



Phytochemical Profiling and Agro-Environmental Applications of *Sphagneticola calendulacea* in Sustainable Agriculture

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Abstract:

Sphagneticola calendulacea (L.) Pruski (syn. *Wedelia calendulacea*), a creeping perennial herb of the family Asteraceae, has gained increasing scientific attention for its ecological resilience, phytochemical richness, and multifunctional applications in sustainable agriculture. The present study evaluates its botanical attributes, phytochemical profile, soil-stabilizing ability, phytoremediation potential, weed suppression capacity, and suitability as green manure. Field-based observations combined with laboratory screening revealed abundant flavonoids, phenolic compounds, and terpenoids in plant extracts, which are associated with antioxidant, antimicrobial, and allelopathic activities. Dense stoloniferous root systems effectively reduced surface soil erosion, while biomass incorporation improved soil organic carbon and microbial activity. Weed growth was significantly suppressed in plots dominated by *S. calendulacea*, suggesting allelochemical-mediated interference. The collective findings highlight the plant's promise as an eco-friendly biological resource for sustainable cropping systems, soil restoration, and low-input agriculture.

Keywords: *Sphagneticola Calendulacea*; Sustainable Agriculture; Phytoremediation; Weed Suppression; Soil Conservation; Green Manure

Introduction:

Sustainable agriculture emphasizes productivity while maintaining soil health, biodiversity, and ecological integrity. Plant-based interventions such as cover crops, green manures, and biological weed suppressants are increasingly promoted as alternatives to chemical-intensive practices.

Sphagneticola calendulacea (L.) Pruski—commonly known as creeping oxeye or Singapore daisy—is a stoloniferous perennial herb distributed widely in tropical and subtropical regions. The species is valued in traditional medicine for treating liver ailments, inflammation, wounds, and skin disorders and has recently attracted attention for its potential

roles in soil stabilization, phytoremediation, and biological weed control.

Rapid vegetative spread, tolerance to waterlogging, and ability to thrive in degraded soils make *S. calendulacea* an ideal candidate for erosion-prone landscapes and marginal agricultural lands. However, systematic studies integrating its agronomic, ecological, and phytochemical attributes remain limited. The present investigation was therefore undertaken to assess the multifunctional utility of *S. calendulacea* in sustainable agriculture.

Objectives:

The study aimed to:

1. Document the botanical and ecological characteristics of *S. calendulacea*.
2. Screen major phytochemical constituents in different extracts.
3. Evaluate its role in soil stabilization and phytoremediation.
4. Assess weed-suppressive and pest-deterrent properties.
5. Examine its suitability as green manure for soil fertility enhancement.

Materials and Methods:**Collection and Authentication:**

Plant material was collected from moist low-lying areas of the Kalsubai region, Western Ghats, Maharashtra, India. Specimens were authenticated by taxonomists at Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, and voucher samples were deposited in the institutional herbarium

Preparation of Extracts:

Shade-dried aerial parts were powdered and subjected to successive solvent extraction using aqueous and hydro-alcoholic systems. Concentrated extracts were stored at 4 °C for phytochemical analysis.

Phytochemical Screening:

Qualitative chemical tests were performed for flavonoids, phenolics, tannins, terpenoids, alkaloids, and saponins following standard pharmacognostic protocols.

Soil Conservation and Phytoremediation Studies:

Experimental field plots were established on gentle slopes. Soil loss was measured after rainfall events using runoff collectors. For phytoremediation assessment, soils artificially enriched with trace concentrations of heavy

metals were planted with *S. calendulacea*, and metal uptake was monitored in harvested tissues.

Weed Suppression and Pest Control:

Allelopathic effects were evaluated by monitoring emergence and biomass of common agricultural weeds in plots covered by *S. calendulacea*. Laboratory bioassays were performed to test insecticidal activity of extracts against selected crop pests.

Green Manure Trials:

Fresh biomass was incorporated into cultivated soil beds, and changes in organic carbon, available nitrogen, phosphorus, potassium, and microbial counts were recorded after decomposition.

Results and Discussion:**Botanical Description and Habitat:**

Sphagneticola calendulacea is a mat-forming perennial herb with creeping stolons, opposite serrate leaves, and solitary yellow capitula. The plant prefers moist sandy loams, riverbanks, wetlands, and irrigation channels. Rapid vegetative propagation and tolerance to fluctuating moisture regimes enable it to act as an effective natural ground cover.

Phytochemical Composition and Medicinal Relevance:

Extracts tested positive for flavonoids, phenolic acids, terpenoids, and tannins. These metabolites are known for antioxidant, antimicrobial, and allelopathic activities, supporting traditional uses in inflammatory disorders and suggesting applications in organic crop protection systems.

Role in Sustainable Agriculture:**Soil Conservation and Phytoremediation:**

Dense fibrous roots and stolons significantly reduced runoff and surface erosion. Plants grown in contaminated soils accumulated

measurable quantities of metals in aerial tissues, indicating moderate phytoremediation capacity suitable for rehabilitation of marginal lands.

Weed Suppression and Pest Management:

Plots dominated by *S. calendulacea* showed reduced density and biomass of invasive weeds, suggesting release of inhibitory allelochemicals. Extracts also exhibited deterrent and toxic effects against selected insect pests, highlighting its potential as a botanical pesticide.

Green Manure and Soil Fertility Enhancement:

Incorporation of plant biomass enhanced soil organic matter, nutrient availability, and microbial populations, confirming its suitability as a green manure crop in low-input farming systems.

Ecological Concerns and Management:

Although agriculturally beneficial, unchecked growth of *S. calendulacea* can lead to invasiveness in natural ecosystems. Controlled cultivation, boundary management, and integration within crop rotation systems are recommended.

Table 1: Physicochemical Parameters of *Sphagneticola calendulacea* Aerial Parts (Dry Powder)

Parameter	Value (% w/w)
Loss on drying at 105 °C	6.12
Total ash	9.48
Acid-insoluble ash	1.23
Water-soluble ash	4.05
Alcohol-soluble extractive	7.84
Water-soluble extractive	12.76
pH (10% aq. solution)	6.1

Table 2: Preliminary Phytochemical Screening of Extracts

Phytochemical Group	Test	Aqueous Extract	Hydro-alcoholic Extract
Alkaloids	Dragendorff's	+	++
Flavonoids	Shinoda	+	++
Phenolics	Ferric chloride	++	++
Tannins	Lead acetate	+	+
Terpenoids	Salkowski	+	++
Saponins	Foam test	+	+
Glycosides	Keller–Killiani	–	+

(+ = present; ++ = strongly present; – = absent)

Table 3: Effect of *S. calendulacea* Cover on Soil Erosion

Treatment	Mean Runoff (L m ⁻²)	Soil Loss (kg ha ⁻¹)
Bare soil (control)	4.6	1280
Crop cover	2.8	720
<i>S. calendulacea</i> ground cover	1.2	310

Table 4: Weed Suppression in Experimental Plots

Weed Species	Density in Control (plants m ⁻²)	Density in <i>S. calendulacea</i> Plot	% Reduction
<i>Cyperus rotundus</i>	42	14	66.7
<i>Parthenium hysterophorus</i>	35	10	71.4
<i>Amaranthus viridis</i>	48	17	64.6
Mean	—	—	67.6

Table 5: Soil Fertility After Green-Manure Incorporation (60 Days)

Parameter	Before Treatment	After Biomass Incorporation
Organic carbon (%)	0.42	0.71
Available N (kg ha ⁻¹)	185	263
Available P (kg ha ⁻¹)	14.6	22.4
Available K (kg ha ⁻¹)	168	245
Microbial count (CFU × 10 ⁶ g ⁻¹ soil)	3.2	6.8

Table 6: Heavy-Metal Uptake by *S. calendulacea* in Contaminated Soil

Metal	Soil Conc. (mg kg ⁻¹)	Plant Tissue (mg kg ⁻¹)	Bioaccumulation Factor
Pb	52	18.4	0.35
Cd	6.1	2.8	0.46
Zn	98	44.7	0.46
Cu	41	19.5	0.48

Table 7: TLC Profile of Hydro-alcoholic Extract

Solvent system: Toluene : Ethyl acetate : Formic acid (5:4:1)

Spot No.	Rf Value	Colour under UV (366 nm)	Probable Compound Group
1	0.21	Blue	Phenolics
2	0.43	Greenish	Flavonoids
3	0.61	Purple	Terpenoids
4	0.79	Yellow	Glycosides

Future Prospects:

Future work should emphasize:

- Quantitative evaluation of allelochemicals
- Heavy-metal uptake kinetics
- Long-term soil fertility trials
- Integration into agroforestry systems
- Development of managed cultivation protocols

Conclusion:

Sphagneticola calendulacea represents a versatile biological resource for sustainable agriculture. Its capacity for soil stabilization, weed suppression, phytoremediation, and organic nutrient enrichment makes it suitable for eco-friendly farming strategies. Scientific exploitation combined with ecological management could

promote its use in land restoration and climate-resilient agriculture.

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