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EVALUATION OF THE GROWTH AND YIELD RESPONSE OF WHITE RADISH (*RAPHANUS RAPHANISTRUM* SUBSP. *SATIVUS* (L.) DOMIN) SUBJECTED TO DIFFERENT TILLAGE METHOD IN MUBI, ADAMAWA STATE, NIGERIA

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ABSTRACT: *This study was mainly aimed at evaluating the growth and yield response of white radish (Raphanus sativus L.) subjected to the common tillage methods in Mubi, Nigeria. A field experiment was carried out during the planting season of 2021 and 2022 in the research farm of Adamawa State University, Mubi. The experimental treatments consisted of zero tillage (ZT), ploughed, harrowed and ridged (P+H+R) and ploughed plus harrowed (P+H). The seed of the radish plant was planted at an inter- and intra-row spacing of 20 and 30 cm, respectively. The study revealed that the three tillage methods had significant differences in their effect against the growth characteristics of the radish plant, with the ZT having the significantly highest plant height, leaf fresh weight and shoot dry weight. The lowest values for most of the white radish growth characteristics were due to the P+H+R treatment. Again, it was indicated that the different tillage methods had a significant effect on the yield characteristics of the radish plant. The P+H+R treatment resulted in significantly higher root length (20.93 cm), root diameter (6.40 cm) and root yield (200.82 kg/ha) than the ZT and P+H treatments. Similarly, ZT and P+H treatment resulted in the significantly highest root weight (69.39 g) and root biomass (8.23 g), respectively, compared to other tillage treatments. However, the P+H resulted in the significantly lowest root yield (29.95 kg/ha) of the radish plant. It was concluded that, for a better root yield response of the white radish plant in Mubi, farmers should adopt the P+H+R tillage method.*

KEYWORDS: Radish, Tillage method, Radish growth, Radish yield and Radish cultivation.

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INTRODUCTION

Radish (*Raphanus sativus* L.), an annual or biennial root vegetable crop, is a member of the family Brassicaceae grown in tropical, subtropical and temperate regions of the world. The crop is cultivated mainly for its swollen taproots, which are often globular, tapering or cylindrical (Nishio, 2017). It is propagated by seeds that usually germinate between 3 and 4 days in moist soil between the temperatures of 18 and 29°C and mature between 3-4 weeks and 6-7 weeks under moderate and colder weather conditions, respectively (Seaman, 2013). Although the crop prefers sandy loam soil, it can also tolerate a wide range of soil types with a pH of 6.5 to 7.0 under full sunlight (Peterson, 2018). All parts of the plant are used in one type of food or another. The taproot has a pungent taste and can be eaten raw in salad or cooked as a vegetable (Singh *et al*., 2020). The consumption of the root and even the leaves aids in reducing blood sugar level, improving digestion and general gut health and preventing cancer due to the presence of anticancer properties (Yoon *et al*., 2025). They also act as detoxifying agents, increase immunity and reduce fatigue due to the presence of essential vitamins and minerals (Saghir *et al*., 2019). Generally, there are different varieties of radish that include red radish or table radish which has red skin and white flesh and have crisp and peppery flavour; and watermelon radish that has white and light green skin, but possesses vibrant pink interior flesh that has a cross-section of it like watermelon and a sweeter flavour; daikon radish which could be white, purple, pink, green or red in colour of the root skin and has a milder sweet flavour; French breakfast radish which is long and thin and has red to pink to white root skin colour with a spicier flavour; green meat radish which is dark green both interior and exterior and often crispy and subtly spicy; sparkier radish that is either dark red or purple at the top and creamy white at the base and is crunchy and peppery; and Easter radish (Emily, 2021). Of these radish varieties, the daikon radish variety is most common and known to inhabitants of Mubi.

Tillage is an agricultural practice that provides a suitable condition for plant seed germination and growth. It involves mechanical manipulation of the soil using tools or machines like hoes and tractors that eventually impacts on the biological, physical and chemical properties of soils. The specific effect of the tillage method can vary depending upon factors that include climate type, plant species and soil type. Improvement of soil structure and balance in the relationship between the different components of soils through appropriate selection of tillage methods can greatly help in creating an enabling environment for the increase in growth and yield of plants (Chen *et al*., 2015). Anozie and Baiyeri (2022) found that the tillage method affects the growth and yield characteristics of carrots significantly, with ridged soil resulting in an increase in both growth and yield parameters of the carrot compared to bed. Reduced tillage or zero tillage was also observed to enhance soil health as well as provide a favourable environment for vegetable crops to grow and absorb soil nutrients (Rashidi and Keshavarzpour, 2008).

Mubi is situated within the northeastern region of Nigeria and falls within the Sudan Savannah vegetation zone of Nigeria. Considering the fact that different plant species, soils and even climatic conditions may require some specific tillage method for the efficient growth and development of plants (Chen *et al*., 2015), it was, therefore, important to evaluate the effect of the different common tillage methods that are known to farmers in Mubi, since more than 80% of farmers in the study area have little or no idea of the best agronomy or land preparation that would be suitable for the cultivation of radish, as the crop is entirely new to most people in the area.

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MATERIALS AND METHODS

Study Area

The field experiment was carried out at the research farm of Adamawa State University, Mubi. The research area has an elevation that ranges between 479 and 1,321 metres above sea level, reflecting its location close to the Mandara mountains, and an average annual rainfall and temperature of 700-800 mm and 3°C, respectively. The soil of the study area is characterised as sandy loam soil.

Treatment and Experimental Design

The experimental treatments consisted of three types of tillage methods that include zero tillage (ZT), ploughing plus harrowing plus ridging (P+H+R) and ploughing plus harrowing (P+H). The P+H+R was carried out manually by upturning the soil from about 20 cm depth and harrowing by breaking the bulk soil and making a heap of about 29 cm above the soil surface through the use of a hoe. The P+H was also done by upturning the soil from 20 cm depth and harrowing by breaking the bulk soil into fine soil particles. A cleared flat and untilled soil was used as the zero-tillage treatment. Completely Randomised Block Design (CRBD) replicated three times was used for the field experiment.

Source of Radish Seed

The seed sample for this study was obtained from Jos, Plateau State, Nigeria, from the seller of the product.

Seed Planting

On the ZT, P+H+R and P+H soils, the radish seed was sown in a hole of about 12 cm in depth at an intra- and inter-row spacing of 20 and 30 cm, respectively. Two seeds were sown per hole and, at one week after sowing, thinned to one radish plant per stand.

Data Collection

Data on growth parameters were obtained twice at one-week intervals. The first and second samplings were at two and three weeks after sowing, respectively. Three plants were sampled on each treatment plot so as to determine the radish plant growth characteristics.

Determination of growth characteristics:

Plant height: The plant height was measured from the base to the tip of the plant with the aid of a metre rule in centimetres (cm).

Leaf area (LA): The LA was determined by measuring the length and breadth of each leaf of a sampled plant using a metre rule. The LA was calculated by multiplying the length and breadth of the leaves.

Leaf fresh weight: The leaf fresh weight of the sampled plants was determined by detaching the leaves from the stem of the plant, after which the weight of the entire detached leaves was determined by weighing on an electronic weight balance in grams.

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Shoot fresh weight: The fresh weight of the shoot was determined after detaching its leaves using an electronic weight balance in grams.

Total dry weight (biomass): The uprooted sampled plants, after washing off the dirt attached to the root, were shade-dried, after which they were oven-dried to constant weight at the temperature of 70°C. The weight was taken after cooling using an electronic balance.

Determination of yield characteristics:

Root dry weight: The dry weight of five randomly selected roots was determined after washing off all dirt or sand particles by oven-drying the roots to constant weight. The root average dry weight was recorded.

Root length: The length of five randomly selected radish roots was determined by measuring the root from its tip to base using a metre rule, and the average root length was recorded.

Root fresh weight: The fresh weight of five randomly selected radish roots was determined using digital weight balance after the harvested roots had been properly washed and the water allowed to dry off.

Root diameter: Five radish roots were randomly selected, and the diameter of each of the roots was determined by measuring the widest part of the root using a Vernier calliper.

Yield (kg) per hectare: This was determined by weighing all the radish roots harvested from each treatment plot and was expressed in kg per hectare.

Data Analysis

The data from this study were analysed using one-way analysis of variance (ANOVA); where there was a significant difference, the means were separated using Least Significant Difference (LSD) at $p \leq 0.05$ level of significance using a Statistical Package for Social Sciences (SPSS) version 25.

RESULTS AND DISCUSSION

The study revealed that ZT treatment resulted in the significantly highest plant height at 2 and 3 weeks after sowing (WAS), leaf fresh weight at 2 WAS and dry weight (shoot biomass) at 3 WAS compared to the P+H and P+H+R treatments. The P+H treatment, on the other hand, had the significantly highest leaf area at 2 and 3 WAS and leaf fresh weight at 3 WAS when compared to that of the other tillage methods. Similarly, the P+H+R treatment led to the significantly highest shoot fresh weight of the radish plant at both 2 and 3 WAS compared to the other tillage methods. However, the P+H+R treatment had the lowest values for most of the growth parameters other than shoot fresh weight, especially at 3 WAS when compared to other treatments (Table 1). The highest values for all the growth parameters of the radish plant planted on ZT could be a result of better soil moisture retention capacity, moderate temperature and a significant amount of available soil nutrients in such untilled soil that might not be so in the other tillage methods, as was affirmed by Agbede (2008); and this consequently favours the growth of the radish plant. Agbede and Adekiya (2018) discovered a significant increase in ginger plant height planted on ZT when compared to those planted on ridged and ploughed

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soils. The lowest values for most of the growth parameters of the radish plant planted on P+H+R soil could be due to low soil moisture content and alteration to soil biological, chemical and physical properties as a result of the upturning, harrowing and heaping of the soil that eventually affected the growth performance of the radish plant than that planted on the other tillage methods. Ali *et al*. (2006) confirmed that soil ploughing and ridging could lead to lower soil fertility due to inversion of the topsoil and possible leaching.

The results on the yield parameters of the radish plant showed that the radish plant planted on P+H+R soil had the significantly highest root length (20.93 cm) and root diameter (6.40 cm) compared to the radish plants on P+H and ZT soils. However, the root length (13.48 cm) and root diameter (5.69 cm) of radish plants planted on ZT were significantly the lowest. Also, the root yield (200.82 kg/ha) of the radish plant on P+H+R soil was significantly the highest, followed by that on ZT. The root yield (29.95 kg/ha) of the radish plant on P+H, however, was significantly the lowest. In terms of root weight, the radish plant on ZT had the significantly highest value (69.39 g), followed by that of P+H+R (32.16 g). On the other hand, the significantly lowest root weight (21.56 g) was due to P+H treatment. Similarly, the significantly highest root biomass (8.85 g) was that of the radish plant on P+H soil, followed by that of the radish plant on ZT, which was significantly similar to that on P+H+R soil (Table 2). The highest root length, root diameter and root yield of the radish plant planted on P+H+R soil were a result of better root penetration, root expansion and more access to soil water and nutrients that the radish plant had due to less soil compaction and bulk density and improved soil aeration. Ali *et al*. (2006) attributed the availability of soil nutrients in tilled soils to efficient and effective oxidation and mineralisation of soil organic matter. Konopinski *et al.* (2011) also recorded a significant increase in the root length, root diameter and yield of parsnip plants subjected to ridged and ploughed soils compared to that of flat or untilled soil. The significantly higher root weight of the radish plant planted on ZT could be ascribed to the higher soil moisture retention, localised accumulation of carbohydrate and efficient utilisation of soil resources (Surajit *et al*., 2020). This was proved by the increase in plant height, shoot fresh weight and leaf fresh weight of the radish plant reported earlier.

CONCLUSION

Zero tillage is effective for the enhanced growth of white radish plants in Mubi. However, ploughed plus harrowed plus ridged soil results in a better yield response of white radish in Mubi than the zero tillage and ploughed plus harrowed tillage methods. The ability of other radish varieties to thrive in Mubi just like the white radish variety and their response to these common tillage methods in the study area is what needs to be evaluated. Therefore, there is a need to evaluate the growth and yield response of radish varieties other than the white type to the common tillage methods in the study area.

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APPENDIX

Table 1: Effect of tillage method on the growth characteristics of white radish at 2 and 3 Weeks after Sowing (WAS)

	Growth parameter									
	Plant height (cm)		Leaf area (cm)		Leaf fresh weight (g)		Shoot fresh weight (g)		Shoot dry weight (g)	
	Sampling Week (WAS)									
Tillage M	2	3	2	3	2	3	2	3	2	3
Zero T	5.50±0.03^{a}	4.93±0.03^{a}	15.43±0.03^{b}	16.54±0.03^{c}	2.37±0.03^{a}	2.97±0.03^{b}	0.33±0.03^{b}	1.00±0.03^{b}	0.27±0.03^{a}	0.50±0.03^{a}
P+H	4.10±0.03^{b}	4.63±0.03^{b}	20.80±0.03^{a}	32.87±0.03^{a}	0.50±0.03^{c}	3.60±0.03^{a}	0.33±0.03^{b}	0.50±0.03^{c}	0.29±0.03^{a}	0.42±0.03^{ab}
P+H+R	4.10±0.03^{b}	4.57±0.03^{b}	14.73±0.03^{c}	26.90±0.03^{b}	1.87±0.03^{b}	1.63±0.03^{c}	1.23±0.03^{a}	1.30±0.03^{a}	0.35±0.03^{a}	0.37±0.03^{b}
p-Value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.05

Means along the column with similar superscript alphabet are not significantly different at p>0.05.

Key: P+H = Ploughed plus harrowed; **P+H+R** = Ploughed plus harrowed plus ridging

Table 2: Effect of tillage method on the yield characteristics of white radish

	Yield parameter				
Tillage Method	Root length (cm)	Root weight (g)	Root diameter (cm)	Root yield (Kg/ha)	Root Biomass (g)
Zero Tillage	13.48±0.03^{c}	69.39±0.03^{a}	5.69±0.03^{c}	107.91±0.03^{b}	8.23±0.03^{b}
P+H	14.76±0.03^{b}	21.56±0.03^{c}	6.22±0.03^{b}	29.95±0.03^{c}	8.85±0.03^{a}
P+H+R	20.93±0.03^{a}	32.16±0.03^{b}	6.40±0.03^{a}	200.82±0.03^{a}	8.17±0.03^{b}
p-Value	0.00	0.00	0.00	0.00	0.00

Means along the column with similar superscript alphabet are not significantly different at p>0.05.

Key: P+H = Ploughed plus harrowed; **P+H+R** = Ploughed plus harrowed plus ridging

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