

Effect of Polyvinyl Chloride Microplastics on Sweet Corn Seed Germination and Seedling Growth



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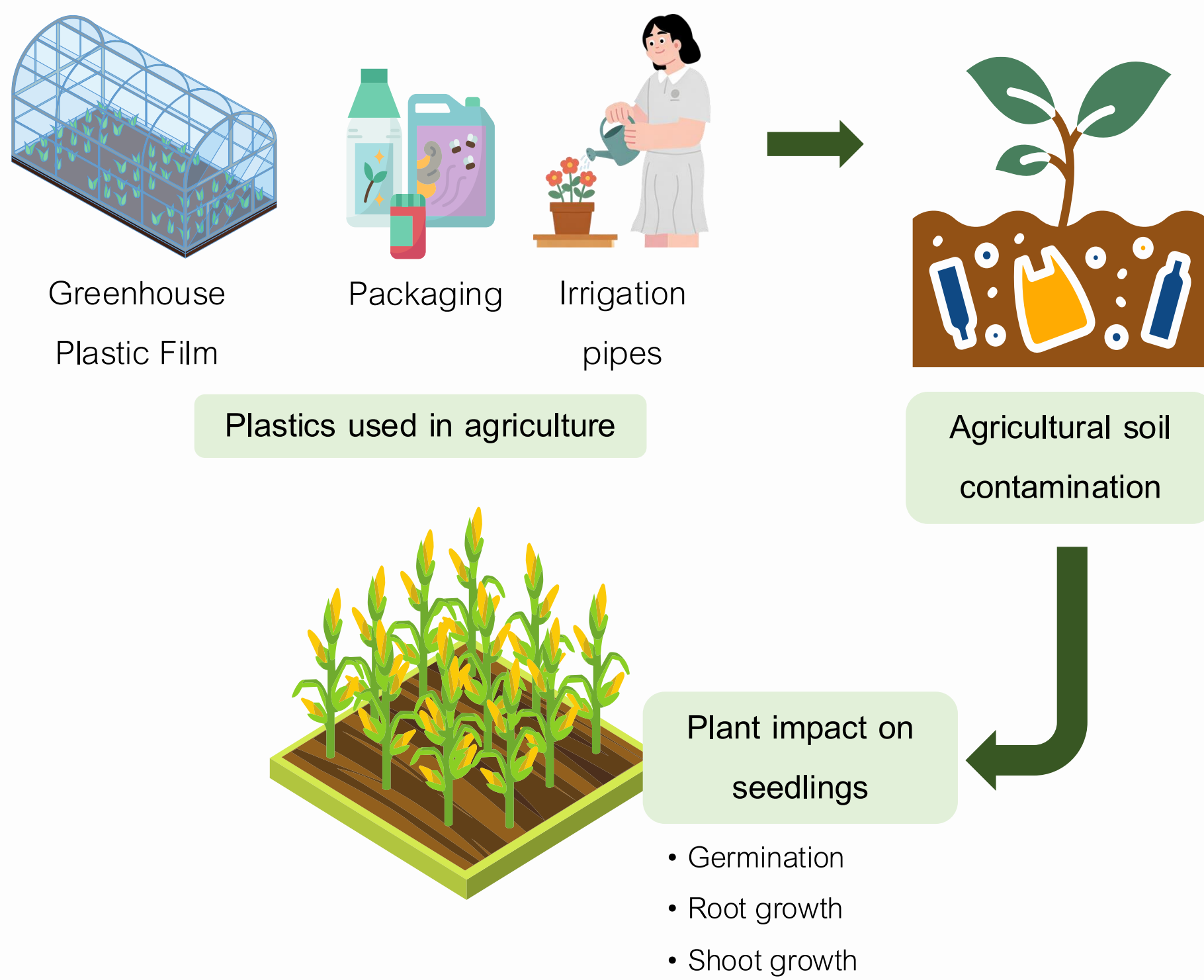
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Introduction



Microplastics (MPs) threaten agricultural soils worldwide, with contamination reaching 0.1–50 mg/kg from plastic mulch, sewage sludge, and irrigation systems. PVC microplastics (PVC-MPs) are particularly concerning as they contain 30–40% phthalate plasticizers that leach into soil, inhibiting plant growth and altering soil properties. Sweet corn is an economically important crop, yet limited information exists regarding PVC-MPs effects on early growth. This study investigated PVC-MPs impacts (3–20 mg/kg) on sweet corn germination and seedling development under greenhouse conditions.

Objectives

- To investigate the influence of PVC-MPs at concentrations of 0–20 mg/kg on sweet corn germination percentage.
- To investigate effects of PVC-MPs on seedling growth parameters including root length, shoot length, and wet weight.

Methodology

1 Materials Preparation

PVC-MPs Preparation

- Ground at -196°C (Freezer mill)
- Size: <125 μm
- Morphology: Irregular fragments



Soil & Seeds Preparation

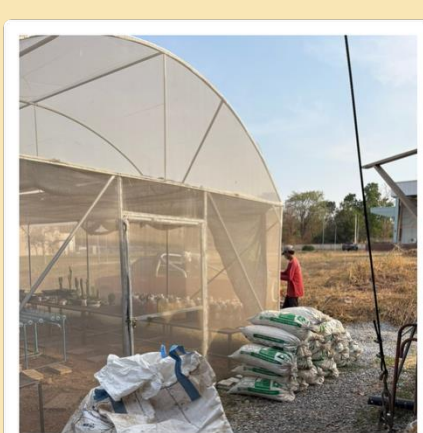
- Silt loam soil (Sand 24.84%, Silt 53.71%, Clay 21.45%)
- CEC: 23.60 cmol/kg, OM: 8.50%
- Sweet corn seeds (>70% germination rate)



2 Experiment Setup



- Treatments: 7 concentrations (0, 3, 5, 7, 10, 15, 20 mg/kg)
- Replication: 24 seeds per treatment
- Container: Seedling trays (6×4 cells)
- Planting: 1 cm depth, 1 seed/cell, 1 kg soil



Cultivation Conditions

- Location: Greenhouse
- Temperature: 20–30°C
- Watering: Daily
- Germination recorded daily

3 Data Collection (Day 7)

- Germination percentage
- Root length (ruler ±1 mm)
- Shoot length (ruler ±1 mm)
- Wet weight (balance ±0.0001 g)

4 Statistical Analysis

- One-way ANOVA
- LSD test ($p < 0.05$)
- Software: SPSS Statistics 30.0
- Data: Mean ± SD ($n=24$)

Results

Table 1 Cumulative number of germinated seeds and final germination percentage of sweet corn under different PVC-MPs concentrations.

Concentration (mg/kg)	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Germination (%)
0	0	2	4	10	12	17	20	83.33 ^{ns}
3	0	1	8	12	15	19	21	87.50 ^{ns}
5	0	4	8	12	17	21	22	91.67 ^{ns}
7	0	0	2	7	11	13	19	79.17 ^{ns}
10	0	1	3	11	16	18	23	95.83 ^{ns}
15	0	0	9	12	14	17	21	87.50 ^{ns}
20	0	0	2	10	17	17	19	79.17 ^{ns}

^{ns} Not significant at $p > 0.05$ by one-way ANOVA ($n=24$ seeds per treatment)

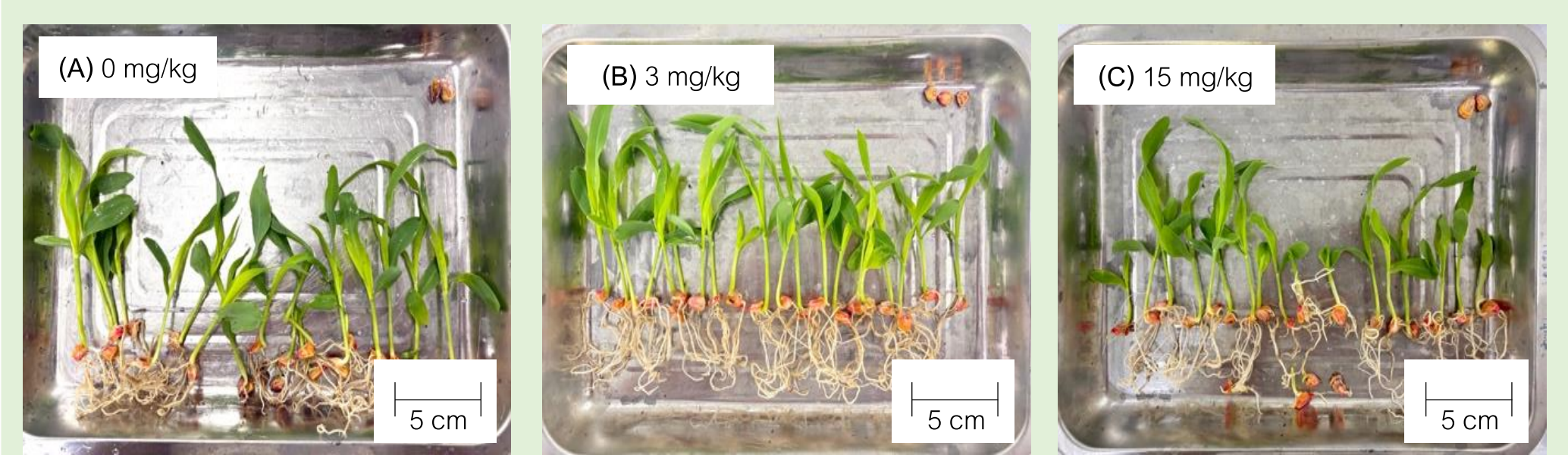
Table 2 Effect of PVC-MPs concentrations on root length, shoot length, and wet weight of sweet corn seedlings at day 7.

Concentration (mg/kg)	Root length* (cm)	Shoot length* (cm)	Wet weight* (g)
0	9.96±4.57 ^{ab}	10.89±5.19 ^a	0.89±0.36 ^a
3	11.07±4.13 ^a	11.39±4.14 ^a	0.84±0.23 ^{ab}
5	11.72±4.35 ^a	10.51±3.30 ^a	0.84±0.26 ^{ab}
7	11.22±5.22 ^a	8.41±3.90 ^{bc}	0.81±0.26 ^{ab}
10	10.81±4.03 ^{ab}	9.99±4.37 ^{ab}	0.83±0.22 ^{ab}
15	8.35±4.22 ^b	7.79±4.52 ^c	0.70±0.22 ^b
20	11.12±4.29 ^a	11.21±3.92 ^a	0.73±0.29 ^{ab}

Values are mean ± SD ($n=24$ seedlings per treatment).

* Different superscript letters within the same column indicate significant differences at $p < 0.05$ by LSD test with one-way ANOVA.

Fig. 1 Visual comparison of sweet corn seedlings at day 7 under different PVC-MPs concentrations: (A) control (0 mg/kg) showing moderate growth; (B) 3 mg/kg showing optimal growth with longest shoots; and (C) 15 mg/kg showing reduced growth with shortest shoots. Images demonstrate the concentration-dependent effect of PVC-MPs on shoot development



Conclusion

This study demonstrated that PVC-MPs at 0–20 mg/kg did not significantly affect sweet corn germination (79–96%, $p = 0.226$) but significantly reduced shoot length at concentrations ≥ 15 mg/kg ($p = 0.042$), decreasing from 11.39 cm at 3 mg/kg to 7.79 cm at 15 mg/kg (32% reduction). Root length and wet weight were not affected ($p > 0.226$). These results suggest a potential threshold concentration of 10–15 mg/kg under greenhouse conditions, above which PVC-MPs may impair early seedling development, indicating greater sensitivity during seedling growth than germination.

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