter with 250 ppm having a greater effect than 125 ppm. In contrast, IAA decreased height but increased stem diameter with 3 ppm having a greater effect than 1 ppm. Following the plant growth regulator treatment, the most typical and obvious effect was an elongation (GA_3) or shortening (IAA) of the stem length within each cultivar. When 125 or 250 ppm GA_3 was used to treat flax under field conditions, the blades of the leaves grew longer, but the width of the leaves and the length of the petioles both decreased. GA_3 treatment caused chlorosis in the leaves, and a reduction in the chlorophyll a and b contents. In contrast, IAA increased the chlorophyll a and b contents. Treatment with 125 ppm GA_3 caused a 30% and 20% reduction in the number of flowers and bolls on Hermes and Opaline, respectively. When 250 ppm was used, the number of flowers and bolls was dramatically reduced by 50 % (Opaline) and 40 % (Hermes) when compared to that of the controls. Application of IAA at both concentrations resulted on an increase in flowering and number of bolls.

Along with its effect on stem height and diameter, IAA also caused an increase in fiber yield but not as great as that of GA_3. Tensile strength of samples from plants treated with IAA was significantly greater than the controls. On the other hand, treatment with GA_3 at 125 ppm did not result in a significantly different strength amongst cultivars, with the exception of the cultivar Hermes which showed a significant difference at 250 ppm. Opaline showed a higher yield when treated with GA_3 than with IAA. In contrast, the cultivar Hermes showed lower yields when treated with GA_3 than with IAA. Fiber fineness of GA_3 - treated samples was highly significant over those treated with IAA or the control. The cultivar Opaline showed a lower degree of fineness than that of Hermes.

Fiber flax cultivars have shortcomings in fiber yield or quality. In this experiment, spraying regulators GA_3 or IAA increased flax fiber yield by 15-26% and fiber fineness by 20%. The prospect of increasing flax yield and fiber quality simultaneously by using growth regulators to compensate for shortcomings in the cultivars holds promise for improving flax production. Differences between the two cultivars examined suggests a cultivar X regulator effect that should be considered in more detailed studies.

Preliminary data derived in this research has shown that the application of PGRs such as GA_3 and IAA to flax could increase the yield and produce finer, stronger fiber. In particular, commercial application of 250 ppm of GA_3 could be used to achieve higher yields and better quality of flax fiber even with less than optimal flax cultivars.