"Assessment of Thiourea Bioregulator Impact on Soil Parameters of Jackfruit (*Artocarpus heterophyllus* L.) cv. Chandra"

Comment [TS1]: Please add the mode of application of thiourea in title. E.g. the title might be ""Assessment of Foliar Thiourea Impact on Soil Parameters of Jackfruit (*Artocarpus heterophyllus* L.) cv. Chandra".

Abstract

A field experiment was conducted from June, 2022 to March, 2023 at the Instructional Farm, Department of Fruit Science and Department of Natural Resources Management (NRM), College of Horticulture and Forestry, Jhalrapatan, Jhalawar in the newly established orchard of jackfruit (*Artocarpus heterophyllus* L.)cv. Chandra.The experiment consisted of 9 treatments with varying concentration of thiourea (0.25% to 2.00%) laid out in Randomized Block Design (RBD) with 3 replications.The plants were planted at a spacing of 8m x 8m.The analysis of variance showed non-significant differences for all ofthe recorded soil parameters ~~viz.~~which were pH, EC (dS m^{-1}), N (kg ha^{-1}), P (kg ha^{-1}), K(kg ha^{-1}) andOC (%).

Comment [TS2]: Experimental design was RCBD or RBD?

Keywords: Bioregulator, Electrical conductivity, Jackfruit (*Artocarpus heterophyllus* L.), Organic carbon,Thiourea

Author's Contribution

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

1. Introduction

The jackfruit tree (*Artocarpus heterophyllus* L.) is a popular choice in climates that tend to be tropical or sub-tropical. It thrives especially well in ~~Southeast~~ southeast Asia. Its natural habitat is the w~~W~~estern Ghats of India where it was ~~first found~~originated. It's often referred to as "the poor man's fruit" in eastern and southern regions of India ~~such as the east and south~~.

This evergreen tree has both male and female flowers on the same plant. It showcases a special growth habit known as "cauliflorous bearing". Here, the trunk holds the female blossoms. In eastern India, young fruit is loved as a vegetable. The skin has a primary protein known as "jacalin".The latest statistics released by the Ministry of Agriculture and Farmers Welfare (2021–22) show that India has 1.88 lakh hectares of jackfruit plantations, resulting in a total production of 19.46 lakh metric tonnes (Anon., 2021-22). The worth of jackfruit goes beyond just its delicious taste, as it has immense potential for nutrition and income generation when cultivated in home gardens and agroforestry systems. This has beendirected to the scientifically driven interest in studying this species. As it spread to

other regions with suitable climates, jackfruit has proven its usefulness (Morton, 1965). An important chemical component of jackfruit is thiourea, a compound containing sulfur and nitrogen, also known as Thiocarbamide.

Thiourea boasts a remarkable composition of ~~42.1%~~ sulphur (42.1%) and ~~36.8%~~ nitrogen (36.8%). The application of this compound to foliage leads to 50% absorption in plant leaves, while the rest of the residue lingers on the ground (Ratnakumar, 2016). Its biologically significant functional groups have been found to promote growth in various crops upon application (Jocelyn, 1972). In today's increasingly dry climate, the development and growth of plants is greatly hindered. However, research has shown that thiourea can effectively improve stress resistance in plants, resulting in enhanced growth~~, and~~ development, antioxidative defense system, sugar to starch metabolism, osmolytes accumulation and protein synthesis (Singh et al 2023; Singh et al 2020). The potential of such a wonderful biomolecule in plantimprovement has inspired authors for assessing its influence on growth and development of Chandra cultivar of jackfruit (*Artocarpus heterophyllus* L.). As such, we intend to examine its impact on the ~~growth and development~~ soil properties of ~~the~~ Chandra cultivar of jackfruit (*Artocarpus heterophyllus* L.).

Comment [TS3]: Since the research is aimed at understanding the effect of thiourea on soil properties; so, it seems necessary to state the objective like this.

2. Materials and methods

2.1 ExperimentalSite

A ten-month field trialwas conducted during the 2022-2023 academic year at the newly established Jackfruit cv. Chandra orchard in the Instructional Farm of the Department of Fruit Science and Department of Soil Science at the College of Horticulture and Forestry in Jhalrapatan, Jhalawar.This particular area in the Jhalawar district, located in South Eastern part of Rajasthan between 23°4’ to 24°52’ N-Latitude and 75°29’ to 76°56’ E- Longitude, falls under Zone V and is renowned as the Humid South Eastern Plain. The ~~yearly~~ average annual rainfall ~~here~~ of the region is~~averages at~~ 954.7 mm. During ~~the~~ summer season, the mercury can reach a scorching 43 - 48°C, while in winter, the minimum temperature can drop to as low as 1.0 - 2.6°C. Our experiment took place in the newly planted block specifically dedicated to the Jackfruit cv. Chandra at the Instructional Farm of the Department of Fruit Science.

2.2 Plant Material

One-year-old aged Chandra jackfruit plants were grown at a spacing of 8 m x 8 m. This specific cultivar is known for its early fruiting, typically within 36 to 48 months after being

transplanted.

2.3 Doses and Time of application of Thiourea

The plant thiourea (treatments) was used at the dose of T_0-0.25%, T_1-0.50%, T_3-0.75%, T_4-1.00%, T_5-1.25%, T_6-1.50%, T_7-1.75% and T_8-2.00%. The treatments were applied in the form of foliar spray. The foliar spray was done during 2nd week of June, August and October (2022) after noting down the initial growth and development parameters of plants.

Comment [TS4]: Theres; no need to write about the growth and development because the objective of paper is only soils.

2.4 Method analysis

2.4.1 pH

Using a glass electrode pH metre and 1:2 soil water suspensions, the pH of the soil was measured. 20g of soil and 40 ml of distilled water were combined in a 100 ml beaker to create a 1:2 soil water suspension (Jackson, 1973).

2.4.2 Electricalconductivity(dSm^{-1})

Electrical conductivity of soil water suspensions (1:2.5) calculated using ECmeter (Model Elico CL 180) as elaborated by Jackson (1973). These $EC_{2.5}$ values wereconvertedlaterto saturation paste value (EC).

2.4.3 Organiccarbon(%)

The chromic acid wet oxidation method developed by Walkley and Black (1934) serves as the foundation for the calculation of soil organic carbon. 1N $K_2Cr_2O_7$ solution was used to oxidise the soil's degradable material. The heat produced when two volumes of H2SO4 and one volume of dichromate are combined helps the process. Ferrous sulphate was used to titrate the residual dichromate. The amount of C contained in the soil sample has an inverse relationship with the titrate.

$$\text{Organic carbon (\%)} = \frac{10(\text{B} - \text{T}) \times 0.003 \times 100}{\text{B} \times \text{Weight of soil (g)}}$$

Where,

B = Volume (ml) of ferrous ammonium sulphate solution required for blank titration.

T=Volumeofferrousammoniumsulphatesolutionneeded fortitrationof soilsample.

2.4.4 AvailableNitrogen(kgha^{-1})

Utilising the alkaline potassium permanganate method as recommended by Subbiah and Asija, available nitrogen was ascertained (Subbiah and Asija,1956).

AvailableN(kg/ha)=R×31.36

Where,

R =Volume of0.02 N H_2SO_4requiredfor titration

2.4.5 AvailablePhosphorusinsoil(kgha^{-1})

Available phosphorus was determined with extraction by 0.5 M $NaHCO_3$ solutionadjustedat pH 8.5 as suggested byOlsen*et al.* (1954).

$$\text{Available P (kg ha}^{-1}) = \frac{\text{R} \times \text{Volume of extract} \times 2.24 \times 10^6}{\text{Volume of aliquot} \times \text{Weight of soil} \times 10^6}$$

Where,

R= ppm P in the aliquot $=\frac{R\times100}{5} \times \frac{2.24}{5}$

(Obtainedfromstandard curve)=(ppm P)R ×8.96 ×2.29

2.4.6 AvailablePotassium(kgha^{-1})

Available potassium was determined by extracting the soil by shaking with 1 N neutral ammonium acetate solution by flame photometer as suggested by Metson(1956).

$$\text{Available K (kg ha}^{-1}) = \frac{\text{R} \times \text{Volume of extract} \times 2.24 \times 10^6}{\text{Weight of soil taken} \times 10^6}$$

Where,

R =ppm ofKintheextract (obtainedfrom thestandardcurve)

3. Statistical Analysis

The data attained from were exposed to statistical examination (ANOVA) in MS Excel programme on computer system through the procedure of randomized block design (RBD) for various characters studied in present investigation. The treatment differences were tested by "F" test for significance based on null hypothesis. The appropriate standard error of mean (S.Em.±) was calculated in each case and critical difference (CD) at 5 per cent level of probability was operated to compare the treatment means, where the treatment effects were significant (Panse and Sukhatme, 1967). Suitable graphical presentations based on the data are given at the appropriate places.

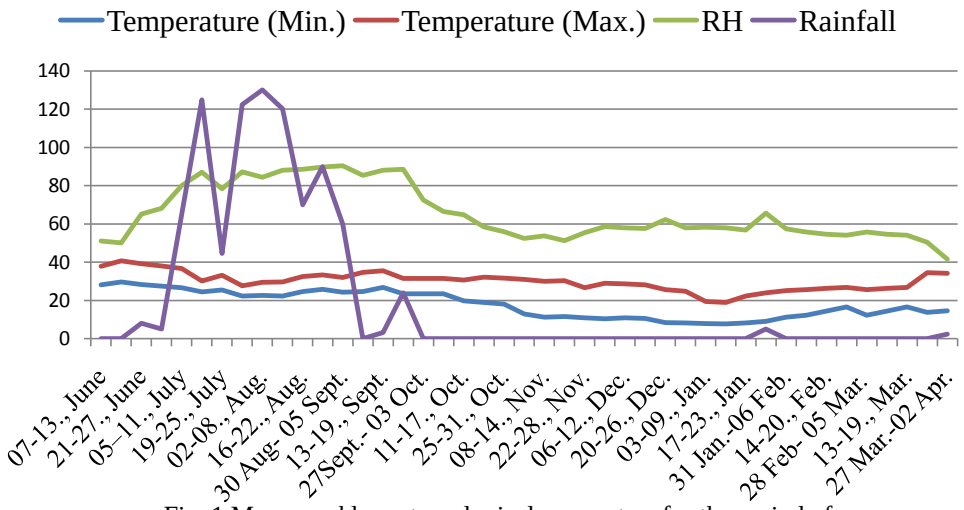

Fig. 1 Mean weekly meteorological parameters for the period of experimentation (from June, 2022 to March, 2023) Jhalawar, India

Comment [TS5]: The graph looks good but would be better if the rainfall would be plotted as bars, keeping other parameters as line graphs,

4. Result and discussion

The data presented in Table 1 clearly demonstrate that varying levels of thiourea leaf spray concentrations had non-significant effect on the soil's available pH, EC, OC, nitrogen, phosphorus and potassium for the jackfruit plants. This could be due to foliar-applied thiourea may not have been effectively translocated to the soil in sufficient quantities. The foliar spray primarily targets the plant's leaves, and the uptake and translocation of the substance to the root zone might have been insufficient to induce changes in soil properties. Another reason for non-significant effect of thiourea may be that the thiourea sprayed on foliage could have been rapidly metabolized or degraded by the plant or microbial activity before reaching the soil. This could limit its availability for interactions with the soil matrix and subsequent effects on soil properties.Similar result was also recorded by Bochalia (2008), Ram *et al*. (2009) and Jeengar (2012)

Table1. Effect of thiourea on pH, EC, N, P_2O_5, K_2O and OC of Jackfruit cv. Chandra orchard soil duringgrowthperiod

	Soil parameters					
Treatments	pH	EC(dS m^{-1})	N	P	K	OC

			(kg ha^{-1})	(kg ha^{-1})	(kg ha^{-1})	(%)
T_0 (Control)	7.4	0.35	323.00	27.44	284.35	0.46
T_1 (Thiourea 0.25%)	7.39	0.32	321.33	26.33	284.00	0.48
T_2 (Thiourea 0.50%)	7.36	0.33	324.67	24	283.33	0.49
T_3 (Thiourea 0.75%)	7.38	0.34	325.66	28.66	286.00	0.51
T_4 (Thiourea 1.00%)	7.35	0.33	332.00	28	292.33	0.52
T_5 (Thiourea 1.25%)	7.32	0.3	328.33	27.66	291.00	0.53
T_6(Thiourea 1.50%)	7.34	0.27	329.33	30	287.99	0.54
T_7(Thiourea 1.75%)	7.45	0.26	322.80	29.33	291.00	0.55
T_8(Thiourea 2.00%)	7.28	0.29	326.00	29	291.33	0.57
SEm (±)	0.024	0.004	2.20	0.48	1.27	0.009
CD (5%)	NS	NS	NS	NS	NS	NS

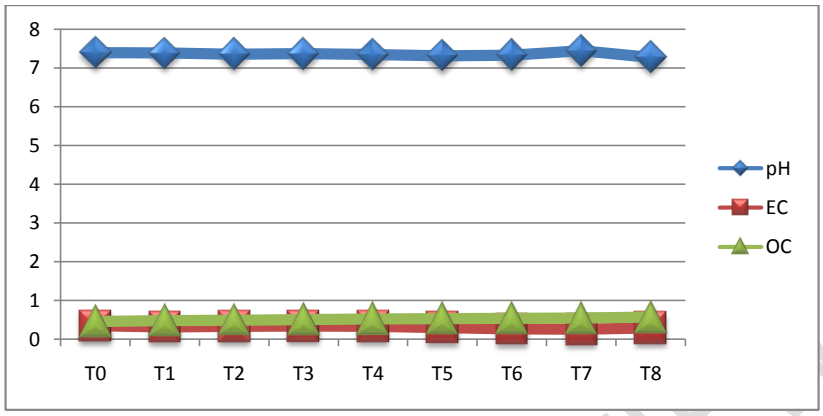

Fig. 2. Effect of thiourea on pH, EC and OC of Jackfruit cv. Chandra orchard soil

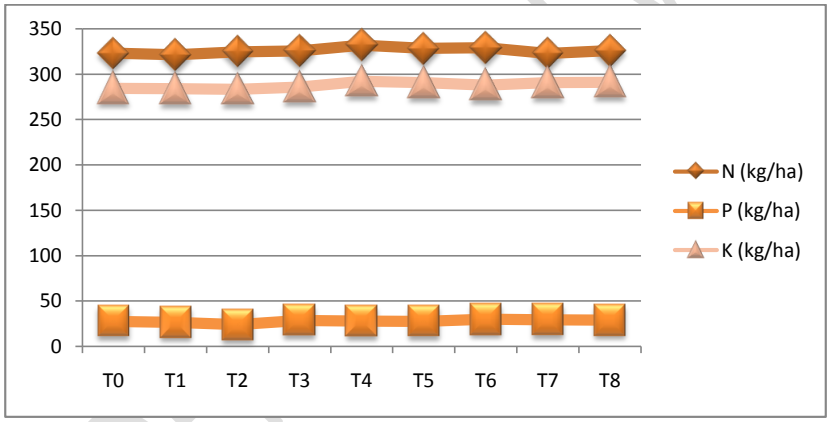

Fig.3. Effect of thiourea on N, P and K of Jackfruit cv. Chandra orchard soil

5. Conclusion

On the basis of results obtained from the field experiment entitled "Assessment of Thiourea Bioregulator Impact on Soil Parameters of Jackfruit (*Artocarpus heterophyllus* L.) cv. Chandra" it is concluded thatvarying levels of thiourea leaf spray concentrations had non-significant effect on the soil's available pH, EC, OC, nitrogen, phosphorus and potassium for the jackfruit plants.

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Comment [TS6]: Considering the potential of study, and overlapping objectives with the investigation performed in adjoining state. The authors are advised to cite these potential articles. Both of them are publicly available on Researchgate.

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