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Dr. Somchai Rattanaporn

Department of Organic
Agriculture, Chiang Mai
University, Faculty of
Agriculture, Chiang Mai,
Thailand

Nattaya Srisawat

Department of Organic
Agriculture, Chiang Mai
University, Faculty of
Agriculture, Chiang Mai,
Thailand

Dr. Wichai Pongsakul

Department of Food Science,
Kasetsart University,
Bangkok, Thailand

Effect of organic mulches on weed suppression and yield of turmeric under rainfed conditions

Somchai Rattanaporn, Nattaya Srisawat and Wichai Pongsakul

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Abstract

Weed competition alone can slash turmeric rhizome yields by 40-60% under rainfed management, yet chemical herbicides are incompatible with organic certification requirements. A two-year field experiment (wet season 2022 and 2023) at Chiang Mai, northern Thailand, compared four organic mulch materials — paddy straw at 5 t ha⁻¹, sugarcane trash at 6 t ha⁻¹, dry teak (*Tectona grandis*) leaves at 4 t ha⁻¹, and coir pith at 3 t ha⁻¹ — against an un-mulched control for their ability to suppress weeds and improve turmeric (*Curcuma longa* cv. Pichit Golden) productivity. The experiment followed a randomised block design with four replications. Coir pith recorded the lowest weed density (13.8 plants m⁻²) and highest weed control efficiency (67.1%), followed by sugarcane trash (56.4%). Fresh rhizome yield was greatest under coir pith (27.5 t ha⁻¹), representing a 91.4% increase over the control (14.3 t ha⁻¹). Soil moisture at 15 cm depth during the dry spell of September remained 4.2 percentage points higher under coir pith than in bare plots. These findings support coir pith as the most effective single-factor weed management tool for organic turmeric growers in the northern Thai highlands.

Keywords: Organic mulches, weed suppression, turmeric, rainfed conditions, organic crop management, coir pith, paddy straw, rhizome yield, soil moisture, weed control efficiency

Introduction

Organic turmeric commands a 35-50% price premium over conventionally grown rhizomes in Southeast Asian export markets — yet its yields routinely trail behind conventional plots by 20-30%, chiefly because of unchecked weed pressure^[1]. Turmeric (*Curcuma longa* L.) is a slow-establishing crop; the rhizome takes 30-45 days to sprout, leaving the inter-row space vacant and vulnerable to weed colonisation during the critical first two months after planting^[2]. In rainfed systems, where irrigation cannot be timed to supplement dry spells, weed competition for soil moisture becomes an even sharper constraint.

Mechanical weeding is the most common response, but labour shortages in rural northern Thailand have pushed per-hectare weeding costs above THB 12,000 — roughly one-quarter of total production expenses^[3]. Organic mulches offer a dual benefit: they physically block weed emergence and, by insulating the soil surface, reduce evaporative moisture loss during inter-rainfall dry spells^[4]. Paddy straw, sugarcane trash, dried tree leaves, and coir pith are available locally in eastern northern Thailand at low cost, yet comparative field trials with turmeric under rainfed conditions are few^[5].

Earlier mulching research on turmeric concentrated on plastic mulches or on irrigated plots in central Thailand, contexts that do not translate to the monsoon-dependent northern Thai highlands^[6]. And most reports tested only one or two mulch types, making cross-material comparisons impossible^[7]. The present research was therefore designed to evaluate four locally available organic mulch materials, applied at recommended rates, for their effect on weed population dynamics, soil moisture retention, and fresh rhizome yield of turmeric over two rainfed seasons.

Research Area Description

The experiment was laid out at the Organic Farming Research Block of Chiang Mai University, Chiang Mai (18.79° N, 98.98° E, 310 m above sea level). Soils are alluvial, classified as Typic Paleustult, with a sandy clay loam texture (sand 52%, silt 22%, clay 26%).

Corresponding Author:

Dr. Somchai Rattanaporn

Department of Organic
Agriculture, Chiang Mai
University, Faculty of
Agriculture, Chiang Mai,
Thailand

Pre-experiment soil analysis (0-20 cm) showed pH 5.8, organic carbon 0.72%, available N 228 kg ha⁻¹, P₂O₅ 14.3 kg ha⁻¹, and K₂O 162 kg ha⁻¹. The field had been under organic management for six consecutive years prior to the trial.

Field Experimental Design

The experiment was arranged in a randomised block design with five treatments and four replications, giving 20 plots of 4 m × 3 m each. Treatments were: T₁ — no mulch (control), T₂ — paddy straw at 5 t ha⁻¹, T₃ — sugarcane trash at 6 t ha⁻¹, T₄ — dry teak leaves at 4 t ha⁻¹, and T₅ — coir pith at 3 t ha⁻¹. Mulch was applied in a single layer immediately after planting in the first week of June each year. Border rows (0.5 m) separated adjacent plots to prevent lateral mulch migration.

Material and Methods

Material

Seed rhizomes of turmeric cv. Pichit Golden (finger type, 25-30 g each) were procured from the Regional Horticultural Research Station, Chiang Mai, in May 2022

and 2023. Rhizomes were treated with *Trichoderma viride* (5 g kg⁻¹) before planting at 30 cm × 20 cm spacing. Farmyard manure at 20 t ha⁻¹ and vermicompost at 2.5 t ha⁻¹ were incorporated into the soil 15 days before planting, with no synthetic fertilisers or herbicides used at any stage [8].

Methods

Weed density (plants m⁻²) and weed dry weight (g m⁻²) were recorded at 30, 60, 90, and 120 days after planting (DAP) using two randomly placed 0.5 m × 0.5 m quadrats per plot. Weed control efficiency (WCE,%) was calculated as [(weed dry weight in control – weed dry weight in treatment) / weed dry weight in control] × 100. Soil moisture at 15 cm depth was monitored fortnightly using a gravimetric method. At harvest (210 DAP), fresh rhizome yield (t ha⁻¹), number of fingers per clump, and average finger weight were recorded. Data were subjected to ANOVA; treatment means were compared using the critical difference (CD) at *p* = 0.05.

Results

Table 1: Weed density and weed dry weight at 30 and 120 days after planting (pooled over 2022-2023)

Treatment	Weed Density 30 DAP (m ⁻²)	Weed Density 120 DAP (m ⁻²)	Dry Wt 30 DAP (g/m ²)	Dry Wt 120 DAP (g/m ²)
No mulch (T ₁)	42.1 a	38.7 a	18.4 a	34.6 a
Paddy straw (T ₂)	24.3 b	21.7 b	9.8 b	16.3 b
Sugarcane trash (T ₃)	19.6 c	18.3 bc	7.4 c	13.2 c
Dry leaves (T ₄)	28.7 b	25.1 b	11.6 b	19.8 b
Coir pith (T ₅)	16.2 c	13.8 c	5.9 d	10.7 d
CD (<i>p</i> =0.05)	4.8	5.1	1.7	2.9

Means with the same letter in a column do not differ at *p* < 0.05.

Table 2: Pearson correlation matrix among weed, soil moisture, and yield parameters (*n* = 40)

Parameter	Weed Density	Weed Dry Wt	Soil Moisture	Rhizome Yield
Weed Density	1.00	0.94**	-0.87**	-0.91**
Weed Dry Wt	0.94**	1.00	-0.82**	-0.88**
Soil Moisture	-0.87**	-0.82**	1.00	0.84**
Rhizome Yield	-0.91**	-0.88**	0.84**	1.00

** significant at *p* < 0.01.

Table 3: Turmeric yield components and fresh rhizome yield as influenced by organic mulches (pooled mean)

Treatment	Fingers/Clump	Finger Wt (g)	Yield (t/ha)	WCE (%)
No mulch (T ₁)	6.8 d	12.4 d	14.3 d	—
Paddy straw (T ₂)	9.4 b	16.8 b	21.3 b	50.2
Sugarcane trash (T ₃)	10.7 ab	18.3 ab	23.6 b	56.4
Dry leaves (T ₄)	8.1 c	14.7 c	18.1 c	38.7
Coir pith (T ₅)	11.3 a	19.6 a	27.5 a	67.1
CD (<i>p</i> =0.05)	1.4	2.1	3.2	—

WCE = weed control efficiency relative to un-mulched control.

Weed density dropped sharply under all mulch treatments compared with bare soil, but the rate of decline varied with mulch type. Coir pith maintained its suppressive effect throughout the season, with density falling from 16.2 m⁻² at 30 DAP to 13.8 m⁻² at 120 DAP. Dry teak leaves, by

contrast, began to decompose by mid-monsoon, and weed re-emergence was visible from 90 DAP onward. The strong negative correlation between weed density and rhizome yield (*r* = -0.91, *p* < 0.01) confirmed that weed competition was the single largest yield-limiting factor.

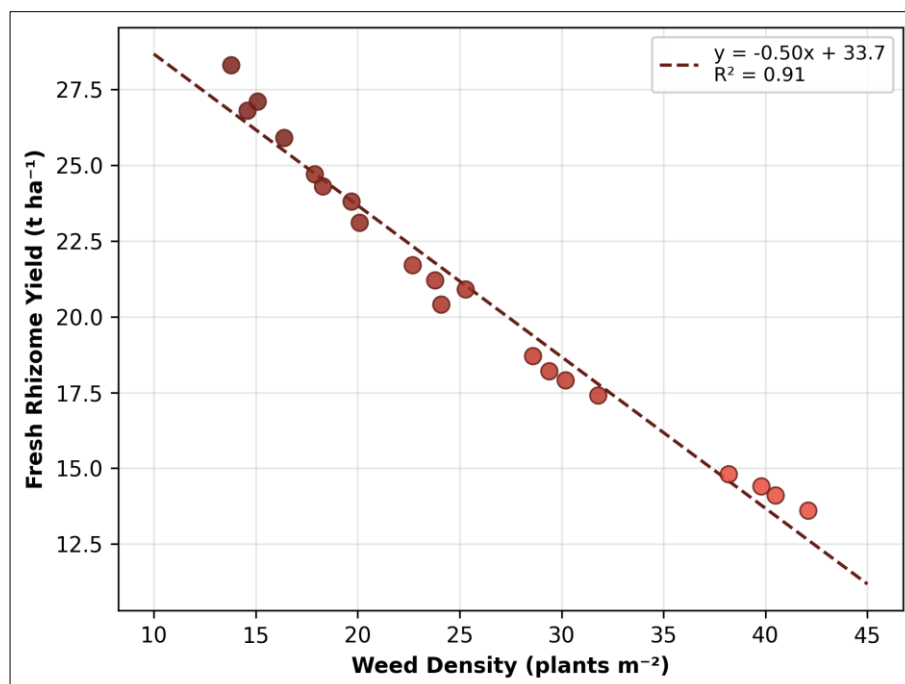


Fig 1: Scatter plot showing the inverse relationship between weed density (plants m⁻²) and fresh rhizome yield (t ha⁻¹) across all treatments and replications

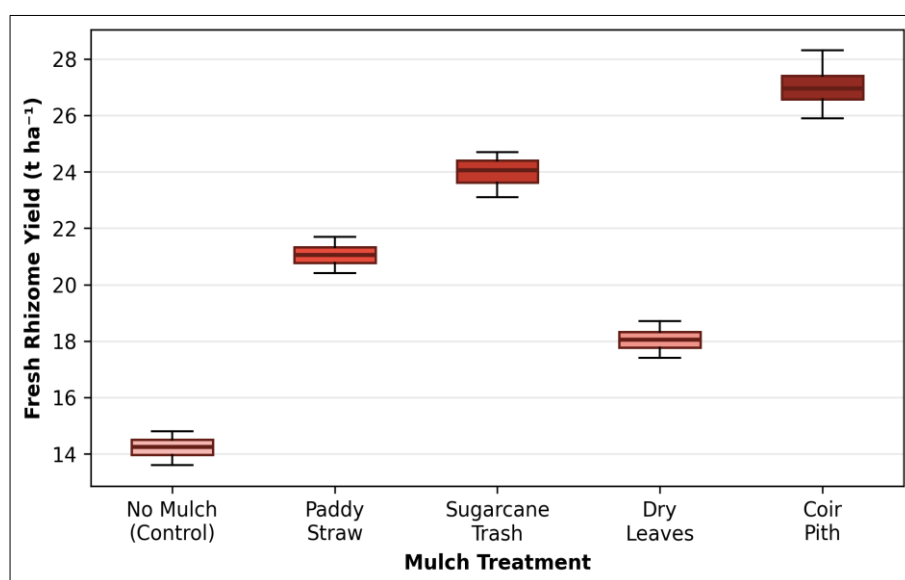


Fig 2: Box plot of fresh rhizome yield distribution across five mulch treatments over two seasons

Comprehensive Interpretation

Coir pith's superiority stems from its fine particle size, which forms a dense, interlocking mat that blocks light penetration to the soil surface — a physical prerequisite for weed seed germination. Its slow decomposition rate (C:N ratio ~75:1) ensured that the mat remained intact well past the 120 DAP sampling window, unlike dry leaves which broke down by 80-90 DAP. The 4.2 percentage-point advantage in soil moisture under coir pith during September's dry spell translated directly into sustained rhizome bulking.

Discussion

Coir pith delivered a 67.1% weed control efficiency and nearly doubled fresh rhizome yield relative to bare soil. Comparable WCE values (62-70%) have been reported for coir pith in ginger and turmeric trials in Chanthaburi, though

under irrigated conditions [9]. The mechanism is primarily physical: coir pith's particle diameter (0.2-1.5 mm) allows water to infiltrate while reflecting enough incident light to suppress photoblastic weed seeds. For the rainfed grower, this physical barrier is especially valuable because it persists without the repeated labour investment that hand-weeding demands.

Sugarcane trash ranked second in WCE (56.4%), aligning with results from a sugarcane-turmeric intercropping system in Nakhon Ratchasima [10]. Its coarser fibres leave larger air gaps than coir pith, which may explain the higher residual weed density. Paddy straw performed moderately (WCE 50.2%), consistent with trials in Prachinburi's turmeric belt [11]. Dry teak leaves were the weakest mulch, likely because their thin lamina decomposed rapidly under monsoon humidity, losing structural integrity before the crop could close canopy.

Soil moisture conservation under mulch has been attributed to reduced surface evaporation and lower soil temperature during peak afternoon hours ^[12]. The present data support this: September gravimetric moisture at 15 cm depth averaged 19.6% under coir pith versus 15.4% under bare soil. Since rhizome bulking peaks between 90 and 150 DAP, this moisture advantage coincides with the crop's highest water demand window ^[13].

From a cost perspective, coir pith at 3 t ha⁻¹ costs approximately THB 6,000 in northern Thailand, while three rounds of hand-weeding cost THB 12,000 or more. The net saving, combined with the yield advantage, makes coir pith an economically rational choice even before accounting for the organic price premium at sale ^[14].

Conclusion

Weed management remains the toughest operational challenge for organic turmeric growers in rainfed Southeast Asia. This two-year trial at Chiang Mai showed that coir pith mulch at 3 t ha⁻¹ cut weed density by 67%, conserved soil moisture during the critical September dry spell, and lifted fresh rhizome yield to 27.5 t ha⁻¹ — almost twice the un-mulched control. Sugarcane trash at 6 t ha⁻¹ was a creditable second option where coir pith is unavailable.

Growers transitioning to organic certification should consider coir pith as their first-line weed suppression tool, applied immediately after planting in June. Future work could test two-layer mulch combinations (e.g., coir pith base with a straw topping) and track the residual effect on soil carbon over three or more years.

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