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EFFECT OF ORGANIC MULCHING ON WEED SUPPRESSION, GROWTH AND YIELD OF RICE VARIETIES IN PORT HARCOURT, RIVERS STATE

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Abstract

This study investigated the effects of organic mulching on weed suppression, growth, and yield of upland rice (UPN 304) in Port Harcourt, Rivers State, Nigeria. A randomized complete block design with four treatments (sawdust, wood shavings, dried guinea grass, and control) and four replications was employed. Mulch materials were applied at 2kg per plant with 2cm thickness at 2 weeks after planting. Data were collected on growth parameters (plant height, leaf area, number of leaves, and tillers), yield components (fresh and dry weight of tillers, number and weight of panicles, 100-grain weight), and weed biomass at two-week intervals from 4-12 weeks after planting. Results showed no significant differences ($p > 0.05$) in growth parameters among treatments, though sawdust achieved the highest plant height (45.20 cm). Dried grass mulch significantly increased fresh tiller weight (6788.89 kg/ha) compared to control (3166.67 kg/ha), while wood shavings produced the highest 100-grain weight (45333.33 kg/ha). Unexpectedly, control plots demonstrated better weed suppression than mulched treatments, possibly due to late mulch application. Wood shavings and dried grass are recommended for enhanced rice yield, though application timing requires optimization for effective weed management.

Keywords: Rice production, organic mulching, weed suppression, sawdust, wood shavings, guinea grass, yield components

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Introduction

Rice, classified under the genus *Oryza*, encompasses two cultivated species (*Oryza sativa* and *Oryza glaberrima*) and 22 wild species. While *Oryza sativa* enjoys global cultivation, *Oryza glaberrima* has been traditionally grown in West Africa for more than a millennium. Rice cultivation occurs under diverse environmental conditions and production systems, with submersion in water being the predominant method worldwide. Uniquely among cereal crops, rice can survive extended periods in standing water. Global rice cultivation distribution shows 57% on irrigated land, 25% on rainfed lowland, 10% on uplands, 6% in deepwater environments, and 2% in tidal wetlands (Chopra and Prakash, 2002).

As the staple food for 2.5 billion people globally, rice occupies 9% of the earth's arable land and represents possibly the oldest domesticated grain with approximately 10,000 years of cultivation history. Rice contributes 21% of global human per capita energy and 15% of per capita protein requirements (IRRI, 2002). In Asia, particularly among economically disadvantaged populations, rice accounts for 50-80% of daily caloric intake, making it nutritionally critical (IRRI, 2001). Asia dominates global rice production with over 90% of total output, led by China, India, and Indonesia. Approximately 85% of global rice production serves direct human consumption, while only 6-7% enters international trade markets. Beyond direct consumption, rice finds applications in cereals, snack foods, beverages, flour, oil, syrup, and religious ceremonies.

Mulching represents a soil management practice involving surface coverage to create favorable conditions for plant growth, development, and efficient crop production. While natural mulches including leaves, straw, and compost have been utilized for centuries, the past six decades have witnessed the introduction of synthetic materials that have transformed mulching methods and benefits. Mulching prevents direct soil moisture evaporation, thereby reducing water losses and surface soil erosion. The evaporation suppression effect also prevents salt-containing water rise, which proves particularly valuable in regions with high-salinity water sources (Yang et al., 2003).

Weed infestation constitutes a major biological constraint in rice production, particularly in direct seeded rice systems due to concurrent emergence of competitive weeds and the absence of water for weed suppression during seedling emergence. Weeds negatively impact yield, quality, and production costs through competition for growth factors (Singh, 2001). Due to their superior adaptability and rapid growth characteristics, weeds dominate crop habitats and diminish yield potential. Yield losses from weed competition typically range from 15-20%, but severe infestations can exceed 50% or result in complete crop failure (Hasanuzzaman et al., 2009).

Objectives

The main objective of this study is to determine the effect of mulching on weed suppression, growth and yield of rice varieties in Port Harcourt, Rivers State. The specific objectives are to:

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i. Determine the effect of the treatments on rice growth parameters. ii. Evaluate the effect of mulching on suppression of weed growth in rice field. iii. Assess the effect of treatments on the yield and yield components of rice.

Conceptual Review

Rice Production in Nigeria: Rice serves as an important commodity contributing significantly to Nigerian food requirements and is cultivated across all agro-ecological zones. Rice production in Nigeria began in 1500 BC with the indigenous red grain species *O. glaberrima* Steud, initially widespread in the Niger Delta region. Nigeria has emerged as West Africa's leading rice producer and Africa's third-largest, following Egypt and Madagascar (WARDA, 1996). Production peaked in 1990 at 3.4 million tons from approximately 1.2 million hectares before experiencing fluctuations. Current estimated annual rice demand reaches 5 million metric tonnes, while local production achieves only 2.21 million metric tonnes, creating an annual deficit of 2.79 million metric tonnes bridged through imports costing approximately N360 billion annually (Imolehin and Wada, 2000).

Factors Affecting Rice Production: Rice production faces both abiotic and biotic constraints. Abiotic factors include drought/flooding, low soil fertility, salinity, iron toxicity, and alkalinity, while biotic factors encompass weeds, insect pests, and diseases (WARDA, 1996). Among biotic factors, weeds pose the most significant constraint to increasing rice productivity (Parthipani et al., 2013). Uncontrolled weed growth causes 33-45% reduction in grain yield, with delayed weeding leading to increased weed biomass and drastic yield reductions, making weed control paramount for lowland rice production enhancement.

Effects of Organic Mulch on Soil and Water Loss: Mulch provides various confirmed ecological functions, particularly soil protection following wildfires. Mulch reduces runoff, sediment, and nutrient content in runoff by increasing ground surface roughness and reducing overland flow rates and runoff velocity. Mulch effectively retains soil moisture through reduced evaporation and increased infiltration while improving soil properties. Short-term mulching conserves soil nutrients by reducing runoff and sediment, while long-term mulching significantly increases soil organic matter and available nutrients through decomposition. Straw, being easily decomposed, benefits soil enzyme activity and promotes fungal and bacterial growth (Singh, 2001).

Mulching Effects on Soil Physico-chemical Properties: Mulches find widespread application in agricultural lands, orchards, forests, and landscapes globally, generally reducing weed competition, maintaining soil temperature, and reducing soil evaporation. Mulches improve soil properties by enhancing moisture retention capacity, releasing nutrients, and promoting biological activities, resulting in improved plant growth (Siwek et al., 2015). Each mulch type possesses specific characteristics, with selection depending on soil type, climate, and plant nutritional requirements. Application of straw and grass mulch significantly increases available phosphorus and potassium in soil, though some mulches (straw, peat, sawdust) may negatively affect crops by depleting soil nitrogen due to wide C:N ratios.

Impact of Mulch on Weed Infestation in System of Rice Intensification (SRI) Farming: SRI represents an innovative methodology increasing rice yield through altered management of soil, nutrients, plants, and water (CIIFAD, 2014). SRI components include transplanting young seedlings (<15 days old), single seedling per hill, wide planting geometry (25×25cm or more), and moist soil conditions during vegetative stages. SRI offers numerous advantages including at least 50% yield increase, 80-90% seed savings, 50% water savings, and reduced production costs. However, SRI's major challenge involves weed infestation due to alternate wetting and drying, wider planting geometry, and aerobic environments (Krupnik et al., 2012). Rice straw from SRI systems can serve as natural herbicide through phenolic compound release during degradation, providing effective weed suppression while recycling nutrients as organic fertilizer.

Economic Importance of Weeds: Rice grain yield losses from weeds vary with cultivation type, geographic region, and environmental/cultural factors associated with rice agro-ecosystems (Larimar, 2008). Weeds represent the primary pest farmers must address for increased production due to severe competition for light, nutrients, water, and space. Uncontrolled weed growth during critical rice growth periods (first four weeks after sowing) can contribute to nearly 100% yield reduction. Beyond yield reduction, weeds decrease harvested produce market value by harboring harmful insects and disease-causing organisms, making early-stage weed control crucial (Singh, 2010).

Weed Management Practices: Effective weed management employs multiple approaches including cultural practices (proper agronomic management, suitable crop establishment methods, efficient fertilizer use, proper crop stand, and competitive cultivar selection), flooding (important for lowland rice as many weeds cannot germinate in anaerobic conditions), manual weeding (traditional hand and hoe weeding practiced 2-3 times per crop cycle), mechanical weeding (rotary and cono weeders reducing labor costs by 6.6-7.6 times compared to hand weeding), chemical control (herbicide application offering labor-saving benefits but risking weed flora shifts and herbicide resistance), and integrated weed management (combining multiple methods to improve herbicide efficiency through rational usage with better crop management options).

Methodology

Research Location

The investigation was conducted at the Agricultural Research and Teaching Farm of the University of Port Harcourt, Nigeria during the period spanning January through August 2021. The research location is situated between latitudes 400 31N and 5000N and longitudes 6° 45" E and 70°E, characterized by mean temperatures of 27°C, relative humidity levels of 78%, and annual precipitation ranging from 2500 to 4000mm (Nwankwo and Ehirim, 2010). Weather data including air temperature, humidity levels, sunshine duration, wind velocity, precipitation, and evaporation were documented at the University of Port Harcourt's Abuja Campus.

Soil Properties

Mixed soil specimens were collected from randomly chosen locations within the experimental area from the 0-15 cm depth before crop establishment. The specimens were air-dried under shade, pulverized, and passed through a 2 mm mesh screen before being analyzed for physical, mechanical, and chemical characteristics. Laboratory analysis was performed on the soil specimens to assess their nutritional composition.

Planting Material Origin

The upland rice cultivar employed in this investigation was the University of Port Harcourt Nigeria 304 (UPN 304), sourced from the Faculty of Agriculture's rice unit seed repository. Mulching materials included sawdust and wood chips purchased from a lumber mill in Rumuosi, located near the University. Guinea grass was collected prior to flowering from the University farm and subsequently dried.

Experimental Arrangement

The field trial was organized using a Randomized Complete Block Design incorporating four (4) treatments with four (4) repetitions. Individual plots measured 3m × 3m with 1m pathways separating plots and 0.5m spacing between repetitions. Plant spacing was maintained at 30cm × 30cm both between and within rows. The seeding rate was established at 100 seeds per plot. The treatments consisted of various mulching materials as follows: Sawdust, Wood chips, Dried guinea grass, and Control (No mulching). The mulching materials were dried and distributed at 2kg per plant with a 2cm thickness using ring application method fourteen days post-planting (2WAP). Manual weeding using hoes was performed in non-mulched plant areas. Bird deterrence during the grain-filling phase was achieved using scarecrows. Quadrat sampling was employed on each plot to document weed density and species composition.

3.5 Data Gathering

Information was gathered biweekly commencing at 4 weeks post-planting (4 WAP) from 4 plants within each plot. The measured parameters included:

3.5.1 Growth Parameters

Plant stature: Plant height was assessed using a graduated measuring stick from ground level to the apex of the tallest leaf.

Leaf surface area: Leaf area was calculated using the formula LA = a . (L.W), where LA represents leaf area (cm2), L denotes leaf length (cm), W indicates maximum leaf blade width (cm), and a represents the angular coefficient or linear regression slope (Fagundes *et al*., 2009, Schwab *et al*., 2014).

Leaf count: This parameter was assessed through counting at biweekly intervals beginning at 4WAP.

Tiller count: This was similarly determined by enumerating tillers at biweekly intervals starting at 4WAP.

Production Parameters

Tiller mass: Tiller weight was recorded for both fresh and dried samples. Fresh weight was obtained by severing tillers at the plant base and weighing immediately. Tillers were sun-dried for approximately two weeks before recording dry weight.

Panicle mass: Panicle weight was measured following threshing. The panicles were weighed in their dried state using a precision balance. Panicles were sun-dried prior to weight determination.

Grain production: Grain weight was also recorded post-threshing. Grains were separated from panicles and weighed using a precision balance.

Data Analysis

Collected data underwent Analysis of Variance (ANOVA) using GenStat Release version 12.1, and statistically significant treatment means were evaluated using the least significant difference (LSD) test at the 5% probability threshold.

3 Results

Soil Physiochemical Properties: The experimental site soil characteristics before planting showed sandy texture (92.40% sand, 3.15% silt, 1.10% clay) with slightly acidic pH (4.69), low total organic matter (2.60%), low nitrogen content (0.08%), adequate exchangeable potassium (0.13%), and available phosphorus of 17.50 mg/kg (Table 1)

Table 1: Physiochemical Properties of the Experimental site before Planting

Soil properties	Value
Physical Characteristics	
Sand (%)	92.40
Silt (%)	3.15
Clay (%)	1.10
Textural class	Sandy
Chemical Characteristics	
pH (H_2O)	4.69
Organic Carbon	1.35
Organic matter	2.60
Total Nitrogen (%)	0.08
Available P (mg/kg)	17.50
Ca	2.00

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Soil properties	Value
Mg	0.20
K	0.13
Na	0.05

Plant Height: Four weeks after planting showed no significant difference ($p > 0.05$) in mulch application effects on plant height. However, sawdust mulching treatment achieved the highest mean plant height (45.20 cm) at 12 WAP (Table 2).

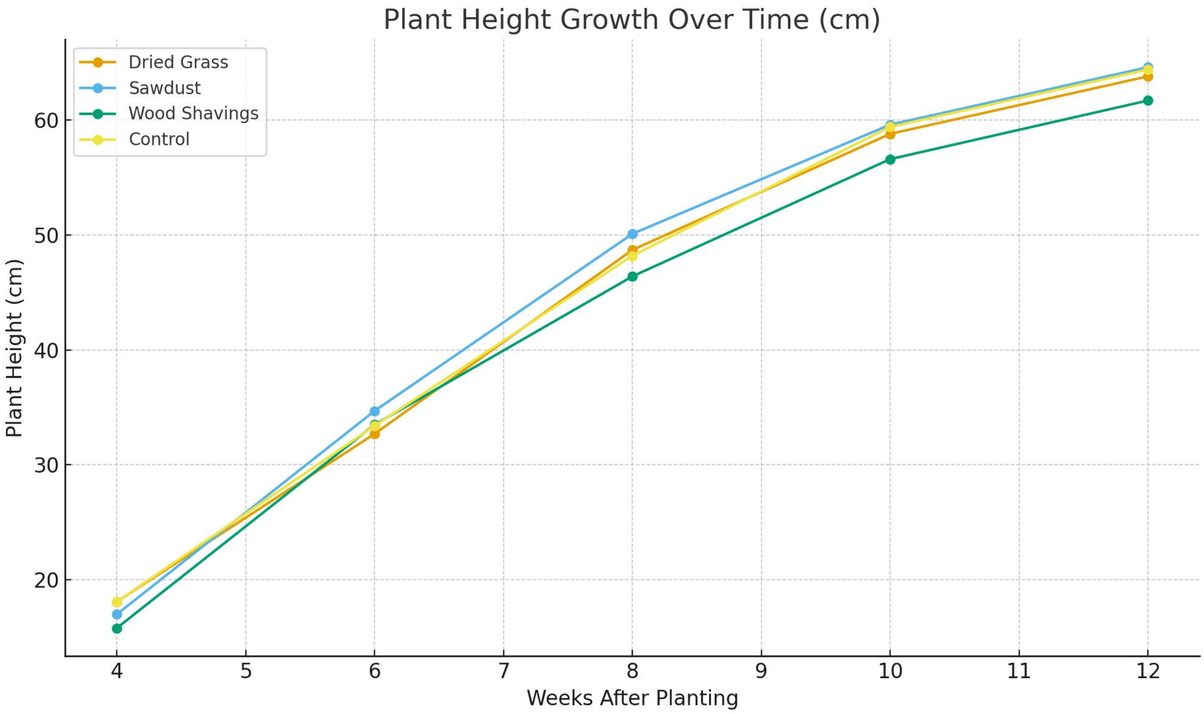
Table 2: Effect of Mulching on Plant Height (cm) in an *Oryza sativa* Plot

Treatment	Weeks After planting					Mean
	4	6	8	10	12	
DG	18.10	32.70	48.70	58.80	63.80	44.50
SD	17.00	34.70	50.10	59.60	64.60	45.20
WS	15.80	33.50	46.40	56.60	61.70	42.80
CO	18.10	33.40	48.20	59.40	64.40	44.70
LSD (p = 0.05)	3.90	5.90	6.50	6.70	6.70	

DG = Dried grass, SD = Sawdust, WS = Wood shavings, CO = Control

Leaf Area: Similar to plant height, mulch application showed no significant difference ($p > 0.05$) on leaf area. Wood shaving mulching treatment encouraged the highest leaf area mean (32.00 cm^2) at 12 WAP (Table 3).

Figure 1: Effect of different mulching treatments on plant height (cm) of upland rice (UPN 304) over 12 weeks after planting in Port Harcourt, Rivers State



Values represent means of four replications. DG = Dried grass, SD = Sawdust, WS = Wood shavings, CO = Control. No significant differences observed between treatments (p > 0.05)

Table 3: Effect of Mulching on Leaf area (cm²) in an *Oryza sativa* Plot

Treatment	Weeks After planting					Mean
	4	6	8	10	12	
DG	5.98	17.24	27.50	48.60	55.40	30.90
SD	6.20	18.86	28.50	46.70	57.20	31.50
WS	5.60	17.60	28.70	48.90	59.20	32.00
CO	6.91	17.14	24.40	42.60	54.10	29.00
LSD (p = 0.05)	2.50	5.30	7.00	11.90	14.00	

DG = Dried grass, SD = Sawdust, WS = Wood shavings, CO = Control

Number of Leaves: No significant difference ($p > 0.05$) was observed in mulch application effects on leaf number. Control treatment achieved the highest leaf number mean (23.50) at 12 WAP (Table 4).

Table 4: Effect of Mulching on Number of Leaves in an *Oryza sativa* Plot

Treatment	Weeks After planting					Mean
	4	6	8	10	12	
DG	4.94	9.50	19.00	29.20	34.20	19.40
SD	4.75	10.38	20.60	28.60	35.80	20.00
WS	4.31	11.12	19.20	29.20	34.20	19.60
CO	5.50	11.60	25.40	35.20	40.10	23.50
LSD (p = 0.05)	1.64	3.40	7.90	7.40	8.00	

DG = Dried grass, SD = Sawdust, WS = Wood shavings, CO = Control

Number of Tillers: Mulch application showed no significant difference ($p > 0.05$) on tiller number. Control treatment recorded the highest mean tiller number (5.30) at 12 WAP (Table 5).

Table 5: Effect of Mulching on Number of Tillers in an *Oryza sativa* Plot

Treatment	Weeks After planting					Mean
	4	6	8	10	12	
DG	0.00	1.88	4.30	6.60	8.60	4.30
SD	0.06	2.19	4.10	6.20	8.20	4.10
WS	0.00	2.25	4.50	6.80	8.70	4.50
CO	0.12	3.25	5.40	7.90	9.90	5.30
LSD (p = 0.05)	0.19	1.40	2.30	2.10	2.40	

DG = Dried grass, SD = Sawdust, WS = Wood shavings, CO = Control

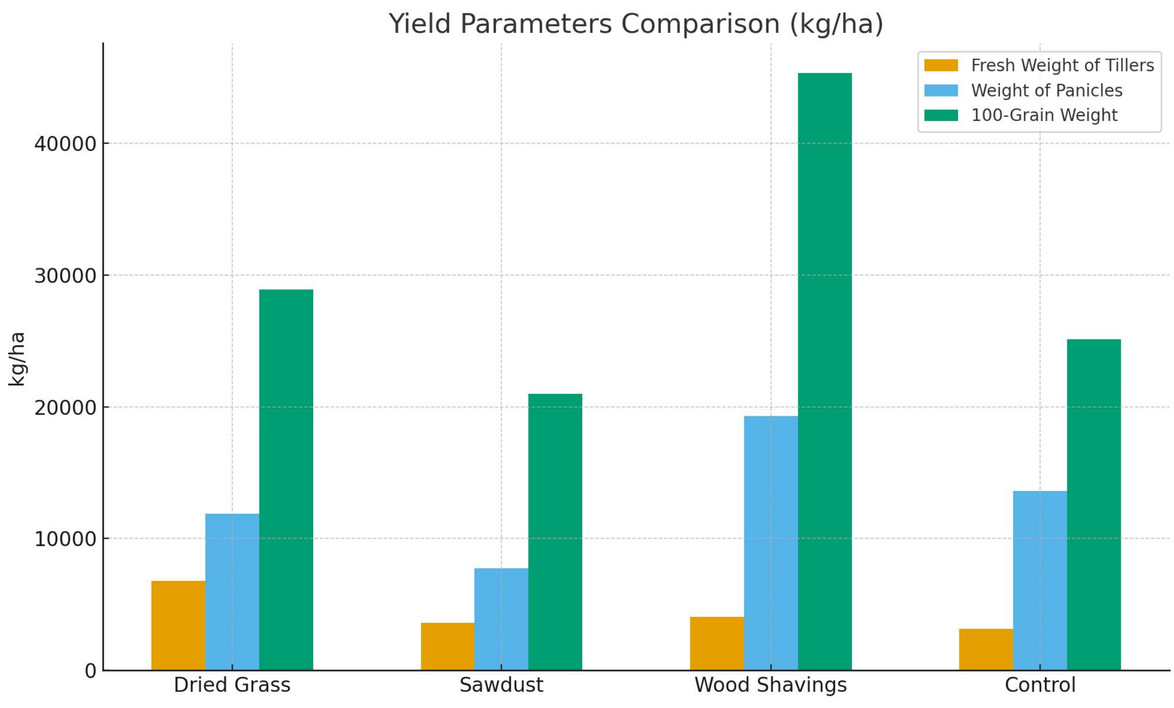
Yield Parameters: Dry grass mulch application resulted in maximum fresh weight yield of rice tillers (6788.89 kg/ha), significantly higher ($p < 0.05$) than control (3166.67 kg/ha). Similar trends were observed in dry weight yield of tillers. Dried grass and wood shavings produced the highest number of (Table 6). panicles yield (56444.44 kg/ha). Wood shaving treatment recorded the highest rice panicle weight (45333.33 kg/ha), significantly higher than control (28888.89 kg/ha). For 100-grain weight, wood shavings achieved the highest weight (45333.33 kg/ha), followed by dried grass (28888.89 kg/ha)

Table 6: Effect of Mulching on Yield of *Oryza sativa*

Treatment	FWOT (kg/ha)	DWOT(kg/ha)	NOP (kg/ha)	WOP(kg/ha)	100 Grain Weight(kg/ha)
DG	6788.89	2944.44	56444.44	11888.89	28888.89
SD	3588.89	3211.11	34666.67	7744.44	21000.00
WS	4077.78	3666.67	56444.44	19300.00	45333.33
CO	3166.67	3722.22	49111.11	13588.89	25111.11
LSD (p = 0.05)	1.38	0.94	6.95	4.40	10.85

FWOT = fresh weight of tillers, DWOT = dry weight of tillers, NOP = number of panicles, WOP = weight of panicles, CO = Control

Figure 2: Yield Parameters Comparison



FWOT = Fresh weight of tillers, WOP = Weight of panicles. Values are means of four replications. Bars with different patterns indicate significant differences at p < 0.05. Dried grass showed significantly higher fresh tiller weight, while wood shavings achieved highest panicle weight and 100-grain weight

Weed Suppression: No significant difference ($p > 0.05$) was observed in mulch application effects on various treatments for fresh weight measurements. Similar trends were noted for dry weight measurements. However, significant difference ($p < 0.05$) existed between weeds in dried grass treatment and control for dry weight measurements (Tables 7 and 8).

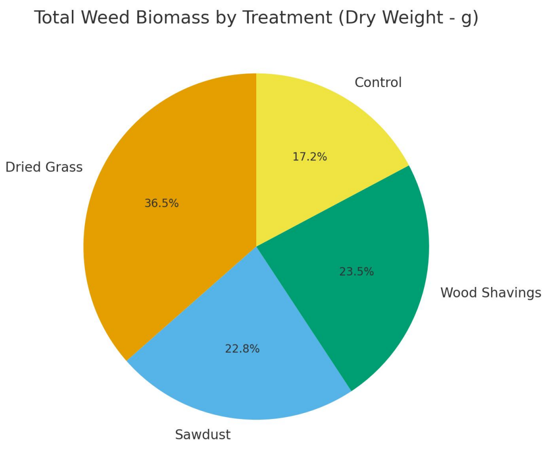
Table 7: Fresh weight of Weeds Collected in the Plots

Treatment	Broad leaves	Grasses
Dried grass	43.50	15.70
Sawdust	30.50	8.10
Wood shaving	28.90	4.80
Control	26.60	2.40
LSD (p = 0.05)	11.10	5.60

Table 8: Dry weight of Weeds Collected in the Plots

Treatment	Broad leaves	Grasses
Dried grass	12.33	5.64
Sawdust	7.90	3.33
Wood shaving	9.38	2.19
Control	7.48	1.01
LSD (p = 0.05)	3.32	1.70

FIGURE 3: TOTAL WEED BIOMASS BY TREATMENT



Values represent combined broad leaves and grass weed dry weight (g) per treatment. Unexpectedly, control treatment showed lowest total weed biomass, indicating better weed suppression compared to mulched treatments, possibly due to late mulch application timing

Discussion

The investigation examined mulch material effects on upland rice variety and weed suppression, revealing no significant differences in mulching treatments on growth parameters (plant height, leaf area, number of leaves, and tillers), though sawdust and wood shaving consistently demonstrated higher means. These findings contrast with Siwek et al. (2015), who reported that mulches significantly improve plant growth by enhancing moisture retention capacity and releasing nutrients. The lack of statistical significance in this study suggests that while mulching materials may influence rice growth parameters, the effects were not pronounced during the experimental period, possibly due to the timing of mulch application or the specific environmental conditions of the study site, as noted by Hasanuzzaman et al. (2009) who emphasized that early season growth shows greater response to mulching.

Yield parameter analysis demonstrated significant improvements with organic mulch applications, particularly dried grass and wood shavings, which substantially increased rice yield components. This aligns with previous research by Iqbal et al. (2020), who reported that locally produced wood debris such as wood shavings enhance soil fertility, increase farmer income, and improve crop growth and development performance. Similarly, Chalker-Scott (2007) noted that uncomposted bark or dried grass materials can improve soil conditions without negatively affecting plant nutrition. The superior performance of wood shavings and dried grass can be attributed to their faster decomposition rates, which facilitate quicker nutrient release to plants compared to control treatments (Singh, 2001), ultimately ensuring higher rice grain yields. This finding supports the work of Bird et al. (2002), who demonstrated that organic mulches increase soil fertility, particularly potassium and nitrogen content.

The weed suppression results revealed an unexpected outcome where control plots (without mulches) performed better in weed suppression compared to mulched treatments, particularly evident in the significantly higher weed biomass in dried grass treatments. This counterintuitive finding contradicts the general expectation that mulches serve as effective weed barriers (Bamidele et al., 2010; Gruber et al., 2008). However, this outcome aligns with observations by Döring et al. (2005), who noted that straw mulch can sometimes promote weed growth under certain conditions. The unexpected results may be attributed to several factors including late application of mulch materials (2 weeks after planting), inadequate quantities of mulch applied, or the initial nutrient availability in control plots that may have favored rice growth over weed competition (Diary et al., 2015). Additionally, the decomposition process of organic mulches may have initially provided favorable conditions for both rice and weed growth, as suggested by Yang et al. (2003), who noted that organic mulches can alter soil microbial communities.

The overall study findings indicate that while organic mulches, especially dried grass and wood shavings, significantly improved rice yield parameters, their effectiveness in weed suppression was limited under the experimental conditions employed. The enhanced yield performance can be

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attributed to improved soil fertility through organic matter decomposition, better moisture retention, and nutrient release from mulching materials, as documented by Gill et al. (1996) and Sharma and Sharma (2003). However, the timing and method of mulch application appear crucial for maximizing weed suppression benefits, supporting the recommendations of Haden et al. (2007) for integrated weed management systems. This suggests that earlier application or alternative application methods might yield different results, as emphasized by Singh (2010) who noted that timing is critical in weed management practices. The study's findings align with Mohammed et al. (2019), who identified the importance of addressing multiple constraints in rice production, including the need for sustainable soil fertility management approaches.

Conclusion

Results demonstrated that mulches, particularly dried grass and wood shavings, exhibited faster decomposition rates facilitating quicker nutrient release to plants compared to control treatments, thereby ensuring higher rice grain yields. Although control treatments performed better in weed suppression, this outcome may have resulted from late mulch application, inadequate mulch quantities, or available nutrients in control plots. Consequently, wood shavings and dried grass are recommended as mulching materials for rice production to ensure optimum yields, though consideration should be given to application timing and integrated weed management strategies for comprehensive crop management.

References

Abayomi, O. O. and Esther, O. A. (2010) 'Economic Analysis of Rice Consumption Patterns in Nigeria', Journal of Agricultural Science Technology, 12, pp. 1–11.

Age, A. I., Demenongu and T. S., Ajumah, S.A (2013). Study Of Socio-Economic Importance and Methods Of Controlling Weeds Among Rural Farmers In Yala Local Government Area Of Cross River State, Nigeria. National Journal of Scientific & Technology Research. 2(12) 25-29.

Babar, S.R., Velayutham, A., (2012). Weed Management Practices on Nutrient Uptake, Yield Attributes and Yield of Rice under System of Rice Intensification.Madras Agricultural Journal 99(1/3), 51-54.

Bamidele, F. S., Abayomi, O. O. and Esther, O. A. (2010) 'Economic Analysis of Rice Consumption Patterns in Nigeria', Journal of Agricultural Science Technology, 12, pp. 1–11.

Bioflora, 2013. Definition of Soil Microbe Groups. Retrieved 11/22, 2013, Retrieved from http://www.bioflora.com/soil-microbes.

Bird, J., Eagle, A., Horwath, W., Hair, M., Zilbert, E.,Van Kessel, C., 2002. Long-term Studies Find Benefits, Challenges in Alternative Rice Straw Management. California Agriculture 56(2), 69-75.

Chalker-Scott L (2007) Impact of mulches on landscape plants and the environment - a review. J. Environ. Hortic. 25:239–249., R. (2001). Speciality rices of the world. Science Publishers, Inc, NH, USA. (Gramene Reference ID 8383).

Chaudhary, R. (2001). Speciality rices of the world. Science publishers, Inc. NH, USA. (Gramene Reference ID 8383)

Chopra, V.L. and S. Prakash (2002). Evolution and Adaptation of Cereal Crops. Science Publishers Inc, NH, USA. (Gramene Reference ID 8381).

CIIFAD., 2014. SRI methodology. Retrieved 25 August 2021, Retrieved from http://sri.ciifad.cornell.edu/aboutsri/methods/index.html.

Dairy E. Kebbeh, M., Itafele, S. and Fagade, S.O. (2015). Challenges and opportunities for improving irrigated rice productivity in Nigeria. In Nigeria rice economy in a competitive World: Constraints, opportunitiesand Strategic choic lookes,1-23.

Devasinghe D., Premarathne, K., Sangakkara, U.,(2011). Weed Management by Rice Straw Mulching in Direct Seeded Lowland Rice (Oryza sativa L.).Tropical Agricultural Research 22(3), 263-272.

Döring, T. Brandt, M., Heβ, J., Finckh, M. & Saucke, H., (2005). Effect of straw mulch on soil nitrate dynamics, weeds, yield and soil erosion in organically grown potates. Field Crops Res. Article in press. ScienceDirect, 2005 02 10.

Fagundes I.D, Streck N.A and Kruse N.D (2009). Estimating leaf area of Aspilia monteridensis (Spreng) Kuntze wing linear dimensions. Revista Cores. 56: 266 – 273.

Gill, K.S. Gajri, P.R., Chaudry, M.R. & Singh, B., (1996). Tillage, mulch and irrigation effects on corn (Zea mays L.) in relation to evaporative demand. Soil & Till. Research 39(3–4), 213–227.

Gruber, S., Achraya, D. & Claupein, W., (2008). Wood chips used for weed control in Organic Farming. J. Plant Dis. Protect. Special issue XXI, 401–406.

Haden, V. R., Duxbury, J. M., DiTommaso, A., Losey, J. E., 2007. Weed Community Dynamics in the System of Rice Intensification (SRI) and the Efficacy of Mechanical Cultivation and Competitive Rice Cultivars for Weed Control in Indonesia.Journal of Sustainable Agriculture 30(4), 5-26.

Hanafi, E. M., El Khadrawy, H., Ahmed, W., Zaabal, M., 2012. Some Observations on Rice Straw with Emphasis on Updates of Its Management.World Applied Sciences Journal 16(3), 354-361.

Hasanuzzaman, M., Ali, M.H., Alam, M.M., Akther, M., Alam, K.F.(2009). Evaluationof pre-emergence herbicide and hand weeding on the weed control efficiencyand performance of transplanted aus rice. American–Eurasian J. Agron. 2,138-143.

Imolehin, E.D. and A.C. Wada (2000). Meeting the rice production and consumption demands of Nigeria with improved technologies. International Rice Commission Newsletter, Vol. 49, FAO, Rome, pp. 23-41.

International Rice Research Institute, 2001. Rice Research and Production in the 21st Century. (Gramene Reference ID 8380).

International Rice Research Institute, 2002. Rice Almanac, 3rd Edition. (Gramene Reference ID 8379).

International Rice Research Institute, 2014. Weed control. Retrieved 5 February 2014, Retrieved from http://www.knowledgebank.irri.org/ericeproduction/PDF_&_Docs/Weed_control.pdf.

Iqbal R. , Muhammad A. S, Mohammad V, Muhammad F.S, Muhammad S.Z, Salman A, Monika T, Imran, Muhammad U. A and Muhammad A. N (2020). Potential agricultural and environmental benefits of mulches—a review. Bulletin of the National Research Centre (2020) 44:75. https://doi.org/10.1186/s42269-020-00290-3

Johnson, J. M., Hough-Goldstein, J. A. and Vangessel, M. J., 2004. Effects of Straw Mulch on Pest Insects, Predators, and Weeds in Watermelons and Potatoes. Environ. Entomol. 33, 1632– 1643.

Krupnik, T. J., Rodenburg, J., Haden, V. R., Mbaye, D., Shennan, C., 2012. Genotypic Trade-Offs between Water Productivity and Weed.

Competition under the System of Rice Intensification in the Sahel. Agricultural Water Management115, 156-166.

Larimer County (2008). Methods of weed control. Retrieved October, 2019 from http://www.larimer.org/weeds/control.htm

Mohammed, U. A., Ibrahim, S.,Hayatu, M. and iplesmed, F. A,(2019) Rice (Oryza Sativa L.) Production in Nigeria: Challenges and ProspectsDUJOPAS 5 (2b): 67-75.

Onwalu A.P (2012). Agricultural Sector and National Development: Focus on value Chain Approach, Paper presented at Sharon House, GRA Onitsha on 24th May 2012.

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Nwankwo, C. N. and Ehirim. C.N (2010) Evaluation of accquifcr characteristic and groundwater quantity using geoelectrical method in Choba, Port Harcourt. Journal of scholar research library (2). pp 396-403.

Parthipani, Ravi V, Subramanian E, Ramesh T.(2003).Integrated Weed Management on Growth and Yield of Transplanted Rice and its Residual Effect on Succeeding Black gram. Journal of Agronomy.12, 99-103.

Raj, S.K. and E.K. Syriac (2017). Weed management in direct seeded rice: A review. Agric. Rev., 38: 41-50.

Saleh, M.K. and Oyinbo, O. (2017). Rice Production under Different Weed Management Technologies Adopted by Rice Farmers in Katsina State, Nigeria. Journal of Agricultural Extension. 21 (1). 1-12.

Satyanarayana, A., Thiyagarajan, T., Uphoff, N., 2007. Opportunities for Water Saving with Higher Yield from the System of Rice Intensification.Irrigation Science 25(2), 99-115.

Schwab N.T, Streck N.A, Rehbein A, Riteiro BSMR, Whmann L.O, Langner J.A and Becker C.C (2014). Linear dimensions of leaves and its use for estimating the vertical profile of leaf area in gladiolus. Bragantia 73:97-105.

Sharma, R.R. and Sharma, V.P., 2003. Mulch influences fruit growth, albinism and fruit quality in strawberry (Fragaria x ananassa Duch.). Fruits 58, 221–227.

Singh. B.N, Fagade, S. Ukwngwu, M.W, Williams, C.Jagtap, S.S, Oladimeji, O.Effisue, A. and Okhidievbia, O. (2001). Rice growing environments andbiophysical constraints in different E.T. Agro Ecological Zones of Nigeria. Meterology Journal, 2(1): 3544.

Siwek P. Domagała-Świątkiewicz, I. and Kalisz, A., 2015. The influence of degradable polymer mulches on soil properties and cucumber yield. Agrochimica, 59(2):108-123.

WARDA, West Africa Rice Development Association Annual Report 1996, West Africa Rice Development Association, 1996.

Yang, R. S. Dungan, A. M. Ibekwe, C. Valenzuela-Solano and D. M. Crohn (2003). Effect of organic mulches on soil bacterial communities one year after application," Biology and Fertility of Soils, vol. 38, no. 5, pp. 273–281.