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Effects of Tillage Practices on Disease Development and Soybean (*Glycine max* L.) Yield in Ibadan, South-Western Nigeria

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Abstract:- Twenty-five percent of Nigeria's Soybean production are been consumed in rural areas. Several biotic and abiotic factors constraint production of soybean, resulting in yield decline. Soil tillage practices is an integral components of cultural soil management practices that impacted diseases. This work, therefore, looks into the effect of three cultural practices on the incidence and intensity of soybean diseases, vis-à-vis their yield. This work was carried out at the Research Field, of National Cereal Research Institutes, Ibadan, in 2020 cropping seasons, using Randomized Complete Block Design in triplicate. Factors are ploughing only (P), ploughing + harrowing (PH), and no-tillage (NoT). Plants were selected from each plot for disease symptoms assessment visually. Data on percentage disease occurrences were analyzed. Means separated by LSD at P=0.05. Disease incidence and severity varied significantly with tillage methods. At 10 weeks after sowing, ploughing alone record significant higher diseases of 29.17% for leaf blight than other tillage methods while plough + harrowing had significantly lower disease incidence for the same disease. Ploughing + harrowing produced a higher seed yield of 2724.83 t/ha, followed by no-tillage (2165.93 t/ha). This study shows that the tillage method affects disease development in Soybean. Further studies on multi-locational field evaluations of the impact of tillage practices on soybean diseases are required.

Keywords:- *Soybean, Nigeria, Tillage; Ploughing + Harrowing, Disease Incidence.*

I. INTRODUCTION

Soybean is arguable the most nutritious and easily digested food of the bean family (IITA, 2009), and varies in plant protein from 24 - 45% and 17-35% in oil. Thus, varieties can taste quite different from one another (USDA, 2000). Nigeria presently produces 500,000 Metric tonnes of soybean annually, and the largest producer in the African continent (IITA, 2011). The plant can be grown in many states of the country with low input. Its production has expanded as a result of its nutritive, economic, and domestic usage (IITA, 2011). About 25 percent of Nigeria's production is consumed directly in rural areas (GAIN report, 2019).

Soybean improves soil fertility by adding nitrogen to the soil, this benefits the traditional farming systems, where soil nutrients have been exhausted by continuous usage to produce more food, and where fertilizers are scarce and expensive (Asiegbu and Okpara, 2002).

Several biotic and abiotic factors constraint production of soybean, resulting in yield decline. Prevalent diseases of soybean in Nigeria are; rust, leaf blotch, leaf spot, bacterial pustule, bacterial blight, soybean mosaic virus while pests include pod, foliage feeders, bean flies, and nematodes (Pivonia and Yang 2004). These pathogens damage the leaves, stem, and pods of the crop, thereby causing yield loss of up to 60% (Allen *et al.,* 2017, Koenning and Wrather 2010). Different pathogens have increased to densities that can cause economic yield losses, in localities where soybean is grown every year (Yujun *et al.,* 1999). Disease prevalence, intensity, and yield loss are closely associated with environmental factors (Grau *et al.,* 2004), cultural practices, and the ability of soybean variety to withstand infection by plant pathogens (Wrather and Koenning, 2006).

Diaporthe phaseolorum sojae and *Phomopsis* spp. causes pod and stem blight disease of soybean respectively. These fungi hibernate on infested crop debris and seeds. They are found in all soybean growing ecologies and cause seed damage and reduced seed quality (Pratt *et al.,* 2011). The characteristic symptom of these diseases is the development of fruiting structures in rows on the stems, nodes, and pods (Travis *et al.,* 2014). These diseases had little or no significant impact on yield, however, seed quality may be affected when seed infections occur. Severely infected seeds may not germinate or produce weak seedlings (Loren, 2001). The management of these diseases is primarily by the use of a disease-free seed and cultural practices that aid the decomposition of plants remain (Pratt *et al.*, 2011).

Pseudomonas syringae pv. *glycinea* causes bacterial blight. This bacterium hibernates on infected soybean tissue and on plant remains (Laura *et al.*, 2008). The symptom is noticed on the leaves and usually one of the first to appear at the second trifoliate leaf stage (Hartman *et al.*, 1999). When this pathogen infects the seed, it may cause cotyledon infection (Laura *et al.*, 2008). It might affect the seedlings, and makes them stunted or may die completely (Laura *et al.*, 2008). Yield loss from this disease is seldom observed, however, if the crop is grown primarily for seed, huge losses can occur. The management of Bacteria blight is through the use of a high-quality seed, avoiding excessive stands, and ploughing of crop residues. (Loren, 2001).

Soil tillage practice is an integral aspect of cultural management techniques that can be manipulated due to its influence on the intensity of plant diseases (Jug *et al.*, 2011). During land preparation, the tillage practice embarked upon, can have a great influence on the disease emergence, has it affects the amounts of plant residues that remain in the soil (Jug *et al.*, 2011) and with interactions with other agro-ecological components can significantly affects the disease development (Jordan and Hutcheon, 2003). Foliar and stem diseases of soybean have been reduced by tillage methods, as stated by several authors. When the soil is tilled at various depths and intensity in other to loosening the soil, the spread of fungal propagules is drastically reduced (Vanova *et al.*, 2011). Soil ploughing has over the years been used to incorporate plant remains, so as to reduce the plant pathogens that survive on plant remains (Poštić *et al.*, 2012).

Although, several authors have reported, plenty of work on soybean production, breeding, and improvement. However, there is acute insufficient information in Nigeria, on cultural management techniques that can influence disease incidence and yield losses in soybean arising from leaf blight and stem rot diseases. Therefore, the present study, evaluates the effect of three tillage practices on the incidence of soybean diseases, yield, and its components.

II. MATERIALS AND METHODS

2.1 Study location

This trial, conducted in the year 2020 planting season, at the Research Farm of National Cereal Research Institutes (NCRI), Ibadan Out-Station, with Latitude 70 221ºN and Longitude 30 581ºE and mean annual rainfall of 1150-1250 mm. Textural class of loamy soil (1:2 soil/water) using USDA textural calculator. Soybean was continuously grown on the field used for this trial, for years, to allow inoculum build-up.

2.2 Experimental design and Seed planting

Randomized Complete Block Design (RCBD) was used in this trial and replicated three times, on a size of 4 x 1.5 m^2 and 50 x 5cm spacing. One meter was maintained between plots. Soybean variety (TGX 1448-2E), were planted by drill planting method, at the rate of 2 – 3 seeds per hill, thinned to 1 plant per hill at 2 weeks after planting (WAP). Control of weeds was done chemically using LegumeForce at 2 litres per hectare, at 3 WAP; and manually using cutlass and hoe for the duration of the work.

2.3 Tillage treatments

The treatments used in this experiment include: ploughing only (P), ploughing + harrowing (PH), and no-tillage (N_OT).

2.4 Disease assessment

Plants were selected and tagged from each plot for symptom's first appeared. The evaluation was performed visually commencing from 4 – 12 WAP and scored.

$$\text{Incidence of infection} = (\text{Number of the infected plant})/(\text{Number of plants in each plot})\ X\ 100$$

A rating scale, of 1-5, was used to assessed blight severity, where 1 = no yellow/spots on leaf or pod, 2 = (1-25%) yellow colour on some leaf or pod, 3 = (26-50%) yellow colour on more leaf or pod,4 = (51-75%) yellow colour and some wilted leaf, and or pod, 5 = (76-100%) yellow colour with more wilted leaf, and or pod (Abdou *et al.*, 2001).

Stems were rated at the milky-wax stage till maturity, using a modified scale of 1 – 5, by Suryadi *et al.*, (2012): 1 = small stem decay symptoms <1% of the stem; 2 = small decay appearances ≤10% of the stem; 3 = appearances of a large decay ≤25% of the stem; 4 = appearances of decay ≤50% of all over the stem; 5 = appearances of decay >50% of the stem and pycnidia appearances.

2.5 Agronomic data collection

Agronomic data collected include number of pods per stand, seeds per plant, and 100 seeds weight (g). Seeds from individual plots, at harvest, were weighed and recorded in tons per hectare to get the seed yield.

2.6 Data analysis

All parameters evaluated were analysed, using Statistical Analysis System (2012), and means separated at a 5 % level of probability.

III. RESULTS AND DISCUSSION

As shown in Table 1: The tillage methods had significant effects on all the diseases assessed. At 10 and 12 WAP, ploughing alone had high disease incidence (29.17%) and (34.67%) respectively, for leaf blight, significantly than all other tillage methods. More so, ploughing + harrowing had lower disease incidence (17.50% and 22.20%) at 10 and 12 WAP respectively, for the same disease. The same trend was also observed on Pod blight disease. As presented in

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Table 2, tillage did not affect disease severity between ploughing alone and no-tillage methods. Although, ploughing + harrowing recorded lower disease severity of (1.5) and (2.0) for leaf blight disease at 10 and 12 WAP respectively, significantly than others. When the soil is ploughed deep, there is always a reduction in disease incidence, as gathered on the ploughing + harrowing plots from this study. This notion agrees with Larson *et al*., (1999) findings on maize disease (brown spot), that ploughing debris into the soil, makes the pathogens further away, out of reach of later maize host and conclude that, if plant remains are covered with soil, it aids decomposition by microorganisms.

There was no difference between ploughing alone and no-tillage for stem rot disease incidence at 12 WAP. However, ploughing + harrowing had lower disease incidence (18.00%) significantly, for the same diseases (Table 1). As shown in Table 2, ploughing alone and no-tillage, had no significant effects on disease severity for stem rot disease at 10 and 12 WAP. Ploughing + harrowing recorded lower disease severity for stem rot disease (1.2) and (1.8) in 10 and 12 WAP respectively. This agrees with the work of several authors when they show that Sudden Death Disease in soybean (SDD) was impacted by the cultural practices employed. And concluded, that SDD was lowered, in chisel tillage plots than no-till plots (Vick *et al*., 2003, 2006 and Wrather *et al*., 1995). Vick *et al*., (2003), also reported that tillage practices, that turn the soil at various depth, can reduce SDD symptoms, since the moisture of the soil is reduced when the soil is exposed, thereby making the survival of the pathogen impossible. While, However, Krupinski *et al*., (2002) reported that no-tillage reduces crop diseases, since the soil topography is not disturb, this increases the effects of beneficial microorganisms in the soil, thereby providing an enabling environment for competition against root pathogens.

At 12 WAP, ploughing alone recorded higher disease incidence (25.50%) for pod blight while ploughing + harrowing recorded lower disease incidence (Table 1). Burns and Shurtleff (1997), was also of the same findings as the ones from this work, that when plant materials were ploughed down, disease incidence was lowered. Also, tillage practices do not have impacts on disease severity between ploughing + harrowing and no-tillage methods used at 10 and 12 WAP, for pod blight disease, while ploughing alone recorded higher disease severity (3.50) and (4.40) in both weeks (Table 2), lower disease severity obtained in no-tillage from this study agrees with the work of Perez-Brandan *et al*., (2012), when they concluded that microbial activity and nutrient cycling is high under no-tillage, and thus heighten natural disease suppression abilities by the microorganisms.

Table 1: Impacts of tillage method on soybean Disease incidence in Ibadan, 2020 planting season.

	Bacterial leaf blight		**Stem rot disease**		**Pod blight**	
Tillage Methods	**10 WAP**	**12 WAP**	**10 WAP**	**12 WAP**	**10 WAP**	**12 WAP**
P	29.17	34.67	26.27	28.50	21.30	25.50
PH	17.50	22.20	16.50	18.00	12.50	15.35
N_OT	20.50	25.42	22.50	29.43	20.50	23.90
LSD	1.45	2.59	0.64	1.83	1.50	1.35

P = Ploughing alone; PH = Ploughing + harrowing; and N_OT = No tillage

Table 2: Impacts of tillage method on soybean Disease severity in Ibadan, 2020 planting season.

	Bacterial leaf blight		**Stem rot disease**		**Pod blight**	
Tillage Methods	**10 WAP**	**12 WAP**	**10 WAP**	**12 WAP**	**10 WAP**	**12 WAP**
P	3.20	3.90	3.30	4.43	3.50	4.40
PH	1.50	2.00	1.20	1.80	1.80	2.00
N_OT	2.90	3.30	3.30	3.90	1.80	2.30
LSD	0.46	34E-9	0.01	0.63	0.01	0.43

P = Ploughing alone; PH = Ploughing + harrowing; and N_OT = No tillage

As presented in Table 3: Ploughing + harrowing recorded high number of pods/plant (55.33) and seeds/plant (140.00), than all other tillage methods. One hundred seed weight did not differ among the three tillage methods used. Ploughing + harrowing produced a higher seed yield of 2724.83 t/ ha, followed by no-tillage (2165.93 t/ha). Though some authors concluded that the tillage method did not have effects on some yield parameters, however, Samuel et al., (2017), reported that soybean and maize yield was increased by 15% and 68% respectively, under no-tillage method. Nezomba et al., 2010 and Ngwira et al., 2012, opined that there is better weed control and water conservation in the no-tillage method, this might be responsible for high yield gather in no-tillage from this work.

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Table 3: Impacts of tillage method on agronomic parameters and total yield of soybean harvested in Ibadan, 2020 planting season.

Tillage Methods	Pods per plant	Seeds per plant	One hundred seed weight (g)	Total harvest (t/ha)
P	32.17	122.03	21.93	1250.33
PH	55.33	140.00	22.67	2724.83
N_OT	48.33	120.33	22.33	2165.93
LSD	0.10	0.67	5.12	522.29

P = Ploughing alone; PH = Ploughing + harrowing; and N_OT = No tillage

IV. CONCLUSION AND RECOMMENDATION

Any tillage practice embarks upon will definitely impact on soil moisture and temperature, thereby making it an effective method in combating crop diseases, this study shows that tillage methods have an effect on disease development in soybean with ploughing + harrowing resulting in lower disease incidence and severity and higher yield, followed by no-tillage. Higher yield contributing parameters like seeds per plant and pods per plant were obtained in Ploughing + harrowing. This implies that full tillage (Ploughing followed with harrowing) can be used as part of the integrated disease management measures to that subdue diseases in soybean. Further studies at the multi-locational level are however required.

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