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CHANGES IN CHEMICAL, BIOCHEMICAL PARAMETERS AND YIELD OF GROUNDNUT THROUGH EXOGENOUS APPLICATION OF CHITOSAN

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ABSTRACT

The study was conducted to evaluate the effect of different concentrations of chitosan (control, 25, 50, 75, 100 and 125 ppm) during year 2019-20. Results revealed that, foliar application of 100 ppm chitosan at 25 and 45 days after sowing significantly enhanced leaf chlorophyll, NPK content in leaves and oil content in seed. Yield plant^{-1} was also increased significantly by 100 ppm chitosan when compared with other treatments and control.

(Key words: Groundnut, chitosan, exogenous application, nitrogen, phosphorus, potassium, biochemical parameters, oil content, yield plant^{-1})

INTRODUCTION

The groundnut oil has several uses but it is mainly used as cooking oil. It is used in many preparations, like soap making, fuel, cosmetics, shaving cream, leather dressings, furniture cream, lubricants, etc. Groundnut oil is also used in making vanaspati ghee and in fatty acids manufacturing. It is also used as a medium of preservation for preparation of pickles, chutney, etc. The groundnut oil is used in making different types of medicated ointments, plasters, syrups and medicated emulsion. It is also used to make various food preparations like butter, milk, candy and chocolate, chutney, groundnut pack, laddu, burfi etc.

Groundnut kernel is popularly known as "poor man's cashewnut" because of its rich caloric and nutritive value. Oil content of groundnut kernels ranges from 48-58%. The oil contains considerable quantity of polyunsaturated fatty acids. It is also a rich source of vitamins like A, B and E along with higher mineral content. The kernels contains about 24-26% proteins, it is rich in essential amino-acids like cystine, cysteine and methionine. It also contains 10% carbohydrate.Considering the importance of groundnut crop present investigation was undertaken to study the effect of chitosan on chemical, biochemical parameters and seed oil content.

Chitosan is one of the most popular materials which have been used in agriculture field. Chitosan is a natural polysaccharide derived by N-deacetylation of chitin, and a major component of the shells of crustacean such as crab, shrimp, and crawfish. Chitosan and their derivatives are nontoxic, biodegradable, and friendly to environment and have a great potential for agricultural application and enhancing crop production. Also, due to its cationic character, chitosan presents a wide variety of physicochemical and biological properties, including antimicrobial, antioxidant, and antihypertensive properties. It has proved to be effective in many crops to protect plants against oxidative stress and to stimulate plant growth. Chitosan has been widely used as growth stimulator, germination accelerator, and yield enhancer in many crop species.Therefore, in the present study an attempt was made to evaluate the effect of different concentrations of chitosan on groundnut.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* season of 2019-20 at farm of Agricultural Botany Section, College of Agriculture, Nagpur in RBD with four replications. Experimental gross plot size was 3.15 m X 2.20 m and net plot size was 2.10 m X 2.20 m. Total chlorophyll content was estimated by calorimetric method as suggested by Bruinsma (1982). N content in leaves was determined by micro-kjeldalh's method as described by Somichi *et al.*(1972). Phosphorus content in leaves was determined by Vando-molybdate yellow color method given by Jackson (1967). Potassium content in leaves was determined by flame photometer by diacid extract method given by Jackson (1967). Seed oil content was estimated by soxhlet's procedure determined by Sankaran (1965). Yield plant^{-1} was also recorded.

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RESULTS AND DISCUSSION

Leaf chlorophyll content

At 45 DAS leaf chlorophyll content went from 1.21-1.62 mg g^{-1}. Significantly maximum chlorophyll content was observed in treatment T_5 (100 ppm chitosan) when compared with treatment T_1 (control) and remaining treatments under study. Treatments T_4 (75 ppm chitosan), T_3 (50 ppm chitosan), T_2 (25 ppm chitosan) and T_6 (125 ppm chitosan) were also found significantly superior in a descending manner when compared with treatment T_1 (control) in chlorophyll content.

At 65 DAS range of chlorophyll content varied from 1.74-1.98 mg g^{-1} but significantly highest chlorophyll content was noted in treatment T_5 (100 ppm chitosan) followed by treatments T_4 (75 ppm chitosan), T_3 (50 ppm chitosan) and T_2 (25 ppm chitosan) when compared with treatments T_1 (control) and T_6 (125 ppm chitosan) .

At 85 DAS leaf chlorophyll content was reduced when compared with 65 DAS extending from 1.61-1.84 mg g^{-1}. Significantly supreme chlorophyll content was recorded in treatment T_5 (100 ppmchitosan) when interrelated with treatment T_1 (control) and remaining treatments under study. Treatments T_4 (75 ppm chitosan) and T_3 (50 ppm chitosan) also synthesized significantly higher chlorophyll content when compared with treatment T_1(control) and rest of the treatments. While treatments T_6 (125 ppm chitosan) and T_2 (25 ppm chitosan) were found at par with treatment T_1 (control) in chlorophyll content.

The chlorophyll reacted positively to the application of chitosan. Chibu and Shibayama (2001) also recorded greater content of chlorophyll in chitosan applied plants. Our outcomes also registered significant increase in amount of both nitrogen and potassium content in plant shoots, which play an important role in increasing the number of chloroplasts cell^{-1}, cell size and number unit^{-1} area as well as increased synthesis of chlorophyll (Possingham, 1980). The significant impact of chitosan on plant growth may be credited to an increase of the key enzyme activities of nitrogen metabolism and increased photosynthesis which enhanced plant growth (Gornik *et al.* 2008; Mondal *et al.* 2012).These might be the reasons for increase in chlorophyll content in the present study.

Rabbi *et al.* (2016) studied effect of foliar application of chitosan on mungbean. The study included different levels of chitosan (0, 25, 50, 75 and 100 ppm) sprayed at 30 and 40 DAS. Analysis concluded that the application of 50 ppm chitosan significantly increased leaf chlorophyll content.

Leaf nitrogen content

Nitrogen is key component in mineral fertilizers and has more influence on plant growth, appearance and pod production and quality than any other essential elements. Nitrogen is an important constituent of protein and protoplasm and essential for the growth of plants. Its shortage leads to chlorosis and stoppage of growth and its presence in moderate doses is essential for plant growth and fruiting. An abundant supply of essential nitrogenous compound is required in each plant cell for normal cell division, growth and respiration. The nitrogen present mostly as protein is constantly moving and undergoing chemical changes. Increased concentration of nitrogen is found in young, tender plant tissues like tips of shoots, buds and new leaves (Jain, 2010).

At 45 and 65 DAS significantly highest leaf nitrogen content was recorded in treatment T_5 (100 ppm chitosan) when compared with treatment T_1 (control) and rest of the treatments under study. Also treatments T_4 (75 ppm), T_3 (50 ppm chitosan), T_2 (25 ppm chitosan) and T_6 (125 ppm chitosan) were found significantly superior in a descending manner when compared with treatment T_1 (control) in leaf nitrogen content.

At 85 DAS the range of leaf nitrogen content was reduced when compared with 65 DAS. At 85 DAS significantly highest nitrogen content in leaves was observed in treatment T_5 (100 ppm chitosan) when compared with treatment T_1 (control) and rest of the treatments under study. Whereas, remaining treatments T_4 (75 ppm chitosan), T_3 (50 ppm chitosan), T_2 (25 ppm chitosan) and T_6 (125 ppm chitosan) were found at par with treatment T_1 (control) in nitrogen content.

In the present investigation chitosan was applied as foliar spray. De-acetylation chitosan provides 5-8% nitrogen which is mostly in the form of primary aliphatic amino group which ultimately increases the leaf nitrogen content in the plant tissues. This might be the reason for increase in leaf nitrogen content in the present study.

Meshram *et al.* (2018) investigated the effect of foliar application of chitosan (0, 25, 50, 75 and 100 ppm) on soybean plant. Investigation showed that application of chitosan @ 25 ppm significantly gained higher nitrogen content in leaf.

Leaf phosphorus content

Phosphorus is an important constituent of protoplasm and nucleic acid and protein also, it is essential for the formation of grain.

At 45 DAS significantly highest leaf phosphorus content was noted in treatment T_5 (100 ppm chitosan) followed by treatments T_4 (75 ppm chitosan), T_3 (50 ppm chitosan), and T_2 (25 ppm chitosan) when compared with treatments T_1 (control) and T_6 (125 ppm chitosan).

At 65 DAS significantly highest phosphorus content was observed in treatment T_5 (100 ppm chitosan) followed by treatment T_4 (75 ppm chitosan) when compared with treatment T_1 (control) and rest of the treatments under study. While, treatmentsT_3 (50 ppm chitosan), T_2 (25 ppm chitosan) and T_6 (125 ppm chitosan) were found at par with treatment T_1 (control) in phosphorus content.

At 85 DAS significantly maximum leaf phosphorus content was observed in treatment T_5 (100 ppm chitosan) followed by T_4 (75 ppm chitosan) when compared with treatment T_1 (control) and rest of the treatments under study. Also treatments T_3 (50 ppm chitosan) and T_2 (25 ppm chitosan) were found significantly superior over control. Whereas treatment T_6 (125 ppm chitosan) was found at par with treatment T_1 (control).

Phosphorus is one of the most important nutrients in the growth and development of plants. It plays a key role in cellular energy transfer, respiration and photosynthesis. The role of chitosan in increasing ionic content may be due to its effects on stabilizing cellular membrane through increasing antioxidants substances, saving cell membranes from oxidative stress and hence, improving plant cell permeability and ultimately enhances nutrient uptake. These might be the reasons for increase in phosphorus content in the present study by the application of chitosan.

Deotale *et al.* (2018) examined the influence of chitosan and indole-3-butyric acid @ 25, 50, 75, 100 and 125 ppm each in improving chemical parameters of soybean. The study noted that application of chitosan @ 50 ppm significantly enhanced phosphorus content in soybean leaves.

Leaf potassium content

At 45 DAS potassium was significantly maximum in treatment T_5 (100 ppm) followed by treatment T_4 (75 ppm chitosan) when compared with treatment T_1 (control) and rest of the treatments under study. Where, treatments T_3 (50 ppm chitosan), T_2 (25 ppm chitosan) and T_6 (125 ppm chitosan) were found at par with treatment T_1 (control) in potassium content.

At 65 DAS potassium content was significantly highest in treatment T_5 (100 ppm) followed by treatment T_4 (75 ppm chitosan) when compared with treatment T_1 (control) and remaining treatments under study. Treatment T_3 (50 ppm chitosan), also increased leaf potassium over control and rest of the treatments. However, treatments T_2 (25 ppm chitosan) and T_6 (125 ppm chitosan) were found at par with treatment T_1 (control) in leaf potassium content.

At 85 DAS potassium was maximum and significantly more in treatment T_5 (100 ppm) followed by treatments T_4 (75 ppm chitosan), T_3 (50 ppm chitosan), T_2 (25 ppm chitosan) and T_6 (125 ppm chitosan) over treatment T_1 (control).

It is concluded from the data that potassium content of the leaves progressively increased up to 65 DAS and declined at 85 DAS. It might be because of the diversion of the potassium towards developing parts i.e. pods. Foliar application of chitosan especially CH_2 significantly increased nutrient elements and carbohydrate in plant tissue. The high cation exchange capacity of chitosan prevents nutrients from leaching. Chitosan absorbs the nutrients from chemical fertilizers and these exchanged nutrients slowly released to the plants. This might be the reasons for increased potassium content in leaves in the present study.

Farouk and Amany (2012) tested chitosan as a foliar application on cowpea and recorded significant increase in inorganic leaf potassium by the application of 250 ppm chitosan.

Oil content in seeds

The data related to oil content were recorded after harvesting of the groundnut crop. The oil was found maximum in treatment T_5 (100 ppm) followed by treatments T_4 (75 ppm chitosan) and T_3 (50 ppm chitosan) when compared with treatment T_1 (control) and remaining treatments under study. Treatments T_2 (25 ppm chitosan) and T_6 (125 ppm chitosan) were found at par with T_1 (control) in seed oil contents.

Data showed that foliar application of 100 ppm chitosan (T_5) stood first in oil content of groundnut. Oil content in treatment T_5 (100 ppm chitosan) was increased by 2.52%, in T_4 (75 ppm chitosan) by 1.77% and in T_3 (50 ppm chitosan) by 1.48% over control (1.48%). It is observed from the results that chitosan improved oil content in seeds. Stimulating effects of chitosan on plant growth parameter such as dry matter attributed to an increase in availability and uptake of nutrients through adjusting osmotic pressure and reducing the accumulation of harmful free radicles by catalysing antioxidants and enzyme activities. This might be the reasons for increase in oil content in groundnut seeds.

Vosoughi *et al.* (2018) tested essential oil composition and total phenolic, flavonoid contents, and antioxidant activity of sage (*Salvia officinalis* L.) extract under chitosan application (control, 0.0, 0.25 and 0.50 g l^{-1}) and irrigation frequencies. They received best results with the application of chitosan @ 0.50 g l^{-1} in sage crop.

Meshram *et al.* (2018) carried out an experiment to understand the efficacy of foliar sprays of chitosan concentrations *viz.*, 0, 25, 50, 75 and 100 ppm on soybean plant. Study found that application of chitosan @ 25 ppm significantly increased oil content in soybean seeds.

Yield plant^{-1}

Significantly maximum seed yield plant^{-1} was produced in treatment T_5 (100 ppm chitosan) when compared with treatment T_1 (control) and rest of the treatments under study. Also treatments T_4 (75 ppm), T_3 (50 ppm chitosan), T_2 (25 ppm chitosan) and T_6 (125 ppm chitosan) were found significantly superior in a descending manner when compared with treatment T_1 (control) in production of seed yield plant^{-1}. The positive effect of chitosan on plant growth may be credited to an increase in the key enzyme activities of nitrogen metabolism and increased photosynthesis which enhanced plant growth (Gornik *et al*., 2008; Mondal *et al*., 2012). Chitosan applications significantly increased total carbohydrates accumulation in the fruits (Mawgoud *et al*., 2010). These might be the reasons for increase in yield in the present study.

Deotale *et al.* (2019) studied the effect of foliar sprays of chitosan @ 25, 50, 75, 100 and 125 ppm on yield of pigeonpea. They reported that foliar application of 50 ppm chitosan significantly enhanced seed yield in pigeonpea over control and rest of the treatments under study.

Table 1.Effect of Chitosan on leaf chlorophyll content and NPK content of leaves in groundnut

Treatments	Leaf chlorophyll content (mg g^{-1})			Leaf nitrogen content (%)			Leaf phosphorus content (%)			Leaf potassium content (%)		
	45 DAS	65 DAS	85 DAS	45 DAS	65 DAS	85 DAS	45 DAS	65 DAS	85 DAS	45 DAS	65 DAS	85 DAS
T_1 (control)	1.21	1.74	1.61	3.97	4.17	3.49	0.26	0.28	0.25	0.35	0.41	0.33
T_2 (25 ppm chitosan)	1.36	1.86	1.68	4.09	4.63	3.54	0.30	0.31	0.27	0.37	0.43	0.42
T_3 (50 ppm chitosan)	1.41	1.89	1.71	4.12	4.82	3.76	0.31	0.32	0.29	0.39	0.44	0.43
T_4 (75 ppm chitosan)	1.51	1.92	1.75	4.23	4.91	3.82	0.32	0.34	0.30	0.42	0.46	0.44
T_5 (100 ppm chitosan)	1.62	1.98	1.84	4.35	5.38	4.91	0.35	0.37	0.33	0.43	0.48	0.45
T_6 (125 ppm chitosan)	1.28	1.79	1.62	4.02	4.20	3.49	0.29	0.30	0.26	0.36	0.42	0.40
SE (m) ±	0.029	0.039	0.048	0.028	0.049	0.139	0.019	0.018	0.008	0.018	0.010	0.021
CD at 5 %	0.087	0.113	0.142	0.081	0.145	0.413	0.049	0.051	0.024	0.053	0.028	0.059

Table 2.Effect of Chitosan on oil content and seed yield plant^{-1} in groundnut

Treatments	Oil content in seed (%)	Yield plant^{-1}(g)
T_1 (control)	44.92	5.50
T_2 (25 ppm chitosan)	45.37	6.71
T_3 (50 ppm chitosan)	46.40	7.36
T_4 (75 ppm chitosan)	46.69	7.49
T_5 (100 ppm chitosan)	47.44	8.31
T_6 (125 ppm chitosan)	45.01	6.19
SE (m) ±	0.560	0.0408
CD at 5 %	1.680	0.1224

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