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EVALUATION OF MORPHO - PHYSIOLOGICAL TRAITS AND YIELD OF GROUNDNUT BY FOLIAR APPLICATION OF CHITOSAN

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ABSTRACT

An investigation was carried out to study the effect of different concentrations of chitosan (control, 25, 50, 75, 100 and 125 ppm) in groundnut. The experiment was conducted at farm of Botany section, College of Agriculture, Nagpur during the *kharif* season of 2019-2020. Observations of plant height, number of branches, leaf area, dry matter were recorded at 25, 45, 65 and 85 DAS. RGR and NARwere calculated at 45-25, 65-45, 85-65 DAS. Yield plot^{-1} was also recorded. Foliar sprays of chitosan at 25 and 45 DAS significantly enhanced above mentioned parameters with the application of 100 ppm chitosan when compared with other treatments and control.

(Key words: Groundnut, chitosan, foliar application, morpho-physiological parameters, yield)

INTRODUCTION

Groundnut, any of several plants that bear edible fruit or other nut like parts is the member of the family fabaceae or Leguminoceae. It is a day neutral, self-pollinated crop plant having chromosome number 2n=40. Groundnut belongs to family leguminaceae, genes Arachis and has chromosome number 2n=40. It is also a day neutral plant, flowers are self-pollinated.

Groundnut is cultivated as *kharif, rabi* and summer crop in India. Groundnut is mostly cultivated in South. During *kharif*-2018 all India groundnut acreage was 38, 90, 000 hectares. Five states, Gujarat 14,67,600 ha; 37.7%, Andhra Pradesh 6,60,000 ha; 17%, Rajasthan 5,49,052 ha; 14.1%, Karnataka 3,82,940 ha; 9.8%, Maharashtra 1,95,594 ha; 5.0% jointly accounted for 83.7% of the national acreage. At the national level, there was a decrease in acreage by 6.3% with respect to *kharif* 2017. The maximum decrease was observed for Gujarat 10.0% while, it was negligible for Andhra Pradesh 1.0%. The observed increase in acreage in Karnataka was nominal 1.3% (Anonymous,2018).

Studies have found that chitosan oligosaccharides have the function of regulating plant development, and are a natural plant growth regulator. They can root and promote stems, shorten stems, and thrive, which is conducive to nutrients to maximize the supply of fruits. Chitosan has wide adaptability to plants, good affinity, no toxicity, no side effects, no harm to humans and animals, biodegradability, no soiling in the soil, slow degradation to small molecular carbohydrates, no pollution to the environment, an excellent pure natural ecological preparation. 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). Hence, considering above facts an experiment was conducted to study the effect of different concentrations of chitosan on groundnut.

MATERIALS AND METHODS

An experiment was carried out at Shankar nagar farm of Agril. Botany section, College of Agriculture, Nagpur during 2019-20 in RBD with four replications and six treatments (control, 25, 50, 75, 100 and 125 ppm). Experimental gross plot was 3.15 m X 2.20 m and net plot was 2.10 m X 2.20 m. Observations on plant height, number of branches, plant^{-1}, leaf area, dry matter were recorded periodically at 25, 45, 65 and 85 DAS. RGR was calculated as per formula given by Blackman (1919) and NAR was calculated by using formula suggested by Williams (1946). The RGR and NAR were calculated at 45-25, 65-45 and 85-65 DAS. Yield plot^{-1} was also recorded.

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RESULTS AND DISCUSSION

Plant height

Plant height is an important character of the vegetative phase and indirectly influences the yield components. It is the shortest vertical distance between the upper boundary of the main photosynthetic tissue on a plant and the stem or shoot base from the ground level.

At 45 DAS plant height was recorded significantly maximum in treatment T_5 (100 ppm chitosan) when compared with treatment T_1 (control) and remaining treatments under study. The treatments T_4 (75 ppm chitosan), T_3 (50 ppm chitosan), T_6 (125 ppm chitosan) and T_2 (25 ppm chitosan) were found at par with treatment T_1 (control) in plant height.

At 65 DAS highest plant height was recorded 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) and T_2 (25 ppm chitosan) were at par with each other but found significantly superior when compared with treatment T_1 (control) and remaining treatments. Treatments T_6 (125 ppm chitosan) and T_1 (control) were found at par with each other in plant height.)

At 85 DAS highest plant height was recorded in treatment T_5 (100 ppm chitosan) when compared with treatment T_1 (control) and remaining treatments under study. Furthermore treatments T_3 (50 ppm chitosan) and T_2 (25 ppm chitosan) significantly increased plant height over control and T_6 (125 ppm chitosan). Whereas, T_6 (125 ppm chitosan) also found significantly superior over control in plant height.

The per cent increase in plant height with respect to foliar application of 100 ppm chitosan were 17.00 at 45 DAS, 19.00 at 65 DAS and 42.24 at 85 DAS when compared with control (T1).

Chitosan improved plant height might be due to increased number of internodes or length of internodes due to increased cell number (Hong Yan and Shu Yu, 2001).

Mondal *et al.* (2013) applied various concentrations of chitosan (0, 50, 25, 75 and 100 ppm) sprayed at 3 different stages viz., 35, 50, and 65 DAS. They suggested than foliar application of chitosan at 100 ppm expressively increased plant height in okra.

Number of the branches plant^{-1}

Branches are the site of the leaves, flower and peg formation. Hence, they are closely associated with the photosynthetic activity and yield of plant. So, number of branches is desirable attribute for higher biomass production and yield.

At 45 DAS impressive increase in number of branches 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. Treatments T_3 (50 ppm) and T_2 (25 ppm) also found superior among rest of the treatments and treatment T_1 (control). Whereas, treatments T_6 (125 ppm) and T_1 (control) were observed at par with each other in number of branches.

At 65 DAS significant rise in number of branches was observed in treatment T_5 (100 ppm chitosan) tracked by treatment T_4 (75 ppm chitosan) when compared with treatment T_1 (control) and rest of the treatments under study. Treatments T_3 and T_2 remained at par with each other but found significantly superior when compared with control. Whereas, treatments T_6 (125 ppm) and T_1 (control) were found at par with each other.

At 85 DAS significantly superior number of branches were perceived in treatment T_5 (100 ppm) when compared with treatment T_1 (control) and rest of the treatments under study. Also treatments T_4 (75 ppm chitosan) and T_3 (50 ppm chitosan) followed superiority in case of number of branches when compared with treatment T_1 (control) and rest of the treatments. However, treatments T_2 (25 ppm chitosan) and T_6 (125 ppm chitosan) were found at par with each other but also found superior over treatment T_1 (control) in number of branches.

At harvest, highest number of branches were recorded in treatment T_5 (100 ppm chitosan) followed by treatments T_4 (75 ppm chitosan) and T_3 (50 ppm chitosan) when compared with treatment T_1 (control) and rest of the treatments under study. Treatment T_2 (25 ppm chitosan) estimated significant number of branches when correlated with treatment T_1 and left over treatment T_6, whereas, treatments T_6 and T_1 were found at par with each other.

Chitosan increased growth character viz., number of branches might be due to increased number of internodes or length of internodes because of increased cell number (Hong Yan and Shu Yu, 2001). This might be the reason for increase in number of branches in present investigation.

Meshram *et al.* (2018) applied varying concentrations of chitosan and IBA (25, 50, 75, 100 and 125 ppm) and concluded that application of 25 ppm of chitosan remarkably increased number of branches in soybean crop.

Leaf area plant^{-1}

Leaf area depends upon the number and size of leaves. Leaves play an important role in the absorption of light radiations and using it in photosynthetic process. Leaf size is influenced by light, moisture and nutrients. Hence, yield depends on leaf area of crop.

At 45 DAS leaf area plant^{-1} was significantly influenced by different treatments. The range of leaf area recorded was 6.49-9.60 dm^2. At this stage significantly maximum leaf area plant^{-1} was noted in treatment T_5 (100 ppm chitosan) followed by treatment T_4 (75 ppm chitosan) when compared with treatment T_1 (control) and other treatments. Also treatment T_3 (50 ppm chitosan) was found significantly superior over control T_1 (control). Whereas, treatment T_2 (25 ppm chitosan), T_6 (125 ppm chitosan) and T_1 (control) were found at par with each other in leaf area.

At 65 DAS the range of leaf area recorded was 11.39-16.03 dm^2 where treatment T_5 (100 ppm chitosan) showed significantly highest leaf area plant^{-1} followed by treatment T_4 (75 ppm chitosan) and T_3 (50 ppm chitosan) when compared with treatment T_1 (control) and rest of the treatments. While, treatment T_2 (25 ppm chitosan), treatment T_6 (125 ppm chitosan) and treatment T_1 (control) were found at par with each other in leaf area.

At 85 DAS significantly highest leaf area was witnessed 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. Treatment T_3 (50 ppm chitosan) also found superiorly significant when compared with treatment T_1 (control) and rest of the treatments. While treatment T_2 (25 ppm chitosan), treatment T_6 (125 ppm chitosan) and treatment T_1 (control) were found at par with each other in leaf area.

Chibu and Shibayama (2001) witnessed existence of greater chlorophyll content in the plant applied with chitosan. This contributed into the increase of the photosynthesize production and leaf area. The application of chitosan elevated key enzymes activities of nitrogen metabolism and improved transportation of nitrogen in functional leaves which might be the reason for enhanced leaf area in the present study.

Baraskar *et al.* (2018) tested four different plant growth regulators. Study was carried out to evaluate the impact of foliar sprays of plant growth regulators GA_3 (100,150,200 ppm), NAA(100,150,200 ppm), salicylic acid (500,1000,1500 ppm) and chitosan(100,125,150 ppm) on okra at three different concentrations and one control (without spray). Outcomes were application of 100 ppm chitosan impressively and significantly elevated leaf area when compared with control.

Total dry weight plant^{-1}

At 45 DAS the results of dry matter production specified that treatment T_5 (100 ppm chitosan) was found significantly superior followed by treatment T_4 (75 ppm chitosan) among all the treatments when compared with control and rest of the treatments under study. Treatments T_3 (50 ppm chitosan) and T_2 (25 ppm chitosan) had established significant results against treatment T_6 (125 ppm chitosan) and treatment T_1 (control). Whereas, treatments T_6 (125 ppm chitosan) also produced significantly higher dry matter over treatment T_1 (control).

At 65 DAS production of dry matter was significantly maximum in treatment T_5 (100 ppm chitosan) followed by treatments T_4 (75 ppm chitosan) and T_3 (50 ppm chitosan) when compared with treatments T_1 (control) and rest of the treatments under study. Correspondingly treatment T_2 (25 ppm chitosan) ensued significantly extra dry matter production when compared with treatment T_1 (control) and remaining treatments. Whereas treatment T_6 (125 ppm chitosan) was at par with treatment T_1 (control).

At 85 DAS dry matter was produced significantly maximum 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. Likewise treatments T_3 (50 ppm chitosan) and T_2 (25 ppm chitosan) supervened significantly extra dry matter production when compared with treatment T_1 (control) and left over treatments. Whereas, treatment T_6 (125 ppm chitosan) stood at par with T_1 (control) in dry matter production.

Stimulating effect of chitosan on plant growth viz., dry matter may be attributed to an increase in the availability and uptake of water and essential nutrients through adjusting osmotic pressure and reducing the accumulation of harmful free radicals by increasing antioxidants and enzyme activities (Guan *et al*., 2009). Higher area of leaves and chlorophyll content has contributed into the increase of the photosynthesize production which reflects significant amount of dry weight (Chibu and Shibayama, 2001). These might be the reasons for increase in dry matter in the present investigation.

Meshram *et al.* (2018) studied the efficacy of foliar application of chitosan and Indole-3-buteric acid on growth and productivity of soybean and stated that the application of chitosan @ 25 ppm improved dry weight in soybean crop significantly.

Relative growth rate (RGR)

Considering all the treatments under study, significantly maximum RGR was noted in treatment T_5 (100 ppm chitosan) i.e. 0.1017 g g^{-1} day^{-1} while, it was noted lowest in T_1(control) i.e. 0.0556 g g^{-1} day^{-1} at 45-25 DAS. Treatment T_5 (100 ppm chitosan) earned highest RGR followed by treatments T_4 (75 ppm chitosan), T_3 (50 ppm chitosan) and T_2 (25 ppm chitosan) when compared with control and further treatments. Whereas, treatment T_6 (125 ppm chitosan) also gave significantly superior RGR when compared with treatment T_1 (control).

During 2nd phase i.e. 65-45 DAS treatment T_5 (100 ppm chitosan) exhibited significantly highest RGR when compared with treatment T_1 (control) and treatments left over. Correspondingly treatment T_4 (75 ppm chitosan) had also significantly higher RGR when compared with treatment T_1 (control) and remaining treatments under evaluation. However, treatments T_3 (50 ppm chitosan), T_2 (25 ppm chitosan), T_6 (125 ppm chitosan) were found at par with treatment T_1 (control) in RGR.

RGR for the duration of 85-65 DAS revealed that treatment T_5 (100 ppm chitosan) brought highest RGR when compared with 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 were found at par with treatment T_1 (control) in RGR.

Mondal *et al.* (2012) accomplished a field experiment to study the effect of different concentrations of chitosan (0, 50, 75, 125 and 150 ppm) on okra. Application of chitosan expressively increased relative growth rate by the application of 100 ppm chitosan.

Meshram *et al.* (2018) tested varying concentrations of chitosan and IBA (25, 50, 75, 100 and 125 ppm) and concluded that application of 25 ppm of chitosan remarkably enhanced RGR in soybean crop.

Net assimilatin rate (NAR)

Net assimilation rate (NAR), synonymously called as unit leaf rate expresses the rate of dry weight increase at

Table1. Effect of chitosan on plant height, number of branches plant^{-1} and leaf area plant^{-1} in groundnut

Treatments	Plant height (cm)				Number of branches plant^{-1}					Leaf area plant^{-1} (dm^2)			
	25 DAS	45 DAS	65 DAS	85 DAS	25 DAS	45 DAS	65 DAS	85 DAS	At harvest	25 DAS	45 DAS	65 DAS	85 DAS
T_1 (control)	10.68	26.34	38.78	40.74	1.30	1.90	2.50	3.35	3.80	1.79	6.49	11.39	12.11
T_2 (25 ppm chitosan)	10.50	27.02	42.36	51.35	1.41	2.50	3.50	4.00	4.62	1.74	6.95	12.76	13.17
T_3 (50 ppm chitosan)	10.33	27.16	42.91	52.39	1.58	2.50	3.50	4.50	4.64	1.73	7.03	13.61	15.01
T_4 (75 ppm chitosan)	10.20	28.57	43.01	54.70	1.41	2.95	4.00	4.64	4.88	1.56	8.91	13.68	15.56
T_5 (100 ppm chitosan)	10.38	30.82	46.15	57.95	1.60	3.0	4.30	5.00	5.00	1.61	9.60	16.03	16.94
T_6 (125 ppm chitosan)	10.73	26.82	39.89	50.30	1.70	2.15	3.25	3.80	3.95	1.61	6.95	11.74	12.98
SE(m)±	**0.460**	**0.851**	**0.625**	**0.564**	**0.097**	**0.044**	**0.100**	**0.112**	**0.173**	**0.053**	**0.322**	**0.512**	**0.524**
CD at 5 %	—	**2.548**	**1.866**	**1.683**	—	**0.117**	**0.294**	**0.329**	**0.503**	—	**0.958**	**1.527**	**1.560**

Table2. Effect of chitosan on total dry weight plant^{-1}, RGR, NAR and yield plot^{-1} in groundnut

Treatments	**Total dry weight plant^{-1} (g)**				**RGR (g g^{-1} day^{-1})**			**NAR (g dm^{-2} day^{-1})**			**Yield plot^{-1}**
	25 DAS	**45 DAS**	**65 DAS**	**85 DAS**	**45-25 DAS**	**65-45 DAS**	**85-65 DAS**	**45-25 DAS**	**65-45 DAS**	**85-65 DAS**	**(kg)**
T_1 (control)	2.58	7.85	29.96	39.01	0.0556	0.0355	0.0132	0.0671	0.0786	0.0382	0.550
T_2 (25 ppm chitosan)	2.23	14.81	33.11	44.05	0.0947	0.0402	0.0147	0.1185	0.0956	0.0425	0.671
T_3 (50 ppm chitosan)	2.19	15.00	34.08	46.25	0.0950	0.0410	0.0153	0.1694	0.0957	0.0442	0.736
T_4 (75 ppm chitosan)	2.55	17.06	34.73	48.02	0.0962	0.0554	0.0162	0.1769	0.1141	0.0455	0.749
T_5 (100 ppm chitosan)	2.38	18.20	37.93	49.27	0.1017	0.0670	0.0171	0.1799	0.1229	0.0487	0.831
T_6 (125 ppm chitosan)	2.10	10.40	31.50	42.26	0.0800	0.0367	0.0143	0.0692	0.0794	0.0423	0.619
SE(m)±	**0.064**	**0.398**	**1.289**	**1.00**	**0.0048**	**0.0034**	**0.0010**	**0.0040**	**0.0059**	**0.0012**	**0.0034**
CD at 5 %	—	**1.186**	**3.861**	**3.00**	**0.0119**	**0.0102**	**0.0030**	**0.0120**	**0.0176**	**0.0031**	**0.0101**

any instant on a leaf area basis with leaf representing an estimate of the size of the assimilatory surface area (Gregory, 1926). Increase in NAR during reproductive phases might be due to increase efficiency of leaves for photosynthesis as a response of photosynthetic apparatus to increase demands for assimilates by growing seed fraction and also due to photosynthetic contribution by pod and sink demand on photosynthetic rate of leaves.

NAR at 45-25 DAS was significantly enhanced by treatments T_5 (100 ppm chitosan), T_4 (75 ppm chitosan) and T_3 (50 ppm chitosan) when compared with treatment T_1 (control) and remaining treatments under study. After that, treatment T_2 (25 ppm chitosan) also showed significantly higher NAR when compared with treatment T_6 (125 ppm chitosan). Where treatment T_6 (125 ppm chitosan) found at par with treatment T_1 (control) in NAR.

At 65-45 DAS significantly superior NAR was recorded in treatment T_5 (100 ppm chitosan) followed by T_4 (75 ppm chitosan) when compared with treatment T_1 (control) and treatments under examination. Treatments T_3 (50 ppm chitosan), T_2 (25 ppm chitosan), T_6 (125 ppm chitosan) were found at par with treatment T_1 (control) in NAR.

At 85-65 DAS NAR was found significantly maximum in treatment T_5 (100 ppm chitosan) followed by treatment T_4 (75 ppm chitosan), T_3 (50 ppm chitosan) and T_2 (25 ppm chitosan) when compared with treatment T_1 (control) and treatments under study. Whereas, treatment T_6 (125 ppm chitosan) also found significantly superior over treatment T_1 (control) in NAR.

Meshram *et al.* (2018) tried varying concentrations of chitosan and IBA (25, 50, 75, 100 and 125 ppm) and concluded that application of 25 ppm of chitosan remarkably enhanced NAR in soybean crop.

Shaheen *et al.* (2019) examined the effect of bio stimulants on plant growth and yield of potato. Foliar application of some plant growth stimulants was done (amino acid, 2.5 cm^3 l^{-1}, chitosan 5 cm^3 l^{-1}, potassium silicate 2 cm^3 l^{-1} and control treatment) for 3 times in 10 days interval starting at 40 days after planting date. The study revealed that application of chitosan @ 5 cm^3 l^{-1} significantly raised net assimilation rate.

Yield

Seed yield is influenced by morpho-physiological parameters such as plant height, leaf area and total dry matter production which are considered as yield contributing parameters.

Significantly maximum seed yield $plot^{-1}$ 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 chitosan), 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 $plot^{-1}$. 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 when compared with control and other treatments.The increase in groundnut yield due to chitosan application may be due to its effect in stimulating physiological processes, improving vegetative growth, followed by the active translocation of photo assimilates from source to sink tissue (Sharifa and Abu Muriefah, 2013). Chitosan when applied externally was observed to increase crop growth and ultimately yield.

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