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Biostimulant-Induced Modulation of Photosynthetic Efficiency in Alfalfa (*Medicago sativa* L.)

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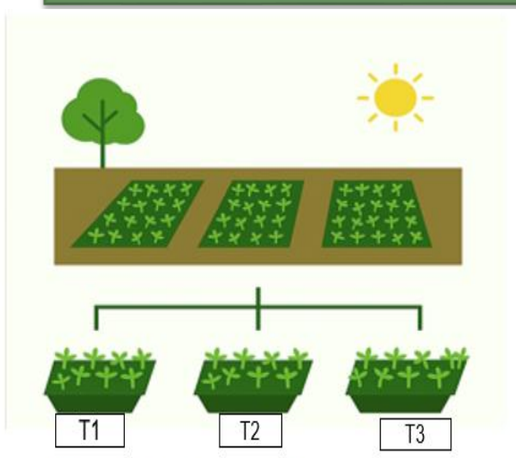
INTRODUCTION & AIM

Alfalfa (*Medicago sativa* L.) is a key forage crop valued globally for its high protein content and nitrogen-fixing capacity, making it essential in livestock feeding systems. However, its biomass yield is often constrained by reduced photosynthetic efficiency, particularly under stress conditions such as drought and nutrient imbalance. Biostimulants natural or synthetic substances including seaweed extracts, humic acids, and microbial or fungal inoculants have the potential to enhance plant metabolism, strengthen stress resilience, and mitigate these negative impacts. Therefore, this study aims to evaluate how two distinct biostimulant applications influence photosynthetic efficiency and overall productivity in alfalfa.

METHOD



Study Design used

The experiment conducted during the 2024 cropping season was arranged in a randomized complete block design (RCBD), with three treatments replicated three times under field conditions

Code	Biostimulant treatments	Dosage
T1	Tricho Immun	21.6g/3L
T2	Biostimulant containing Si, MTU®, and pidolic acid	(2ml/3L)
T3	Control (no biostimulant)	

Measurement

Measurements of (i) gas exchange parameters and (ii) chlorophyll fluorescence parameters were conducted under a photosynthetic photon flux density of 1500 µmol photons m^{-2} s^{-1}.

Instrument used: Licor 6800

RESULTS & DISCUSSION

- Our findings show that biostimulant application significantly improved net photosynthetic rate, transpiration rate, intercellular CO_2 concentration, water use efficiency, and quantum yield of PSII, indicating improved photochemical efficiency.
- The result indicated that ΦPSII was increased by 43.9%, net photosynthetic rate by 37.8%, and transpiration rate by 97.6% in T2 treatment compared to control.

RESULTS & DISCUSSION

***Table 2: Influence of biostimulants on gas exchange parameters of alfalfa (Medicago Sativa* L.)**

Treatments	Ass (µmol m^2 s^{-1})	Transpiration (mmol $m^{-2}s^{-1}$)	Intercellular Co_2 conc. (µmol mol^{-1})	Ambient Co_2 conc. (µmol mol^{-1})	WUE (kg m^{-3})
T1	23.23± 0.72^{b}	8.97 ±0.26^{b}	204.0±5.51^{c}	396.3±15.71^{a}	2.56±0.15^{ab}
T2	29.14±0.53^{a}	12.70±0.75^{a}	284.0±3.87^{b}	395.8±7.36^{a}	2.32±0.18^{b}
T3	21.14±0.48^{b}	6.43±0.26^{c}	720.0±10.52^{a}	396.6±3.82^{a}	3.33±0.26^{a}
Cv (%)	4.9	11.3	2.7	4.0	15.4
Lsd (5%)	2.71	2.39	24.85	35.72	0.95

Ass: photosynthesis rate, means with same letters are not different from each other

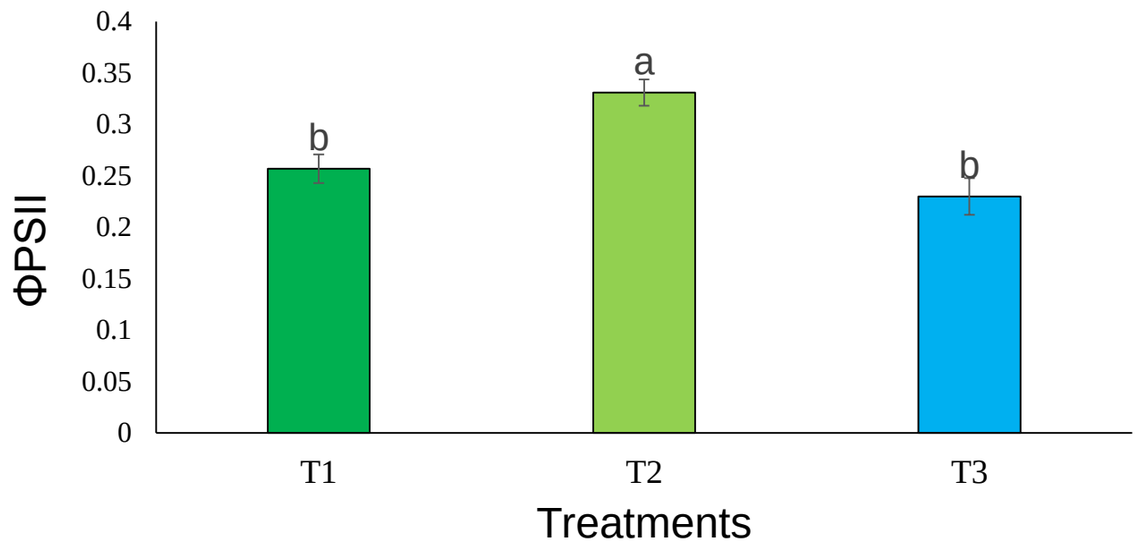


Figure 1: Effect of biostimulant on Quantum yield of PSII of alfalfa *(Medicago Sativa* L.*)*

- Similarly, Tricho Immun (T1) also increased ΦPSII, net photosynthetic rate and transpiration rate by 11.7%, 9.8%, and 39.5% respectively, compared to the control.
- No significant effects were observed on ambient CO_2. On the other hand, the control treatment tended to outperform the biostimulants in both water-use efficiency (WUE) and intercellular CO_2 concentration.

CONCLUSION

- Biostimulant significantly enhance photosynthetic performance and resource-use efficiency in alfalfa
- T2 was most effective in improving photosynthetic parameters
- Overall, biostimulant application serve as a promising strategy to enhance forage crop productivity and sustainability in agriculture.

FUTURE WORK / REFERENCES

Future research should assess changes in gene expression associated with photosynthesis and stress tolerance and apply transcriptomic approaches to identify the pathways activated by biostimulants.