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Effect of Chitosan on Biochemical, Yield and Yield Attributing Parameters of Cotton *(Gossypium hirsutum* L)

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Abstract
Cotton as a cash crop plays a key role in our economy as it is one of the best export earning commodities in India. It is the most important fiber crop not only in India but also in the entire world. Besides the increase in yield, chemical inputs damage the soil and environment to the large extent. To avoid this, biopolymers are formed from living organisms. Chitin is the natural polysaccharide found in the exoskeleton of crustaceans and some fungi. The experiment was conducted at Central Demonstration Farm, Wani Rambhapur, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during Kharif *season, 2020-2021. The experiment was laid out in randomized block design with four replications and seven treatments. Sowing of hirsutum cotton variety AKH-09-5 was done by dibbling method at 60 cm × 30 cm (R × P) spacing. Foliar sprays of chitosan were carried out on 35 and 55 DAS. Results found that biochemical parameters like chlorophyll content index (SPAD value); yield and yield attributing parameters like number of sympodial branches, number of bolls, boll weight (g) and seed cotton yield (g) were recorded significantly maximum values in treatment T4 (75 ppm chitosan) over control.*
***(Keywords: -** Cotton, Chitosan, biopolymer, biochemical parameter, yield and yield attributing parameters)*

I. Introduction

Cotton is a leading natural fiber source and the backbone of the textile industry. Cotton is often referred to as "white gold" as it's an important commercial crop in India. The only country in the world, where all four spinnable fiber yielding numbers of Gossypium species, namely, *Gossypium arboreum*, *Gossypium herbaceum* (Diploid 2n=26; also known as old world cotton) and *Gossypium hirsutum*, *Gossypium barbadense* (Tetraploid 2n= 52; also known as new world cotton) are commercially cultivated in India. *G. hirsutum* is, however, the most popular cultivated species which accounts for about 95% of total cotton production worldwide (Chen *et al*. 2007).

To reduce the environmental hazards due to chemicals, biopolymers are used. Because soil conservation is a key to environmental sustainability. Biopolymers are the polymers produced from living organisms and they have monomeric units that covalently bonded to form larger structures. Chitosan is a biopolymer and was originally used as a dye deepening agent in textile industries. But due to its eco-friendly nature and antibacterial properties, a number of research were done to use chitosan in agriculture. It is found that chitosan has a great capability to enhance crop production.

In agriculture, chitosan can be used in various ways like seed coating or by foliar sprays, etc. Also in horticulture, chitosan is known for increasing the shelf life of post harvest produce. Foliar spray of chitosan is beneficial for improving the growth and yield of the plant.

In recent times, 'bio' products are progressively promoted sustainable development and environmental protection. As chitosan is a biopolymer, produced from living organisms, it would not only reduce the use of chemical inputs and their detrimental impact on nature and natural resources, but it would also improve agro-ecosystem health, natural biological cycles, soil health and its biological activities that come up with ensuring environment conservation. Therefore, to avoid the use of toxic and hazardous chemical compounds, biopolymers are one of the finest alternatives because of their biodegradability i.e. environment-friendly nature.

Considering the importance of crop and soil conservation, the above experiment was conducted.

II. Materials And Methods

The field experiment was laid out in Randomized Block Design (RBD) with four replications and seven treatments comprising of different doses of chitosan *viz*., T1 (control), T2 (25 ppm), T3 (50 ppm), T4 (75 ppm), T5 (100 ppm), T6 (125 ppm) and T7 (150 ppm). Spraying of chitosan was done twice. Observations were taken as follows:

Biochemical Observations

Chlorophyll content Index (SPAD value)

By using a chlorophyll meter device (SPAD meter), three readings of the base, middle and top leaf were taken and the average was calculated and noted.

Seed cotton yield and its attributes

Number of monopodia per plant

Numbers of monopodia on each plant from each treatment and replication were counted separately and the mean value was recorded.

Number of sympodia per plant

Numbers of sympodia were counted separately on each plant and the average value was recorded at the time of harvest.

Number of bolls per plant

From the initiation of the first picking, the number of bolls per plant was counted and recorded up to the last picking. The average numbers of bolls were recorded at harvest.

Boll weight (g)

The weight of a single boll (g) was calculated by the taking mean of five bolls weight (g) and noted.

Seed cotton yield per plant (g)

The seed cotton obtained was weighed separately and mean seed cotton yield per plant (g) was calculated and recorded.

Ginning percentage

It was worked out by following the formula (Verma *et al*., 2017).

Statistical Analysis:

The analysis of variance was performed for all the characters to test the significance of differences between the treatment as per the methodology suggested by Panse and Sukhatme (1954).

III. Results And Discussion:

Biochemical parameter

Chlorophyll content index (SPAD Value)

Data regarding chlorophyll content index was recorded at 60, 90, 120 DAS. At 60 DAS, a significantly maximum chlorophyll content index was recorded in treatment T4 to the rest of all treatments under study except treatment T3 and T5. Treatments T4, T3 and T5 were at par with each other. However, a significantly minimum chlorophyll content index was found in treatment T1 followed by treatments T7 and T2 when compared with other treatments. Treatments T1, T7 and T2 were at par with each other. At 90 DAS, a significantly maximum chlorophyll content index was recorded in treatment T4 (75 ppm chitosan) to the rest of all treatments under study except T3. Treatment T4 and T3 were found at par with each other. However, a significantly minimum chlorophyll content index was found in treatment T1 (control) followed by treatments T7 and T2. Treatments T1, T7 and T2 were at par with each other. At 120 DAS, a significantly maximum chlorophyll content index was recorded in treatment T4 (75 ppm chitosan) to the rest of all treatments under study except T3. Treatment T4 and T3 were at par with each other. However, a significantly minimum chlorophyll content index was found in treatment T1 (control) followed by treatment T7 when compared with other treatments. Treatment T1 and T7 were at par with each other.

Chitosan has nitrogen in its formula ($C_{11}H_{17}O_7N_2$), which is regarded as a vital element for plant growth (Sheikha and Malki, 2011) and nitrogen is the component of the chloroplast. This may be one of the reasons for the increase in chloroplast content. Chitosan application showed an increase in chloroplast content which may be because of an increase in key enzyme activities of nitrogen metabolism and increasing photosynthesis which enhanced plant growth which come up with the increase in photosynthesis (Gornik *et al*., 2008; Mondal *et al*., 2012). Farouk and Amany (2012) carried out an experiment that revealed that foliar application of chitosan @ 250 ppm under water stress conditions significantly enhanced the chlorophyll content of the cowpea plant. Mondal *et al*. (2013) conducted a field experiment to evaluate the effect of chitosan on the mungbean plant. Five concentrations of chitosan *viz*., 0 (control), 25, 50, 75 and 100 ppm were taken and applied twice at 25 and 35 DAS. The result revealed that 50 ppm chitosan significantly increased chlorophyll content.

Table No. 1: Effect of chitosan on Biochemical parameters

Treatment(s)	Chlorophyll content index		
	60 DAS	90 DAS	120 DAS
T1 (Control)	31.98	38.97	42.44
T2 (25 ppm Chitosan)	32.75	42.24	47.21
T3 (50 ppm Chitosan)	38.2	45.21	49.4
T4 (75 ppm Chitosan)	39.69	48.51	52.62
T5 (100 ppm Chitosan)	36.08	44.16	48.44
T6 (125 ppm Chitosan)	35.73	42.98	47.46
T7 (150 ppm Chitosan)	32.54	40.54	46.26
F test	Sig	Sig	Sig
SE (m) ±	1.22	1.25	1.32
CD at 5%	3.63	3.73	3.93

Table No. 2: Effect of chitosan on yield and yield attributing parameters.

Treatment (s)	Number of monopodia	Number of sympodia	Number of bolls	Weight of bolls	Ginning (%)	Seed cotton yield	% Increase in yield
T1 (Control)	1.27	16.19	16	3	34.02	29.02	-
T2 (25 ppm Chitosan)	1.42	18.03	17.7	3.22	34.5	31.21	7.54
T3 (50 ppm Chitosan)	1.81	19.57	20.67	3.85	36.11	36	24.05
T4 (75 ppm Chitosan)	1.71	21.33	21.47	4.11	37.08	37.3	28.53
T5 (100 ppm Chitosan)	1.64	18.75	18.58	3.64	35.26	35.67	22.91
T6 (125 ppm Chitosan)	1.55	18.2	18	3.56	35.05	33.04	13.85
T7 (150 ppm Chitosan)	1.39	17.58	17.25	3.03	34.21	30.43	4.85
F test	NS	Sig	Sig	Sig	NS	Sig	-
SE(m)±	-	0.63	0.66	0.17	-	1.29	-
CD at 5%	-	1.89	1.97	0.53	-	3.83	-

Figure No. 1: Effect of chitosan on Biochemical parameters

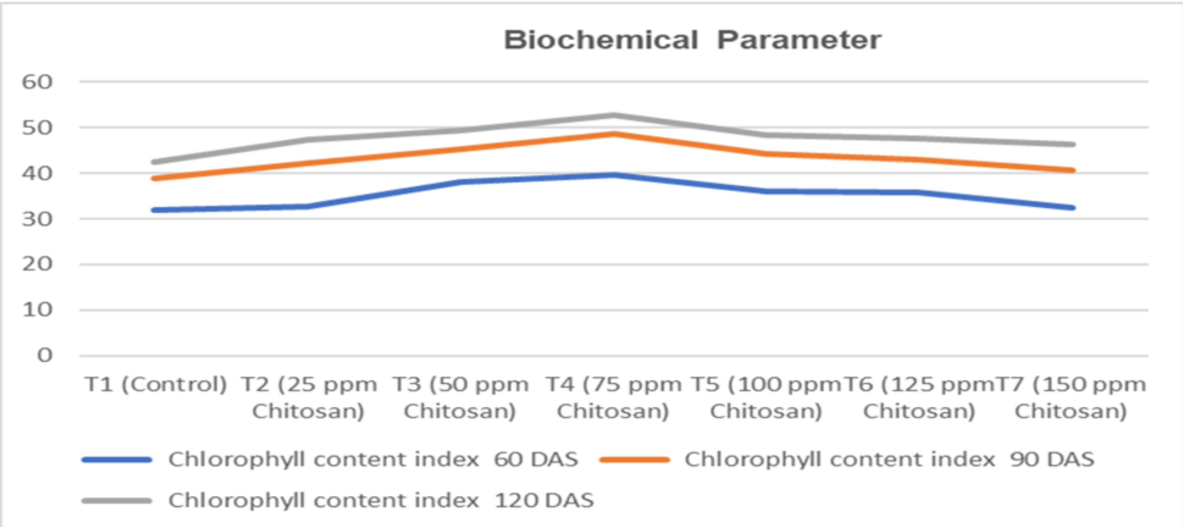
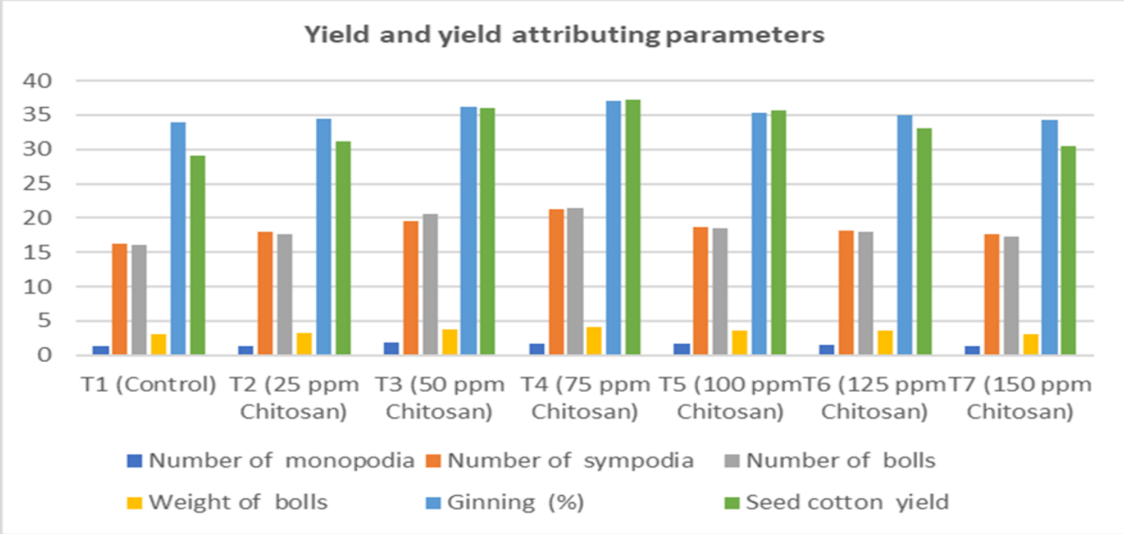


Figure No. 2: Effect of chitosan on yield and yield attributing parameters



Yield and yield contributing parameters

Number of monopodia per plant

The number of monopodia was not significantly influenced by the chitosan treatments.

Number of sympodia per plant

The data revealed that a significantly maximum number of sympodia was found in treatment T4 except for T3. Treatment T4 and T3 were at par with each other. However, a significantly minimum number of sympodia was found in treatment T1 followed by the treatments T7 and T2 when compared with other treatments. Treatments T1, T7 and T2 were at par with each other.

Similar results were obtained by Mondal *et al.* (2011) in that field experiment study of the effect of plant growth promoter on growth parameters and yield of Indian spinach was carried out. The results revealed that a higher number of branches was registered due to the foliar application of chitosan @ 75 ppm. Farouk and Amany (2012) did a research experiment to investigate the effect of foliar application of chitosan on cowpea under water stress conditions. The results showed that foliar application of chitosan @ 250 ppm significantly enhanced the number of branches. Deotale *et al.* (2018) conducted a field experiment to investigate the effect of different concentrations of chitosan and IBA @ 25, 50, 75, 100 and 125 ppm. The foliar spray was given at 30 DAS on soybean. The increase in the number of branches was recorded at 25 ppm concentration of chitosan.

Number of bolls plant-1

According to the data evaluated, a significantly maximum number of bolls was recorded in treatment T4 to the rest of all treatments under study except T3. Treatment T4 and T3 were at par with each other. However, a significantly minimum number of bolls were found in treatment T1 followed by treatment T7 and T2. Treatments T1, T7 and T2 were at par with each other.

Mondal *et al.* (2012) evaluated the effect of foliar spray of chitosan on yield and yield attributing characters of okra. The experiment comprised of five levels of chitosan (0, 50, 75, 100 and 125 ppm) sprayed at 25, 40 and 55 DAS. Results indicated that the application of chitosan @ 100 or 125 ppm significantly increased the number of fruits plant-1 over control. Mondal *et al.* (2013) evaluated different concentrations of chitosan *viz.*, 0 (control), 25, 50, 75 and 100 ppm at 25 and 35 DAS. They observed that foliar application of chitosan @ 50 ppm on mungbean significantly increased the number of pods plant-1 over control.

Boll weight (g)

The data revealed that significantly maximum boll weight was recorded in treatment T4 (75 ppm chitosan) to the rest of all treatments under study except treatment T3 and T5. Treatment T4, T3 and T5 were at par with each other. However, significantly minimum boll weight was found in treatment T1 (control). It was followed by treatment T7 and T2 when compared with other treatments. Treatments T1, T7 and T2 were at par with each other.

Sharifa and Abu-Muriefah (2013) conducted a field experiment to study the response of different concentrations of chitosan (100, 200 and 400 ppm) and revealed that foliar application of 200 ppm chitosan enhanced the seed weight of the common bean. Rabbi *et al.* (2016) experimented to investigate the effect of chitosan *viz.*, 0, 25, 50, 75 and 100 ppm on mungbean sprayed at 30 and 40 DAS. Results revealed that the application of chitosan @ 50 ppm significantly increased seed weight. Islam *et al.* (2018) performed an experiment in which different concentrations of oligochitosan which were prepared from chitosan were investigated to study the effect on chilli and tomato plants. Four chitosan levels @ 25, 50, 75 and 100 ppm with control were taken as treatments. In the case of tomatoes, average fruit weight was observed more at 50 ppm concentration. In the case of chilli, the weight of 50 fruits was observed more at 75 ppm concentration.

Ginning percentage (%)

Ginning percentage was not significantly influenced by the chitosan treatments.

Seed cotton yield (g plant-1)

The data revealed that significantly maximum seed cotton yield was recorded in treatment T4 (75 ppm chitosan) to the rest of all treatments under study except treatment T3 and T5. Treatment T4, T3 and T5 were at par with each other. However, significantly minimum seed cotton yield was found in treatment T1 (control) followed by treatment T7 and T2 when compared with other treatments. Treatments T1, T7 and T2 were at par with each other.

Foliar application of chitosan reduced the water use of pepper plants by 26-43% while maintaining biomass production and yield (Bittelli *et al*., 2001; Limpanavech 2008). Also, the application of chitosan increases key enzyme activities of nitrogen metabolism and increased photosynthesis which enhanced plant growth which contributed to enhancement in yield (Gornik *et al*., 2008; Mondal *et al*., 2012). Mondal *et al.* (2012) evaluated the effect of foliar spray of chitosan on yield and yield attributing characters of okra. The experiment comprised of five levels of chitosan (0, 50, 75, 100 and 125 ppm) sprayed at 25, 40 and 55 DAS. Result indicates that application of chitosan @ 100 or 125 ppm significantly increased fruit yield over control. Mondal *et al.* (2013) investigated various concentrations of chitosan *viz*., 0 (control), 25, 50, 75 and 100 ppm applied at 25 and 35 DAS. They found that foliar application of chitosan @ 50 ppm significantly increased seed yield over control in mungbean.

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