Original Research Article

Effect of Chitosan Fortified Briquettes and Nano Urea Formulations on Growth, Yield and Biochemical Parameters of Sweet Corn (*Zea mays saccharata* L.)

ABSTRACT

Aims: The field experiment was conducted to study the effect of chitosan fortified briquettes and nano urea formulations on growth, yield and biochemical parameters of sweet corn (*Zea mays saccharata* L.).

Study design: The field trial was laid out by using randomized block design comprising eleven treatments replicated thrice.

Place and Duration of Study: The field experiment was carried out at the Instructional Farm, Department of Agronomy, College of Agriculture, Dapoli, Ratnagiri, Maharashtra during *Rabi* 2023-24.

Methodology: The treatments of the experimental trial were T_1 : Control, T_2 : 100% RDF through straight fertilizer (SF), T_3 : 100% RDF through Konkan Annapurna Briquettes (KAB), T_4 : 100% RDF through Chitosan fortified briquettes (CFB), T_5 : 75% RDF through CFB, T_6 : T_5 + Foliar application of synthesized Nano urea @ 30 ppm, T_7 :T_5 + Foliar application of synthesized Nano urea @ 60 ppm, T_8 : T_5+ Foliar application of synthesized Nano urea @ 90 ppm, T_9 : T_5 + Foliar application of synthesized Nano urea conjugate @ 30 ppm, T_{10} : T_5+ Foliar application of synthesized Nano urea conjugate @ 60 ppm, T_{11} : T_5+ Foliar application of synthesized Nano urea conjugate @ 90 ppm. Sweet corn *var*. Sweet-70 was used for the trial. Seeds were sown at spacing of 60 cm × 20 cm. The recommended dose of fertilizer (RDF) used in the experiment was 200:60:60 NPK kg ha^{-1}. Briquette application was done at 15 and 40 DAS and foliar application of nano urea was done at 25 and 50 DAS.

Results: Results revealed that significantly higher values of growth, yield attributes, yield and biochemical parameters of sweet corn was observed in treatment 75 % RDF (CFB) + foliar application of synthesized nano urea conjugate @ 30 ppm (T_9) over rest of the treatments. The green cob and green stover yield of sweet corn was increased in treatment T_9 by 152.93% and 145.97% over control (T_1), respectively.

Conclusion: Application of 75% RDF through chitosan fortified briquettes (at 15 and 40 DAS) along with foliar application of 30 ppm synthesized nano urea conjugate twice at 25 and 50 DAS might increase the growth, yield attributes, yield and biochemical parameters of sweet corn.

Keywords: Sweet corn, Chitosan fortified briquette, Nano urea conjugate, Growth, Yield, Biochemical parameters.

1. INTRODUCTION

Sweet corn (*Zea mays saccharata* L.) is a type of maize that is grown for its high sugar content and is eaten as a vegetable. It is a popular vegetable which secured second place

for farm values add fourth place for commercial values among all commercial crops. It is highly nutritious food as it contains 5-6% sugar, 10- 11% starch, 3% water soluble polysaccharides, 70% water and also contains moderate levels of protein and vitamin (yellow varieties) and potassium (Oktem and Oktem, 2005). According to study,every 100 g of sweet corn contains 19.02 g carbohydrates, 2.70 g dietary fiber, 1.18 g fat and 3.2 g proteins. It can boost farm profits because of its increasing demand. Sweet corn is more productive than wheat and has a greater nutritional value than rice; as a result, it is no longer referred to as a "coarse grain" but rather as a “nutritious grain”.

Nutrients are very important for healthy growth and development of crop. Sweet corn is a nutrient exhaustive crop hence, require higher dose of fertilizer. Insufficient and improper application of fertilizers reduces the yield and profits to the farmers. Requirement of nitrogen is high for the cereal crops as they are heavy feeder. Nitrogen is the primary nutrient, a major constituent of protein, nucleic acid, growth harmones, vitamins and chlorophyll (Tilak *et al.* 2023). The leaf chlorophyll is influenced by the leaf N content and is essential for photosynthesis, affecting the growth and yield of maize. The application of conventional fertilizers like urea results in increase the loss of nitrogen nutrient in terms of leaching, volatilization, denitrification etc. But if nano-urea is applied at specific growth stages to this family leads to tremendous increase in growth and yield. Nano-urea is slow releasing, biodegradable nitrogen formulation which enter to the plant by means of stomatal opening of plants so absorption of nutrient without significant loss leads to increase nitrogen use efficiency (Aher and Umesha, 2023).Nano urea a nanotechnology based sustainable option for farmers towards smart agriculture and combat climate change. Nano urea can be helpful in minimizing the environmental footprint by reducing the loss of nutrients from agriculture fields through leaching and gaseous emissions. Nano urea is a potential component of nutrient stewardship as it promotes precision and sustainable agriculture (Muchhadiya *et al.,* 2024).

High dose of application of chemical fertilizers to increase crop productivity is not a suitable option for the long run, as the chemical fertilizers on one hand increase the crop productivity, whereas, on other hand, disturb the soil mineral balance and decreases soil fertility. In order to overcome the limitations of conventional chemical fertilizers, nano fertilizers and briquette technology are the most advanced technology in the way of supplying mineral nutrients for plantsas per their need during crop growth stages.

2. MATERIAL AND METHODS

2.1 Experimental site:

The field experiment was conducted at Instructional Farm, Department of Agronomy, College of Agriculture, Dapoli, Ratnagiri during *Rabi*, 2023-24. Sweet corn var. Sweet-70 was tested for this study. The experimental plot was sandy clay loam in texture, medium in available nitrogen (314.38 kg ha^{-1}), low in available phosphorus (11.50 kg ha^{-1}), high in available potassium (268.00 kg ha^{-1}), high in organic carbon (0.98 g kg^{-1}) and acidic in reaction (5.49).

2.2 Treatment details:

The field experiment was laid out in randomized block design comprising of eleven treatments replicated thrice. The treatments of the experimental trial were T_1 : Control, T_2 : 100 % RDF through straight fertilizer (SF), T_3 : 100 % RDF through Konkan Annapurna Briquettes (KAB), T_4 : 100 % RDF through Chitosan fortified briquettes (CFB), T_5 : 75 % RDF through CFB, T_6 : T_5+ Foliar application of synthesized Nano urea @ 30 ppm, T_7 :T_5+ Foliar application of synthesized Nano urea @ 60 ppm, T_8 : T_5+ Foliar application of synthesized Nano urea @ 90 ppm, T_9 : T_5+ Foliar application of synthesized Nano urea conjugate @ 30 ppm, T_{10} : T_5+ Foliar application of synthesized Nano urea conjugate @ 60 ppm, T_{11} : T_5+ Foliar application of synthesized Nano urea conjugate @ 90 ppm. The recommended dose

of fertilizer (RDF) used in the experiment was 200:60:60 NPK kg ha^{-1}. For treatment T_2, straight fertilizers *viz.*, urea, single super phosphate and murate of potash was used to fulfill the recommended dose of fertilizer.Konkan Annapurna Briquettes (KAB) are prepared by mixing of urea and Godavari/Gromor (14:35:14) fertilizers in the proportion of 3:2 ratio. Chitosan fortified briquettes were formulated with chitosan fortification @ 2% (on weight basis). Seeds were sown at a spacing of 60 cm × 20 cm. Briquette application was done at 15 and 40 days after sowing (DAS) and foliar application of nano urea was done at 25 and 50 DAS. Irrigation was applied as per the need of the crop at regular intervals, along with necessary cultural operations i.e., weeding and crop protection methods were adopted.

2.3 Statistical analysis:

The results were subjected to analysis of variance and tested for significant differences (P=0.05) as described by Panse and Sukhatme (1967).

3. Results and discussion

3.1 Effect on growth attributes of sweet corn

The scrutiny of the data presented in Table 1 implies that, the growth parameters of sweet corn was noticeably influenced due to different treatments. Among the different treatments, application of 75% RDF (CFB) + foliar application of synthesized nano urea conjugate @ 30 ppm (T_9) recorded higher plant height (cm), number of functional leaves $plant^{-1}$, leaf area $plant^{-1}$ (cm^2), dry matter production $plant^{-1}$ (g) at harvest. The lower values on growth parameters were observed in the control i.e., T_1.

Table 1. Effect of different treatments on growth parameters of sweet corn at harvest

Treatment		Plant height (cm)	No. of functional leaves $plant^{-1}$	Leaf area $plant^{-1}$ (cm^2)	Dry matter $plant^{-1}$ (g)
T_1:	Control	135.53	8.10	2702.59	94.47
T_2:	100% RDF through straight fertilizer (SF)	145.93	8.50	2934.72	116.61
T_3:	100% RDF through Konkan Annapurna Briquette (KAB)	152.13	9.17	3377.79	148.20
T_4:	100% RDF through Chitosan fortified briquettes (CFB)	160.40	9.73	3783.78	158.37
T_5:	75% RDF through Chitosan fortified briquettes (CFB)	153.60	9.27	3438.76	150.99
T_6:	T_5 + Foliar application of synthesized Nano urea @ 30 ppm	160.47	9.87	3841.96	160.80
T_7:	T_5 + Foliar application of synthesized Nano urea @ 60 ppm	167.07	10.23	4084.76	187.63
T_8:	T_5 + Foliar application of synthesized Nano urea @ 90 ppm	173.53	10.67	4315.24	202.86
T_9:	T_5 + Foliar application of synthesized Nano urea conjugate @ 30 ppm	187.93	11.23	4753.80	214.52
T_{10}:	T_5 + Foliar application of synthesized Nano urea conjugate @ 60 ppm	176.67	10.83	4426.10	206.02
T_{11}:	T_5 + Foliar application of synthesized Nano urea conjugate @ 90 ppm	174.53	10.77	4401.26	204.01

S.Em. (±)	2.13	0.09	41.13	1.23
C.D. at 5 %	6.28	0.27	121.33	3.62

In general, the improvement in all the growth attributes under treatment 75% RDF (CFB) and foliar application of synthesized nano urea conjugate @ 30 ppmmight be due slow release of nutrient through briquette and synthesized nano urea conjugate. Also the placing of fertilizer close to seed gives the better response to applied nutrients. In addition to this Chinnappa *et al.* (2023) reported that the small size of nano fertilizers results in better absorption of nano nutrients which affect plant growth mechanism. Plant metabolic activities such as chlorophyll synthesis and photosynthetic activity both of which enhance vegetative growth increased due to proper supply of nutrients and accumulation of dry matter in leaves helped, the photosynthetic area to remain active for longer period and was responsible for overall growth of plant. These findings are in close conformity with Choudhary *et al*. (2017), Kaviyazhagan *et al.* (2022), Khedekar *et al.* (2022), Srivastava and Singh (2023), Owusu and Adu-Gyamfi (2024), Kumar *et al.* (2024).

3.2 Effect on yield attributes and yield of sweet corn

Data presented in Table 2 clearly indicated that the yield attributes and yield of sweet corn was noticeably influenced by the different treatments. Among the different treatments, application of 75% RDF (CFB) + foliar application of synthesized nano urea conjugate @ 30 ppm (T_9) recorded maximum length, girth and weight of cob as well as weight of grains cob^{-1} and remained significantly superior over rest of the treatments. Similarly, treatment T_9 recorded significantly higher green cob yield (219.72 q ha^{-1}), green stover yield (255.64 q ha^{-1}) and total biological yield (475.36 q ha^{-1}) of sweet corn over rest of the treatments. In contrast, Control treatment (T_1) recorded lowest cob yield (86.87 q ha^{-1}) among all the treatments under study.Increase inn yield attributes might be due to slow release of nutrients from briquettes and effective absorption of nano urea conjugate which prevent the losses of nutrient from leaching, volatilization and runoff followed by better retention of nutrients. Nano fertilizers promotes the plants to absorb more nutrients and water from the soil. Also, it increases the plant metabolic process like photosynthesis leads to accumulation of higher photosynthates which then translocate to economic part of the plant. These results are in close conformity with Abdel- Aziz *et al.* (2018), Kalia *et al.* (2019), Elshayb *et al.* (2022).

3.3Effect on biochemical parameters of sweet corn

An examination of data in Table 3 revealed that the chlorophyll-a, chlorophyll-b, total chlorophyll and carotenoids content in leaves of sweet corn was influenced significantly due to different treatments. Data clearly indicated that the sweet corn grown under 75% RDF (CFB) + foliar application of synthesized nano urea conjugate @ 30 ppm (T_9) recorded higher chlorophyll a, chlorophyll b, total chlorophyll and carotenoid content in the leaves of sweet corn which was significantly superior over rest of the treatments. Control treatment (T_1) recorded significantly lower chlorophyll a, chlorophyll b and total chlorophyll than all other treatments. Chlorophyll is found in the membrane of chloroplast and it is closely associate with nitrogen level. Carotenoid act as accessory pigment and play major role in photosynthetic energy transduction and protect chlorophyll by preventing the formation of single species. Higher chlorophyll and carotenoid content might be due to increase in photosynthetic rate due to increased nitrogen content in leaves. These results are in close conformity with Choudhary *et al.* (2022) in maize and Sudha *et al.* (2023) in maize.

Table 2. Effect of different treatments on yield attributes and yield of sweet corn

Treatment		Length of cob (cm)	Girth of cob (cm)	Weight of cob (g)	Weight of grains per cob (g)	Green cob yield (q ha^{-1})	Green stover yield (q ha^{-1})	Total biomass yield (q ha^{-1})
T_1:	Control	14.07	12.29	307.00	135.84	86.87	103.93	190.80
T_2:	100% RDF through straight fertilizer (SF)	14.60	12.97	343.00	143.24	126.86	150.22	277.08
T_3:	100% RDF through Konkan Annapurna Briquette (KAB)	15.43	13.83	360.80	150.80	142.72	170.35	313.07
T_4:	100% RDF through Chitosan fortified briquettes (CFB)	16.30	14.68	389.53	162.20	160.93	190.37	351.31
T_5:	75% RDF through Chitosan fortified briquettes (CFB)	15.60	13.94	363.87	153.05	144.10	173.57	317.67
T_6:	T_5 + Foliar application of synthesized Nano urea @ 30 ppm	16.47	14.89	394.93	164.80	162.62	196.39	359.02
T_7:	T_5 + Foliar application of synthesized Nano urea @ 60 ppm	17.13	15.51	410.10	171.57	178.56	213.45	392.01
T_8:	T_5 + Foliar application of synthesized Nano urea @ 90 ppm	18.00	16.08	430.67	181.25	194.29	231.11	425.40
T_9:	T_5 + Foliar application of synthesized Nano urea conjugate @ 30 ppm	19.43	17.53	448.47	196.73	219.72	255.64	475.36
T_{10}:	T_5 + Foliar application of synthesized Nano urea conjugate @ 60 ppm	18.40	16.40	435.13	186.02	201.22	238.03	439.24
T_{11}:	T_5 + Foliar application of synthesized Nano urea conjugate @ 90 ppm	18.30	16.22	433.00	182.61	195.73	233.88	429.61
S.Em. (±)		0.16	0.13	2.16	1.71	5.32	4.51	9.48
C.D. at 5 %		0.48	0.39	6.38	5.05	15.69	13.30	27.97

Table 3. Effect of different treatments on biochemical parameters of sweet

Treatment		Chl-a (mg g^{-1})	Chl-b (mg g^{-1})	Total chlorophyll (mg g^{-1})	Carotenoid (mg g^{-1})
T_1:	Control	0.177	0.082	0.259	0.828
T_2:	100% RDF through straight fertilizer (SF)	0.216	0.124	0.340	0.873
T_3:	100% RDF through Konkan Annapurna Briquette (KAB)	0.268	0.194	0.462	0.903
T_4:	100% RDF through Chitosan fortified briquettes (CFB)	0.339	0.251	0.590	0.933
T_5:	75% RDF through Chitosan fortified briquettes (CFB)	0.288	0.208	0.496	0.905
T_6:	T_5 + Foliar application of synthesized Nano urea @ 30 ppm	0.353	0.263	0.617	0.935
T_7:	T_5 + Foliar application of synthesized Nano urea @ 60 ppm	0.415	0.318	0.733	0.979
T_8:	T_5 + Foliar application of synthesized Nano urea @ 90 ppm	0.478	0.373	0.852	1.021
T_9:	T_5 + Foliar application of synthesized Nano urea conjugate @ 30 ppm	0.570	0.442	1.012	1.053
T_{10}:	T_5 + Foliar application of synthesized Nano urea conjugate @ 60 ppm	0.507	0.391	0.898	1.022
T_{11}:	T_5 + Foliar application of synthesized Nano urea conjugate @ 90 ppm	0.488	0.380	0.867	1.021
S.Em. (±)		0.012	0.013	0.018	0.007
C.D. at 5 %		0.036	0.039	0.054	0.022

(Note- Chl- Chlorophyll)

4. CONCLUSION

It can be concluded that the application of chitosan fortified briquette and nano urea conjugate significantly improved the growth, yield and biochemical parameters of sweet corn. Thus, for obtaining higher growth, yield and biochemical parameters, sweet corn needs to be supplied with 75% recommended dose of fertilizer through chitosan fortified briquettes (at 15 and 40 DAS) along with foliar application of synthesized nano urea conjugate @ 30ppm with two sprays at 25 and 50 DAS.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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