International Journal of Environmental Sciences & Natural Resources
ISSN: 2572-1119

Juniper Publishers
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Review Article
Volume 5 Issue 3 - September 2017
DOI: 10.19080/IJESNR.2017.05.555663

Int J Environ Sci Nat Res

Plant Density; Plant Growth Retardants: Its Direct and Residual Effects On Cotton Yield and Fiber Properties

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Submission: September 22, 2017; **Published:** september 25, 2017

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Abstract

Short cotton plants necessitate the use of higher plant densities per area unit. Plant size may be reduced genetically or chemically. Plant Growth Regulators, which affects physiological processes using hormones in the plant, can be used to modify plant size. Also, an important objective for using plant growth retardants PGR's in cotton is to balance vegetative and reproductive growth as well as to improve lint yield and fiber quality. Optimized cotton yields might be reached by means of growth-control management with different combinations of plant densities and chemicals. The objective of this study was to determine if growth retardants might be substituted for plant density, and vice versa, and to investigate their effects on yield and fiber properties.

Foliar sprays of growth retardants (PGR's) Cycocel and Alar were applied at concentrations of 250, 500, and 750 ppm after 105 days after plantation (square and boll setting stage) to Egyptian cotton cultivar planted at three plant densities (166.000, 222.000 and 333.000 plant ha^{-1}). The objectives of this two-year study were to determine if growth retardants might be substituted for plant density, and vice versa, and to investigate their effects on yield and fiber properties. Number of opened bolls plant^{-1}, seed-cotton yield plant^{-1}, and earliness increased as plant density decreased in both years, as did seed-cotton and lint yield ha^{-1} in the second season. In the first year, the intermediate plant density gave highest yields. Plant density had no significant effect on lint percentage or fiber properties. Both Cycocel and Alar increased the number of opened bolls plant^{-1}, boll weight, seed and lint indices, seed-cotton yield plant^{-1} and both seed-cotton and lint yield ha^{-1}, but effects were not always significant and response varied for different traits.

Neither Cycocel nor Alar affected lint percentage, yield earliness or fiber properties at any plant density. The interaction of plant density × growth retardant was significant for number of opened bolls m^{-2} and plant^{-1}, seed-cotton yield plant^{-1} and ha^{-1}, and lint yield ha^{-1}. This implied that the effect of growth retardant on cotton yield depended essentially on the number of plants per unit area or space available to each plant, and that applying growth retardants could enhance the effect of low plant density.

Introduction

Chemical may be used to reduce plant size in cotton (Gossypium barbadense L) which can increase cotton yield by allowing an increased number of plants per unit area. Mondino et al. [1] indicated that to optimize yield, it is necessary to establish a balance between biomass production and harvest index. Short cotton plants necessitate the use of higher plant densities per unit area. Plant size may be reduced genetically or chemically. Plant Growth Regulators (PGR), which affects physiological processes using hormones in the plant, can be used to modify plant size. Also, an important objective for using PGR's in cotton is to balance vegetative and reproductive growth as well as to improve lint yield and fiber quality [2]. Application of Cycocel and Alar, when plants had at least four fruiting branches, reduced plant height and length of lateral branches [3]. They have also been shown to enhance yield-related physiological functions by increasing gross plant photosynthesis or by increasing the retention of bolls by enhanced partitioning of photosynthesis to fruiting forms [4]. Treated plants are compact, conical in form [2,3] and can be spaced closer to achieve higher plant populations. Also, short, compact, open-canopy plants resulting from such treatments conceivably could improve energy distribution through better light penetration and improve insect control through better insecticide coverage thereby increasing yield.

Koraddi et al. [5] found that application of 60 ml Cycocel ha^{-1} at 90, 105, and 120 days after sowing increased mean yield of cotton plants. Pipolo et al. [6] found that single and double applications of 25 g ha^{-1} of Cycocel resulted in yield increases of 11.5 % and 11.6 %, respectively. These treatments also enhanced earliness and seed weight, and micronaire. More et al. [7] found plant height, number of branches, number of leaves plant^{-1}, and number of internodes and internodal length to be significantly decreased when plants were treated with 100, 150, and 200 ppm of Cycocel. Singh and Chouhan [8] reported cotton yield of a control treatment to be 1.06 t ha^{-1} and to have increased to 1.14 t ha^{-1} when 80 ppm of Cycocel was sprayed once at flower initiation and again 20 days later. Cycocel decreased the percentage of boll shedding and increased net economic return [9]. Mohmoud et al. [10] found that Cycocel and Alar decreased plant height with application rates of 500 and 5000 ppm, respectively, when applied at-early growth stages, while late application increased plant height and leaf abscission, but decreased the number of nodes plant-1 and number of leaves plant^{-1}.

Bednarz et al. [11] indicated that lower cotton population densities resulted in plants with more main-stem nodes and monopodial branches with increased fruit retention, resulting in greater fruit production per plant. They added that mean net assimilation rate from first flower to peak bloom was inversely related to population density. Sawan [9] found, when cotton was grown at 2, 3 or 4 plants hill^{-1} (166.000, 222.000 and 333.000 plant ha-1, respectively), that increasing plant density decreased number of bolls plant^{-1}, and seed-cotton yield plant^{-1}, but increased yield ha^{-1}. Fiber quality was not significantly affected by plant density. Gannaway et al. [12] found that when cotton was grown at 6, 12, 18, and 24 plants m^{-1} of a row, lint gin turnout and boll size decreased, as population increased. Plant population had essentially no effect on fiber length, strength and elongation, but micronaire reading decreased as the population increased. Campanella and Hood [13] indicated that plots sown at a rate of 9 seeds m^{-1} (90,000 ha^{-1}) produced 2-10% more yield, saved 31-66% in sowing costs, and increased profit margins by 7-13%, when compared to sowing rates of 12 and 15 seeds m^{-1}.

Considerable research with Cycocel effects on cotton has been widely reported, but little work has been carried out with Alar. Inadequate information is available on cotton's response to these chemicals under Egyptian growing conditions. Little or no literature was found on interactions between plant density and growth retardant treatments. To fill this gap and confirm the applicability of other work, this study was designed to evaluate the effects of Cycocel and Alar (growth retardants available in Egypt) on cotton yield and fiber properties as inter-related to plant density of an Egyptian variety of G. barbadense under Egyptian field conditions Sawan et al. [14-16].

Conclusion

This work confirmed the applicability of some other reports on PGR under Egyptian conditions and indicated that yield components and yield could be improved without affecting fiber properties by applying Cycocel at 500 or 750 ppm or Alar at 250 ppm to a plant density of 166,000 plants ha^{-1}. Yields at higher plant densities could be enhanced by either treatment, but were less than those observed at a plant density of 166.000 plants ha^{-1}. There was a definite correlation between plant density and growth and growth retardants, which suggested that cotton plants produced more when each plant had optimum growing space, that maximum yield depended on an optimum balance of space plant^{-1} vs. number of plants ha^{-1}, and that the yield effect of wider spacing can be enhanced by treatment with growth retardants [14-16].

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How to cite this article: Zakaria M S. Plant Density; Plant Growth Retardants: Its Direct and Residual Effects On Cotton Yield and Fiber Properties. 2017;5(3): 555663. DOI: 10.19080/IJESNR.2017.05.555663.

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