Effects of Levels of Tillage on Destruction and Re – Emergence of Weeds of Benue River Makurdi Flood Plains

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Abstract- This study was conducted to investigate effects of different levels of soil tillage on weed destruction and re – emergence during the cropping season of the year 2012. The experiment was conducted on the experimental farm of Department of Agricultural and Environmental Engineering, University of Agriculture, Makurdi. The field was laid out in a randomized complete block design (RCBD) with four treatments and three replications. The treatments were ploughing and harrowing once (PH), ploughing and harrowing twice (PHH), ploughing and harrowing thrice (PHHH) and no – tillage (NT). A 75 Hp four – wheel drive MF 375 E tractor, 3 – discs MF plough and 14 – discs offset MF harrow were used for the tillage operations. The parameters studied were weed destruction and re – emergence. The total rainfall within the period was 928.7 mm. Atmospheric temperatures fluctuated between 32ºC and 39ºC and the relative humidity was between 70 % and 86 %. Results showed that the soil of the experimental plot was generally dark and was predominantly sandy. Ploughing and harrowing thrice cut down the highest number of weeds and gave the best soil conditions which yielded the least number of weed re – emergence. More weeds re – emerged on no – tillage sub – plots with percentages ranging between 42.99 % and 65.11 %. The results also showed that tillage is a viable alternative to chemical weeds control.

Keywords: Effects, Destruction, Levels, Tillage, Weeds.

I. INTRODUCTION

Tillage is defined as the physical manipulation of the soil for the purposes of managing previous crop residues, preparing a seedbed for planting, controlling competing vegetation, and incorporating fertilizers and other crop production inputs [1].Farmers perform tillage when they prepare soil for the raising of crops. Soil tillage has three primary purposes: prior to planting, farmers use tillage to mix compost, manure and other fertilizers into the root zone where growing plant roots may reach it; tillage also aids seed germination by creating a smooth, uniform soil surface for planting; and after planting, farmers use tillage to control pests, erosion and weeds between crop plants – including vegetable, fruit, forest, medicinal and farm crops [2]; [3].

There are two types of tillage and these are the primary and secondary tillage. [4] wrote that a primary tillage operation constitutes the initial, major soil – working operation, normally designed to reduce soil strength, cover plant materials and re – arrange soil aggregates. Secondary tillage operations are intended to create refined soil conditions following primary tillage.

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[5] stated that secondary tillage consists of operations carried out after primary tillage to create proper soil tilth for seeding and planting. Its main objectives are to pulverize the soil of the seedbeds, to destroy grasses and weeds, to cut crop residues and mix them with the top soil, to break the big clods resulting from primary tillage and to make the field surface uniform and leveled.

The plough is the major implement used for primary tillage, while a wide variety of harrows and cultivators are used for secondary tillage. Tractors of different sizes and power ratings are required to pull the various tillage implements on the soil to perform the role and defined objectives.

Weed is a term applied to a plant that grows where it is not wanted. Weeds, like many plants, are usually divided into three categories: annuals, biennials and perennials. Annuals complete an entire life cycle in one growing season. The seeds may live buried in the soil as long as 70 years. Examples are lamb's – quarters and chickweed. Repeated ploughing and cultivating may be necessary to control annual weeds. Biennials live through two growing seasons, producing only greenery the first year, and bearing flowers and fruits in the second. Biennial plants usually have strong root systems that send up new shoots when the original tops are removed. Example is the bull thistle. Perennial weeds are often the most troublesome weeds to control because they have strong, well – developed underground parts and produce large numbers of seeds. Perennials live for at least three years, flowering and producing fruit each year after reaching maturity. Examples are bindweed, sorrel and leafy spurge [6]. Perennial weeds such as milk weed and hemp dogbane may be a problem with no – till systems [7].

A. Statement of the problem

Weeds are usually characterized by rapid growth, and they typically replace other more desirable plants. Most weeds damage cultivated plants by competing with them for sunlight, water, and mineral nutrients, while some weeds are parasites that grow directly on other plants and thus either weaken or kill them. Many weeds are also hosts for diseases – causing organisms [6]. [8] reported that tillage depth and intensity alter the soil physical and chemical properties that affect plant growth and crop yields. A lot of research has been done on soil tillage and effects of tillage on crop yield, physical, chemical, and biological properties of the soil. However, effects of different degrees of tillage on the destruction and re – emergence of weeds of River Benue Makurdi flood plains have never been studied.

B. Objectives of the study

1. To determine the types of weeds that are predominant on the study area,

2. To determine the effects of different levels of tillage on the destruction and re – emergence of weeds on the study area,
3. To recommend the best level of tillage for weed control for the area.

II. MATERIALS AND METHODS

A. Experimental Plot

The experimental plot was located at the Experimental Farm of College of Engineering, University of Agriculture, Makurdi. The area, which was a virgin forest consisting basically of tall guinea grass (*Panicum maximum*), elephant grass (*Pennicetum purperum*), spear grass (*Imperata cylindrica*) and patches of deciduous trees, was cleared with a bulldozer in 2004.The field slopes into a small seasonal stream which usually dries up during the dry season. No farming activities have been carried out on the field prior this study. Makurdi lies between 7º 45' – 7º 52' N and 8º 35' – 8º 41' E. The site is characterized by undulating rolling plain with irregular river valleys. It lies within the humid zone with average annual temperature of 31.5ºc and the relative humidity of 65 – 69%. The rainfall varies between 1000mm to 2500mm. The soil of the area is Makurdi sandstones (Makurdi formation), which is part of the sedimentary basin of Nigeria dominated by the crystalline and the sedimentary rock in about the same proportion [9]. The slope of the experimental field, measured with a hand – held digital slope meter was 7º 48'.
The experimental plot was 36m wide and 40m long. The experiment was laid out in a randomized complete block design (RBCD). Four three – digit random numbers were selected by closing the eyes and pointing a finger to any position on the table of random numbers [10]. The random numbers were ranked from the smallest to the largest. The four treatments were then assigned to the four sub – plots by using the sequence in which the random numbers occurred as the treatment number and the corresponding rank as the plot number to which the particular treatment was assigned. The randomization process for a RBCD for this experiment was then applied separately and independently to each of the blocks. The plot was divided into three blocks with four sub – plots. The tillage treatments viz – a – viz plough and harrow (PH); plough, harrow, harrow (PHH); plough, harrow, harrow, harrow (PHHH); and no tillage (NT) were replicated in sub – plots as shown in Fig. 1.

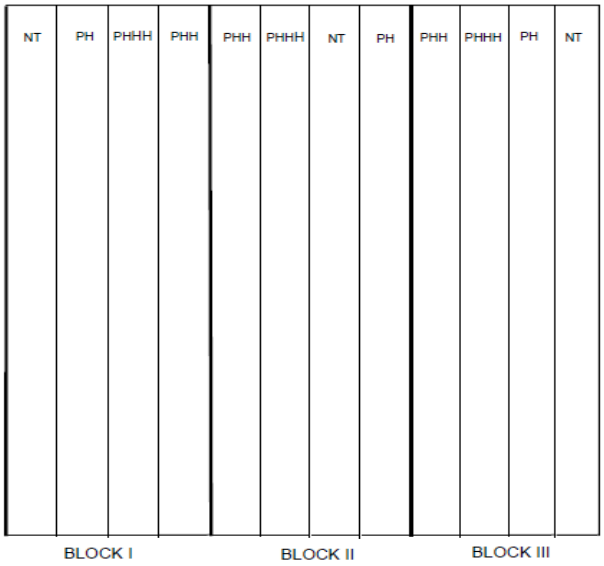

Fig. 1 Final Layout of the randomized complete block design (RCBD) of the Experimental Plot with Four Treatments and Three Replications (Not to scale)

B. Meteorological Data

The data for rainfall, temperature and humidity were obtained from the Department of Physics, University of Agriculture, Makurdi, and the Nigerian Meteorological Agency (NIMET), Tactical Air Command (TAC), Makurdi Airport. The rainfall for the study period (April – November, 2012), temperature and relative humidity are shown in Table 1.
From the table it is observed that a total of 928.7 mm of rain fell between May and November when the studies were conducted. The temperature data showed that except for April and May when the temperatures were 39ºC and 36ºC respectively, the temperatures were ranged between 32ºC and 33ºC. The data on relative humidity showed an increase in the relative humidity with decrease in temperature from May to October, 2012. This is in consonant with the report by [6] which stated that a fall in temperature increases the relative humidity. The meteorological graphs for the study period are shown in Fig. 2. The mean for the rainfall and the highest temperatures and humidity for each month were used for rainfall, temperature and humidity graphs.

Table 1: Daily Rainfall (mm), Monthly Highest Temperature Extremes (ºC) and Monthly Highest Relative Humidity (%) for Makurdi (Year 2012)

Meteor Data	Apr	May	June	July	Aug	Sept	Oct	Nov
Rainfall (mm)	179.1	46.7	227.6	89.2	142.4	85.2	158.0	0.5
Mean:	25.6	7.8	15.2	4.7	8.4	6.1	7.9	0.3
Temp (ºC)	39	36	33	32	33	33	33	36
R H (%)	72	77	82	84	86	84	84	70

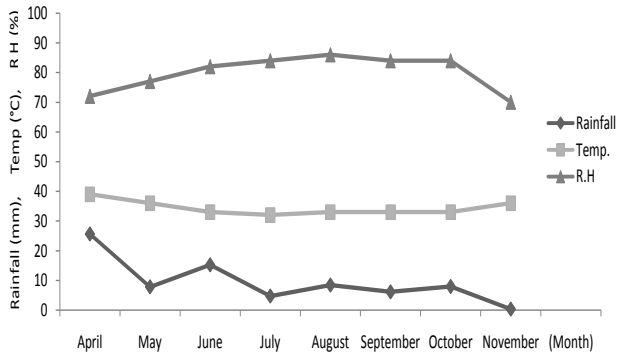

Fig. 2: Rainfall, Temperature and Relative Humidity for Makurdi in the Year 2012

C. Specifications of Tractor and Machinery Used for the Study

A 75 Hp four – wheel drive Massey Ferguson tractor (MF 375 E) was used. Specifications of the tractor are Gross weight: 2,200 kg; Overall width: 1,651 mm; Overall length: 3,542 mm and Ground clearance: 338 mm [11].

A 3 – discs Massey Ferguson (MF) plough was used. The disc diameter and plough width are 660 mm and 1900 mm respectively.

A 14 – discs offset Massey Ferguson (MF) harrow with 560 mm diameter and harrow width of 2200 mm was used.

The MF 375 E tractor was used for both the ploughing and harrowing operations on the experimental plot at the tractor speed of 3 km/hr.

D. Determination of Weed Destruction

Weights of Weeds before Tillage Three 1 m^2 portions were measured out from each of the sub – plots using a tape rule. Weeds were then uprooted from each of the 1 m^2 portions on all the sub – plots. Three readings were taken from each sub – plot. A 25 kg capacity manual weighing machine was used to determine the individual weights of the uprooted weed samples. Mean weights of weeds from 1m^2 were equated to weight of weeds in 1 hectare and the same thing was done for all the 3 m^2 portions on all the sub – plots.

Weights of Weeds after Tillage After ploughing and harrowing, three 1 m^2 portions were again measured out on each of the tilled sub – plots. The measurements were done on the same spots measured out before tillage. The cut weeds were then collected from the surface of these 1 m^2 portions.

Weights of Germinated Weeds One Month after Tillage One month after tillage, weeds have re – emerged on the experimental plot. It was discovered that there were no tall spear, elephant or guinea grasses, which were predominant before tillage this time. Instead, it was smaller grasses that re – emerged on the experimental plot. Three 1 m^2 portions were again measured out on each of the sub – plots making sure they were the same spots used before and after tillage. All the weeds on these portions were then uprooted, and weighed. These weights were used to make comparisons with the other weights of weeds determined before and immediately after tillage. The objective is to know which level of tillage destroyed more weeds and which level produced better soil condition that yielded less re – emergence of weeds. The totals of the weights of the weeds one month after tillage were each equated to one hectare.

E. Data Analysis

Analysis of variance (ANOVA) for Randomized Complete Block Design (RCBD) was used to determine if the tillage treatments had any effect on weed destruction and weed re - emergence. IBM SPSS Statistics version 19 software was used for the analysis.

III. RESULTS AND DISCUSSIONS

A. Weights of Weeds before and after Tillage and Re - Emerged

Table 2 shows the mean values of weights of weeds before tillage and weight of cut weeds after tillage on hectare basis. The means of the totals in each sub – plot was computed and was equated in each case to weight of weeds for 1hectare per sub – plot. For example, in Block I Sub - plot II, the mean from a total of 4.9 kg was 1.63 kg. Since 3 m^2 yielded 1.63 kg, on hectare (10000 m^2) basis that gave 5433 kg.

The weights of weeds cut down after tillage and collected from the surface of the 3 m^2 portions on each of the sub – plots were equated to weights of cut down weeds in 1hectare. The weights here were used to compare the tillage treatments and weed destruction.

Table 3 shows the means of the weights of the weeds that re – emerged one month after tillage on each sub – plot, equated to 1 hectare.

The results showed that ploughing and harrowing thrice (PHHH) cut the highest number of weeds in Blocks II and III, while ploughing and harrowing once (PH) cut the highest weeds in Block I.

In Block I, the mean values of weights of weeds (per hectare) on the individual sub – plots before tillage were: SP I, 5667 kg; SP II, 5433 kg; SP III, 5333 kg; and SP IV, 4100 kg (Table 2). After tillage, the weights of cut down weeds (per hectare) on each sub – plot were: SP I, 0.0 kg with no – tillage (NT); SP II, 1433 kg with ploughing and harrowing once (PH); SP III, 667 kg with ploughing and harrowing thrice (PHHH); and SP IV, 667 kg with ploughing and harrowing twice (PHH). This implies that ploughing and harrowing once (PH) gave the best weed cutting in Block I since it had 5433 kg.

In Block II, the mean values of weights of weeds on the sub – plots before tillage were: SP I, 3667 kg; SP II, 4567 kg; SP III, 3667 kg and SP IV, 2667 kg. After tillage, the weights of cut down weeds from the individual sub – plots were: SP I, 233 kg with ploughing and harrowing twice (PHH); SP II, 567 kg with ploughing and harrowing thrice (PHHH), SP III, 0.0 kg with no – tillage (NT) and SP IV, 433 kg with ploughing and harrowing once (PH). In Block II, ploughing and harrowing thrice (PHHH) cut down more weeds with 567 kg since it had 4567 kg of weeds before tillage.

In Block III, the mean values of weights of weeds on each sub – plot before tillage were: SP I, 2767 kg; SP II, 3556 kg, SP III, 6333 kg and SP IV, 4333 kg. After tillage, the weights of cut down weeds on each sub – plot were: SP I, 667 kg with ploughing and harrowing twice (PHH); SP II, 1567 kg with ploughing and harrowing thrice (PHHH), SP III, 1333 kg with ploughing and harrowing once (PH) and SP IV, 0.0 kg with no – tillage (NT). Here, ploughing and harrowing thrice (PHHH) cut down the most weeds with 1567 kg since it had 3556 kg of weeds before tillage.

It was observed that more weeds re – emerged on the sub – plots which were not tilled than on all the other sub – plots that were tilled (Table 3). This showed that tillage had more effect on weeds destruction than chemical weeding. On the influence of no – tillage on biological properties, [12] observed that despite the fact that chemicals are used to kill weeds, higher biological activity occurs under no – tillage, an indicator of a healthier soil. Comparing the values in Tables 2 and 3, it was also observed that ploughing and harrowing thrice (PHHH) gave the best soil conditions which favored the least re – emergence of weeds. Through ploughing and harrowing thrice (PHHH), only 467 kg, 633 kg and 433 kg re – emerged one month after in Block I (SP III), Block II (SP II) and Block III (SP II) respectively (Table 3).

Table 2: Mean Values of Weights of Weeds before Tillage and Weight of Cut Weeds after Tillage on Hectare Basis

	Weights of weeds equated to 1ha, kg											
	SP I			SP II			SP III			SP IV		
Block	Before	After	% Incr.	Before	After	% Incr.	Before	After	% Incr.	Before	After	% Incr.
I	5667	0.0	-	5433	1433	26.37	5333	667	12.51	4100	667	16.27
II	3667	233	6.35	4567	567	12.42	3667	0.0	-	2667	433	16.24
III	2767	667	24.11	3556	1567	44.07	6333	1333	21.05	4333	0.0	-

Key: NT = No Tillage

Table 3: Mean Values of Weights of Re – Emerged Weeds One Month after Tillage on Hectare Basis

	Weights of re – emerged weeds (kg; %)								
Block	SP I	%Increase	SP II	%Increase	SP III	%Increase	SP IV	%Increase	Total
I	1333	43.48	733	23.91	467	15.23	533	17.38	3066
II	700	19.63	633	17.75	1533	42.99	700	19.63	3566
III	567	11.42	433	8.72	733	14.76	3233	65.10	4966

B. Soil Texture of the Experimental Plot

[13] reported that the soil of the experimental plot is generally dark in colour, containing small amounts of gravel and is predominantly sandy.

The textural class ranges between loamy sand and sandy loam.

C. Analysis of Variance (ANOVA)

Analysis of variance on the effects of the levels of tillage treatments with weed destruction and re – emergence are shown in Tables 4 – 7.

Table 4: Analysis Of Variance (RCBD) of Treatment versus Weed Destruction (Data in Table 2)

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Treatment	2073272.917	3	691090.97	4.129*	.048
Error	1338904.000	6	105919.05		
Total	3412176.917	11			

Key: * = Significant at 5% Level (P < 0.05).

Table 5. LSD Test on the Treatment versus Weed Destruction Result

Treatment (I)	Treatment (J)	Mean Difference (I – J)	Std. Error	Sig.
PH	PHH	544.00000	334.02894	.142
	PHHH	132.66667	334.02894	.702
	NT	1066.33333*	334.02894	.013
PHH	PH	- 544.00000	334.02894	.142
	PHHH	- 411.33333	334.02894	.253
	NT	522.33333	334.02894	.157
PHHH	PH	- 132.66667	334.02894	.702
	PHH	411.33333	334.02894	.253
	NT	933.66667*	334.02894	.023
NT	PH	- 1066.33333*	334.02894	.013
	PHH	- 522.33333	334.02894	.157
	PHHH	- 933.66667*	334.02894	.023

Key: * = The mean difference is significant at the 0.05 level.

Table 6. Analysis of Variance (RCBD) of Treatment versus Weed Re - Emergence (Data in Table 2)

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Treatment	4617015.000	3	1539005.000	5.548*	.023
Error	2219208.000	8	277401.000		
Total	6836223.000	11			

Key: * = significant at 5% level (P < 0.05).

Table 7. LSD Test on the Treatment versus Weed Re - Emergence Result

Treatment (I)	Treatment (J)	Mean Difference (I – J)	Std. Error	Sig.
PH	PHH	122.00000	430.03953	.784
	PHHH	211.00000	430.03953	.637
	NT	- 1311.00000*	430.03953	.016
PHH	PH	- 122.00000	430.03953	.784
	PHHH	89.00000	430.03953	.841
	NT	- 1433.00000*	430.03953	.010
PHHH	PH	- 211.00000	430.03953	.637
	PHH	- 89.00000	430.03953	.841
	NT	- 1522.00000*	430.03953	.008
NT	PH	1311.00000*	430.03953	.016
	PHH	1433.00000*	430.03953	.010
	PHHH	1522.00000*	430.03953	.008

Key: * = The mean difference is significant at the 0.05 level.

Treatment versus Weed Destruction The effect of tillage treatments on weeds destruction was significant with the computed *F* value of 4.129 at 5% level of significance (P < 0.05). This means that some differences among the treatments did exist (Table 4). The Least Significant Difference (LSD) test performed to compare the treatment means is shown in Table 5.

Treatment versus Weeds Re – Emergence The effect of tillage treatments on weeds re – emergence was significant with the computed *F* value of 5.548 at 5 % level of significance (P < 0.05).This means that some differences among the treatments did exist (Table 6). The LSD test showing the comparisons between the treatment means is shown in Table 7.

IV. CONCLUSIONS

From analysis of the results, the following conclusions were made:

1. The experimental plot which has never been cropped prior to this experiment displayed all the potentials of a good agricultural land in terms of suitability and required conditions.
2. The different levels of tillage treatments showed that there were significant differences both on destruction of weeds and weed re – emergence at the 5% levels of significance ($P < 0.05$).
3. In the entire experimental plot, ploughing and harrowing thrice (PHHH) proved to be the best level which destroyed more weeds, giving little room for re – emergence.
4. There was more weed re – emergence on the no – tillage sub – plots.
5. Results of the LSD tests to compare the treatment means showed that there were differences among the treatments (Tables 5 and 7).

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