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Effect of weed composts as an integrated nutrient source on productivity and yield components of Maize (*Zea mays* L.) in a maize-groundnut cropping system

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Abstract

A field experiment was conducted at the Main Research Station, University of Agricultural Sciences, Hebbal, Bengaluru, to evaluate the efficacy of composts prepared from four abundant weed species like *Chromolaena odorata*, *Parthenium hysterophorus*, *Cassia sericea* and *Eichhornia crassipes* (Water Hyacinth) as nutrient sources for maize. The study laid out in a Randomized Complete Block Design (RCBD) with fourteen treatments, investigated the substitution of 25% Nitrogen (N) through weed composts combined with 75% or 100% Recommended Dose of Fertilizer (RDF). Results from the pooled data of two years indicated that the conjunctive use of 25% N through weed composts along with 100% RDF significantly enhanced growth parameters and yield attributes compared to inorganic fertilizers alone. The highest kernel yields (6124 to 6248 kg ha⁻¹) were recorded with the application of weed composts + 100% RDF, which were statistically on par with the standard practice of 10 t ha⁻¹ Farm Yard Manure (FYM) + 100% RDF (6301 kg ha⁻¹). Notably, treatments receiving 25% N through weed composts + 75% RDF produced significantly higher yields than 100% RDF alone, demonstrating the potential for fertilizer savings. The study concludes that converting problematic weeds into compost is a viable strategy to supplement chemical fertilizers and enhance maize productivity.

Keywords: Weed compost, *Chromolaena*, *Parthenium*, *Cassia*, water hyacinth, integrated nutrient management, maize

Introduction

Modern agriculture faces the dual challenge of sustaining food production while maintaining soil health. The continuous and imbalanced use of chemical fertilizers has led to a decline in soil fertility and stagnation in crop productivity. Simultaneously, the proliferation of invasive weeds such as *Parthenium hysterophorus*, *Chromolaena odorata* and *Eichhornia crassipes* poses a significant threat to ecosystems and agriculture.

Converting this huge weed biomass into compost offers a unique opportunity to address both issues. Weeds are often rich in nutrients and can serve as a valuable source of organic matter. *Chromolaena* and *Parthenium*, for instance, accumulate significant amounts of nitrogen, phosphorus and potassium in their tissues. Previous studies have shown that weed utilization as compost can improve soil physical, chemical, and biological properties, favouring better crop growth. This study investigates the efficacy of utilizing composts prepared from four specific weed species to substitute inorganic nitrogen in maize cultivation, aiming to identify a sustainable integrated nutrient management strategy.

Materials and Methods

Experimental Site and Design

The experiment was conducted during the *Kharif* seasons of 2009 and 2010 at the Main Research Station (MRS), Hebbal, Bengaluru. The soil was red sandy loam with a pH of 6.8, available nitrogen (N) of 294.2 kg ha⁻¹, available phosphorus (P₂O₅) of 30.5 kg ha⁻¹ and available potassium (K₂O) of 210.1 kg ha⁻¹. The experiment adopted a Randomized Complete Block Design (RCBD) with 14 treatments and three replications.

Treatment Details

The treatments included varying levels of RDF combined with 25% N substitution through different composts:

T₁ - 25% of N through Compost of *Chromolaena odorata* + 75% RDF

T₂ - 25% of N through Compost of *Chromolaena odorata* + 100% RDF

T₃ - 25% of N through Compost of *Parthenium hysterophorus* + 75% RDF

T₄ - 25% of N through Compost of *Parthenium hysterophorus* + 100% RDF

T₅ - 25% of N through Compost of *Cassia sericea* + 75% RDF

T₆ - 25% of N through Compost of *Cassia sericea* + 100% RDF

T₇ - 25% of N through Compost of Water hyacinth + 75% RDF

T₈ - 25% of N through Compost of Water hyacinth + 100% RDF

T₉ - 25% of N through Farm yard manure (FYM) + 75% RDF

T₁₀ - 25% of N through Farm yard manure + 100% RDF

T₁₁ - 100% RDF + 10 tons ha⁻¹ FYM

T₁₂ - 75% Recommended fertilizer dose (RDF) alone

T₁₃ - 100% RDF (150 kg N, 75 kg P₂O₅ and 40 kg K₂O/ha) alone

T₁₄ - Absolute control (No fertilizer or compost or FYM)

The Recommended Dose of Fertilizer (RDF) for maize was 150:75:40 kg N:P₂O₅:K₂O ha⁻¹.

Compost Preparation

Fresh biomass of *Chromolaena*, *Parthenium*, *Cassia* and water hyacinth was collected before seeding for compost preparation for the maize-groundnut cropping system experiment conducted at Hebbal. Green biomass of *Parthenium* and *Cassia* was collected from farm surroundings, wastelands and roadsides, *Chromolaena* from the forest ecosystem around GKVK and water hyacinth from the nearby Hebbal Lake prior to flowering. Cow dung obtained from the dairy farm, UAS, Hebbal, Bengaluru, was used to prepare slurry in a 1:2 ratio (cow

dung:water), which served as an additive. Microbial inoculum consisting of *Pleurotus sajor-caju*, *Phanerochaete chrysosporium* and *Trichoderma harzianum* was procured from the Department of Agricultural Microbiology, UAS, GKVK, Bengaluru. Compost treatments included *Chromolaena* (C1), *Parthenium* (C2), *Cassia* (C3) and water hyacinth (C4), each combined with cow dung slurry at 20 per cent and microbial culture at 5 kg tonne⁻¹ of organic material. For composting, about 500 kg of fresh biomass of each weed was chopped into 2-3 inch pieces and composted separately in pits of 4 × 3 × 3 ft dimensions by layering 100 kg biomass in 15-20 cm thickness, followed by uniform application of 10 kg cow dung slurry and microbial inoculum per layer, repeated until the pit was filled up to 15 cm above ground level. The pits were covered with 1-2 cm thick red earth and moisture content was maintained at 50-60 per cent by periodic watering. Turning of composting pits was carried out at 30, 45 and 60 days to enhance aeration, temperature, uniform mixing and decomposition, and fully matured, pleasantly odour composts were obtained after 90 days.

Results and Discussion

The integration of weed composts with 100% Recommended Dose of Fertilizers (RDF) resulted in consistently higher cob lengths (16.4-16.9 cm) compared to 100% RDF alone (14.1 cm). The maximum cob length (16.9 cm) was recorded in the *Cassia* compost + 100% RDF (T₆) treatment.

Yield attributes

A similar trend was observed for the number of kernels per cob. The treatment 10 t FYM + 100% RDF (T₁₁) recorded the highest value (595.3), which was statistically on par with *Chromolaena* compost + 100% RDF (T₂) at 579.4 and FYM + 100% RDF (T₁₀) at 577.6. Regarding 100-seed weight, the highest value was recorded in T₁₁ (38.0 g), followed by T₂ and T₁₀ (both at 36.5 g).

Table 1: Effect of weed composts on yield attributes of Maize (Pooled Data of 2 Years)

Treatment	Cob Length (cm)	No. of Kernels per Cob	100-Seed Weight (g)
T ₁ (<i>Chromolaena</i> + 75% RDF)	15.8	457.7	32.7
T ₂ (<i>Chromolaena</i> + 100% RDF)	16.6	579.4	36.5
T ₃ (<i>Parthenium</i> + 75% RDF)	16.0	444.0	30.7
T ₄ (<i>Parthenium</i> + 100% RDF)	16.4	568.8	36.2
T ₅ (<i>Cassia</i> + 75% RDF)	16.2	451.4	30.3
T ₆ (<i>Cassia</i> + 100% RDF)	16.9	556.9	35.7
T ₇ (<i>Water Hyacinth</i> + 75% RDF)	15.3	421.2	29.7
T ₈ (<i>Water Hyacinth</i> + 100% RDF)	16.4	549.5	34.3
T ₉ (FYM + 75% RDF)	15.5	409.4	28.2
T ₁₀ (FYM + 100% RDF)	16.7	577.6	36.5
T ₁₁ (10 t FYM + 100% RDF)	16.3	595.3	38.0
T ₁₂ (75% RDF Alone)	11.4	275.4	21.8
T ₁₃ (100% RDF Alone)	14.1	425.8	29.7
T ₁₄ (Absolute Control)	9.0	175.7	17.5
S.Em±	0.3	0.6	1.6
C.D. (p=0.05)	1.0	5.0	4.8

Kernel and Stover Yield

The kernel yield showed distinct advantages under Integrated Nutrient Management (INM). Treatments receiving weed composts with 100% RDF produced yields ranging from 6,124 to 6,248 kg ha⁻¹, matching the standard practice of 10 t FYM +

100% RDF (6,301 kg ha⁻¹). Notably, *Cassia* compost + 75% RDF (T₅) yielded 4,855 kg ha⁻¹, significantly outperforming the 3,766 kg ha⁻¹ recorded for 100% RDF alone (T₁₃). The stover yield followed a similar trend, with the highest biomass observed in T₁₁ (9,023 kg ha⁻¹).

Table 2: Effect of weed composts on Kernel and Stover Yield of Maize (Pooled Data)

Treatment	Kernel Yield (kg ha ⁻¹)	Stover Yield (kg ha ⁻¹)
T ₁ (<i>Chromolaena</i> + 75% RDF)	4917	7246
T ₂ (<i>Chromolaena</i> + 100% RDF)	6180	8694
T ₃ (<i>Parthenium</i> + 75% RDF)	4535	7151
T ₄ (<i>Parthenium</i> + 100% RDF)	6223	8707
T ₅ (<i>Cassia</i> + 75% RDF)	4855	7392
T ₆ (<i>Cassia</i> + 100% RDF)	6248	8903
T ₇ (<i>Water Hyacinth</i> + 75% RDF)	4430	7196
T ₈ (<i>Water Hyacinth</i> + 100% RDF)	6124	8685
T ₉ (FYM + 75% RDF)	4018	6189
T ₁₀ (FYM + 100% RDF)	6197	8685
T ₁₁ (10 t FYM + 100% RDF)	6301	9023
T ₁₂ (75% RDF Alone)	2568	4029
T ₁₃ (100% RDF Alone)	3766	5825
T ₁₄ (Absolute Control)	1622	2627
S.Em±	221	268
C.D. (p=0.05)	644	779

Discussion

The significant enhancement in maize productivity through the integrated use of weed composts and chemical fertilizers can be attributed to the “priming effect”, where organic amendments improve the physical environment of the soil, thereby increasing the efficiency of inorganic fertilizers.

The high performance of *Chromolaena odorata* and *Cassia* composts (T₂ and T₆) is supported by Quansah *et al.* (2001) [7], who found that these species possess high nitrogen and phosphorus concentrations with rapid decomposition rates, ensuring a steady nutrient supply during the critical silking and grain-filling stages. Similarly, the effectiveness of *Parthenium* compost (T₄) aligns with Kishor *et al.* (2010) [9], who reported that *Parthenium* serves as a rich source of micronutrients and improves soil enzyme activities, leading to better kernel development.

The observation that 75% RDF + Weed Compost outperformed 100% RDF alone highlights a significant fertilizer-saving potential. According to Dilshad *et al.* (2010) [6], organic matter enhances the cation exchange capacity (CEC) of the soil, reducing nutrient leaching and improving the translocation of photosynthates from the source (leaves) to the sink (kernels). This is reflected in the significantly higher 100-seed weight observed in compost-treated plots.

Furthermore, the parity between weed composts and traditional FYM (T₁₁) is consistent with Ramesh *et al.* (2009) [8], who argued that diverse organic sources can effectively maintain soil quality and yield levels in Indian cropping systems. The successful utilization of Water Hyacinth (T₈) further demonstrates the potential of converting problematic aquatic weeds into nutrient-rich amendments, as found by Lata and Veenapani (2011) [10], who noted its ability to improve soil porosity and moisture retention.

Conclusion

The study demonstrates that invasive weed species such as *Chromolaena odorata*, *Parthenium hysterophorus*, *Cassia* spp. and water hyacinth can be effectively converted into compost and utilized as nutrient sources in maize cultivation. Substitution of 25% of mineral nitrogen with weed-based compost maintained yields comparable to the standard FYM application and significantly outperformed the sole use of chemical fertilizers. This approach provides a dual advantage of managing invasive weed biomass while reducing dependence on inorganic fertilizers.

The integration of weed-based composts with chemical fertilizers proved to be an effective strategy for enhancing maize productivity and yield attributes. The key findings of the study are summarized as follows:

- **Superiority of integrated nutrient management:** Application of 25% nitrogen through weed composts (particularly *Chromolaena*, *Parthenium*, and *Cassia*) in combination with 100% RDF consistently produced superior yield attributes, including cob length, number of kernels per cob, and seed weight, compared to the application of 100% RDF alone.
- **Productivity benchmarks:** The treatment comprising 10 t FYM ha⁻¹ combined with 100% RDF recorded the highest kernel yield (6,301 kg ha⁻¹) and stover yield (9,023 kg ha⁻¹). However, treatments involving weed composts (T₂, T₄, and T₆) were statistically comparable to this standard practice.
- **Fertilizer-saving potential:** A notable outcome of the study is the possibility of reducing chemical fertilizer use by 25%. Treatments receiving weed composts along with 75% RDF (e.g., T₅) produced significantly higher yields than the 100% RDF-alone treatment, indicating improved fertilizer use efficiency through organic amendments.
- **Resource valorization:** Composting invasive weeds such as *Chromolaena odorata*, *Parthenium*, and water hyacinth serves as a sustainable and cost-effective nutrient source for farmers while offering an environmentally sound approach to managing problematic weed biomass.

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