

RESEARCH PAPER

Effect of Phosphorus Management and Mulching on the Growth and Yield of Sunflower in Coastal Saline Areas of South 24 Parganas

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ABSTRACT

Sunflower is an important crop of the coastal part of South 24 Parganas due to its ability to thrive well in salinity-affected soil with low water requirements. But the yield of sunflower is very poor due to the non-availability of promising hybrids, lack of knowledge on phosphorus management and soil management practices to minimize soil salinity. Keeping those ideas in view, an experiment was conducted at the Instructional Farm of The Neotia University, West Bengal, during *rabi* (winter), 2025, to study the effect of phosphorus and mulching on the growth and yield of sunflower in coastal saline areas. The experiment was laid out in split plot design replicated thrice. The treatments consisted of six main plot treatments, *i.e.* P_0 : No P_2O_5 (control), P_1 : 50% recommended dose of P_2O_5 , P_2 : 75% recommended dose of P_2O_5 , P_3 : 100% recommended dose of P_2O_5 , P_4 : 50% recommended dose of P_2O_5 + seed inoculation with VAM, P_5 : 75% recommended dose of P_2O_5 + seed inoculation with VAM and 3 sub plot treatments M_0 : No mulching (Control), M_1 : Paddy straw mulching, M_2 : Plastic mulching. The hybrid considered for the study was DRS-1. The results revealed that the treatment 75% recommended dose of P_2O_5 + seed inoculation with VAM recorded highest value in plant growth parameters, yield attributes and yield. Among, mulching, the plastic mulching outperformed straw mulching and control. The study concluded that the application of 75% recommended dose of phosphorus and seed inoculation with VAM under plastic mulching could be considered as the best practice to achieve higher growth and productivity of sunflower.

HIGHLIGHTS

- ① A reduction of chemical phosphatic fertilizer by 25% and inclusion of VAM enhanced growth and productivity of sunflower.
- ② Plastic mulching increased growth and yield of hybrid sunflower in coastal Sundarbans.

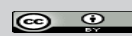
Keywords: Growth parameters, plastic mulching, sunflower, VAM, yield, yield attributes

Sunflower (*Helianthus annuus* L.), a crop of the family *Asteraceae*, is native to the southern parts of Mexico and united states of America. Due to its extensive phenotypic plasticity, sunflowers are an oleaginous species that are grown in many parts of the world, including China, Argentina, the United States, Russia, and Ukraine (Kostenkova 2019; Nungula *et al.* 2023). Sunflower is a major oilseed crop that has been increasing in global importance and ranks

just after soybean and groundnut in overall world oilseed production (Tomar, 2003; Chappa *et al.* 2022). The oil of sunflower is edible and it contains 20-27 percent protein and 40-47 percent oil (Saleem

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et al. 2003; Kumar *et al.* 2019; Chappa *et al.* 2023). Sunflower has plenty of medicinal properties and are used as a medicine for pulmonary afflictions. The plant parts are also used as dyes for the textile industry, body painting and other decorations. The sunflower oil is used for cooking, salad dressing and for the manufacturing of margarine and shortening (Kunduraci *et al.* 2010).

Phosphorus is an essential plant nutrient important to obtain higher and sustained productivity of oil (Cheptock *et al.* 2021; Mirriam *et al.* 2022). Phosphorus can influence the seed yield, oil yield and oil quality of sunflower (Bahl and Toor, 1999). Phosphorus is used to build nucleic acids and phospholipids, like important molecules which plays vital role in energy transfer processes like NADPH, ATP and regulate enzymatic and metabolic activities. Phosphorus is a vital element that helps in rapid growth because it has an important role in the transfer of energy inside the plant. It facilitates the development of plant roots in the early stage of growth, which is important for effectively uptake of other nutrients (Sudharani *et al.* 2018). It is a vital component of phospholipids, nucleotides and nucleic acids. It helps root growth, early flowering, and maturation while protective cell structure. Most soils will have plenty amount of phosphate to meet the demand. Phosphate is crucial for early flowering, later in the season and is vital to the energy store and transfer process. It is significant to provide the oilseed crop with enough phosphate to increase the oil and protein content of the seeds. Basically, for sunflower, phosphorus is a vital nutrient that helps a number of critical physiological functions. It is important for the creation of energy through the synthesis of adenosine triphosphate (ATP) and the enhancement of enzyme activity in plant cells (Maaruf and Raheem, 2024).

Vesicular-arbuscular mycorrhizae (VAM) fungi are receiving greater attention in sustainable agriculture for their beneficial effects on plant growth and yield. Vesicular-arbuscular mycorrhizae (VAM) are widespread in soils, and often the growth of mycorrhizal plants is higher in comparison to non-mycorrhizal plants. Seed inoculation with VAM fungi can increase phosphorus (P) uptake and improve P nutrition by developing better root structure (Antunes *et al.* 2007; Parvaz *et al.* 2025). Mycorrhiza has a symbiotic association between the

soil fungi and higher plant roots (Smith and Smith, 1997; Maitra *et al.* 2025a). The vesicular-arbuscular mycorrhizae (VAM) fungi can enhance plant growth by making mineral nutrients, *i.e.*, P, Zn, and Cu, available to plants.

On the other hand, the process of covering the soil surface by placing organic or inorganic materials is called mulching. Mulching is beneficial for plants by conserving soil moisture, minimizing the evaporation losses from the soil surface, modifying soil temperature and checking weed growth (Maitra *et al.* 2025b). Mulching lowers unproductive evaporation from the surface of soil, increasing the amount of water available for transpiration, a benefit in situations where water is rare and maintaining the water status of plants (Chakraborty *et al.* 2008). Further, mulching is beneficial in saline tracts as it restricts the capillary movement of soil water during the dry season (Maitra *et al.* 2026). In an intensive cropping system, crop residue is available and sometimes it is misused (Hossain *et al.* 2021; Ray *et al.* 2025). Crop residue mulching is a method where the soil surface is sheltered by the organic residue of the preceding crop (Erenstein, 2002), such as straw, maize stalks, or stubble of leafy organic material that may also be brought from another place (Bot and Benites, 2005). Plastic mulching has become effective in different crops (Santosh *et al.* 2021, 2022). Based on the above-mentioned facts, an experiment was conducted to study the impact of VAM and mulching on sunflower in the coastal soils of Sundarbans.

MATERIALS AND METHODS

The field experiment was carried out at the Instructional Farm, School of Agriculture and Allied Sciences, The Neotia University Sarisha, Jhinga, South 24 parganas, West Bengal during *rabi* season (November to march 2025). The farm is located at the 22.261248 ° N latitude and 88.194339 ° S at an elevation of 7.10 m above mean sea level (MSL). The experimental field was a medium land with good irrigation and drainage facilities. The soil was typical new alluvial soil, Inceptisol and loamy in texture having moderate water holding capacity (WHC). The percentage of sand, silt and clay were 58.29, 21.78 and 19.93%, respectively. The experiment was laid out in split-plot design having 6 main plot treatments *i.e.* P₀- No P₂O₅ (Control),



P₁- 50% recommended dose of P₂O₅, P₂- 75% recommended dose of P₂O₅, P₃- 100% recommended dose of P₂O₅, P₄- 50% recommended dose of P₂O₅ + seed inoculation with VAM, P₅- 75% recommended dose of P₂O₅ + seed inoculation with VAM and 3 sub plot treatments M₀ -No mulching (Control), M₁ -Paddy straw mulching, M₂ -Plastic mulching. Half the dose of N and entire dose of P and K were applied as basal and the remaining quantity of N was applied at 30 DAS. The mycorrhizal inoculum (glomus sps.) was done during the sowing time of sunflower. Manual hand weeding was done with the help of *khurpi*. 1st weeding is done at 30 DAS and 2nd at 45 DAS. The observations were recorded from 10 randomly selected plants. The data were subjected to statistical analysis using analysis of variance method (Gomez and Gomez, 1984) and the significance of different sources of variations were tested by error mean square using Fisher and Snedecor's 'F' test at a probability level of 0.05.

RESULTS AND DISCUSSION

Phosphorus management significantly influenced the plant height (cm.), dry matter accumulation (g/m²), leaf area index and crop growth rate (g/m²/day)

of sunflower. Among the phosphorus management treatments, treatment P₅, i.e., 75% recommended dose of P₂O₅ + seed inoculation with VAM recorded highest plant height of (172 cm), dry matter accumulation (861 g/m²), leaf area index (1.29) and crop growth rate (13.42 g/m²/day) of sunflower. Among the mulching treatments, application of plastic mulching, i.e. M₂ recorded highest values of plant height (154 cm.), dry matter accumulation (683 g/m²), leaf area index (0.82) and crop growth rate (9.71 g/m²/day) (Table 1).

Application of phosphorus along with VAM inoculation led to better growth of sunflower as the symbiotic association of VAM produce mycelial network which extend in soil much more than few short root hairs and therefore absorb more nutrient elements dissolved in water (St. John, 1980). VAM is well known to increase the growth of many plant species, mainly through increased uptake and translocation of not only P but also other nutrients (Abbott and Robson 1982). VAM is also helpful in uptake of Zn, Cu, Mn and Fe (Sreenivasa *et al.* 1993).

Phosphorus management also influenced the yield attributes and yield of sunflower significantly (Table 2). Highest capitulum diameter (13.93 cm), seeds

Table 1: Effect of phosphorus management and mulching on the growth attributes of sunflower

Treatments	Plant height (cm)	Dry matter accumulation (gm ⁻²)	Leaf area index (60 DAS)			Crop growth rate (g m ⁻² day ⁻¹)			
			30 DAS	60 DAS	90 DAS	0-30 DAS	30-60 DAS	60-90 DAS	90 DAS-At harvest
Phosphorus management									
P ₀	126	432	0.15	0.290	0.219	0.50	6.46	4.25	4.94
P ₁	136	545	0.17	0.563	0.402	0.53	7.17	6.27	5.70
P ₂	143	597	0.19	0.11	0.529	0.55	8.36	7.08	5.32
P ₃	149	692	0.25	0.835	0.692	0.71	9.79	8.90	4.97
P ₄	161	786	0.33	0.874	0.767	0.76	10.89	10.66	5.29
P ₅	172	861	0.43	1.290	0.944	0.84	13.42	9.72	6.44
S. Em. (±)	2.17	3.26	0.002	0.011	0.008	0.008	0.110	0.232	0.094
C.D. (<i>p</i> =0.05)	4.84	7.26	0.005	0.026	0.018	0.018	0.245	0.518	0.211
Mulching									
M ₀	140	614	0.24	0.680	0.550	0.60	9.00	7.31	5.15
M ₁	150	659	0.25	0.787	0.576	0.64	9.32	7.99	5.46
M ₂	154	683	0.26	0.815	0.650	0.71	9.71	8.15	5.72
S. Em. (±)	0.77	1.30	0.001	0.005	0.004	0.006	0.051	0.056	0.034
C.D. (<i>p</i> =0.05)	1.59	2.70	NS	0.010	0.009	0.012	NS	0.116	0.071

P₀: No P₂O₅ (control), P₁: 50% recommended dose of P₂O₅, P₂: 75% recommended dose of P₂O₅, P₃: 100% recommended dose of P₂O₅, P₄: 50% recommended dose of P₂O₅ + seed inoculation with VAM, P₅: 75% recommended dose of P₂O₅ + seed inoculation with VAM, M₀: No mulching (control), M₁: Paddy straw mulching and M₂: Plastic mulching.

Table 2: Effect of phosphorus management and mulching on the yield attributes and yield of sunflower

Treatments	Capitulum diameter (cm)	Seeds capitulum ⁻¹	Seeds wt. capitulum ⁻¹ (g)	100 seed wt. (g)	Seed yield (t ha ⁻¹)	Stover yield (t ha ⁻¹)
Phosphorus management						
P ₀	10.74	366.68	29.56	4.55	0.81	2.93
P ₁	11.51	429.95	32.24	4.74	1.00	3.80
P ₂	11.79	468.15	34.33	5.26	1.18	4.39
P ₃	12.04	493.15	36.08	5.81	1.51	5.03
P ₄	13.08	520.57	42.93	6.29	1.85	5.80
P ₅	13.93	579.13	50.69	6.59	2.07	6.43
S. Em. (±)	0.133	4.315	0.681	0.049	0.031	0.041
C.D. (p=0.05)	0.297	9.614	1.518	0.156	0.069	0.091
Mulching						
M ₀	11.82	457.25	35.50	5.46	1.30	4.49
M ₁	11.93	475.01	37.64	5.58	1.42	4.78
M ₂	12.80	496.56	39.78	5.59	1.49	4.93
S. Em. (±)	0.068	2.207	0.223	0.018	0.008	0.013
C.D. (p=0.05)	0.140	4.555	0.460	NS	0.017	0.028

P₀: No P₂O₅ (control), P₁: 50% recommended dose of P₂O₅, P₂: 75% recommended dose of P₂O₅, P₃: 100% recommended dose of P₂O₅, P₄: 50% recommended dose of P₂O₅ + seed inoculation with VAM, P₅: 75% recommended dose of P₂O₅ + seed inoculation with VAM, M₀: No mulching (control), M₁: Paddy straw mulching and M₂: Plastic mulching.

capitulum⁻¹ (579.13), seeds weight capitulum⁻¹ (50.69 g), 100 seed weight (6.59 g), seed yield (2.07 t ha⁻¹) and stover yield (5.80 t ha⁻¹) were achieved by P₅ i.e. 75% recommended dose of P₂O₅ + seed inoculation with VAM. The percentage increase on seed yield of P₅ over P₄, P₃, P₂, P₁ and P₀ were 11.89 %, 37.08 %, 75.42 %, 107.00 %, and 155.55 %, respectively.

Among the mulching treatments, M₂ i.e. plastic mulching recorded the highest capitulum diameter (12.80 cm), seeds capitulum⁻¹ (496.56), seeds weight capitulum⁻¹ (39.78 g), 100 seed weight (5.59 g), seed yield (1.49 t ha⁻¹) and stover yield (4.93 t ha⁻¹). Application of straw mulching and plastic mulching is effective to reduce evaporation losses, improve soil moisture content, suppress weed growth and reduce soil salinity resulted in the highest values of yield attributes and yield as compared to no mulching. The results confirmed the findings of Zhonglin et al. (2026).

CONCLUSION

Phosphorus fertilization, VAM inoculation and mulching significantly influenced the growth and yield of sunflower under the coastal saline soils of West Bengal. Application of the optimum level of phosphorus improved plant growth, nutrient

uptake, and yield attributes, while VAM inoculation enhanced nutrient uptake by developing the root system. On the other hand, plastic mulching resulted in its superiority over other treatments in enhancing sunflower productivity. These findings concluded that application of phosphorus in combination with VAM under plastic mulching improved sunflower productivity in coastal saline soils.

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