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EFFECTS OF LAND PREPARATION PRACTICES AND SPACING ON WEED GROWTH AND YIELD OF UPLAND RICE (*Oryza sativa* L.)

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ABSTRACT

Effects of four tillage practices and spacing on weed growth, seedling establishment and yield of an upland rice cultivar (FARO 11) were evaluated in two field experiments at the University of Ilorin Teaching and Research Farm in 1994 and 1995. Crop establishment and grain yield were lower in minimally tilled than in conventionally tilled soil. The poor rice yield in the minimally tilled plot was attributed partly to weed infestation and poor crop establishment. The number of filled grains per panicle of rice was signifiantly higher in minimum than in conventional tillage plots suggesting that significant yield increase of upland rice is attainable with minimum tillage practices, There were however indications that such yield improvement is obtainable if weeds are adequately controlled and optimum crop stand is ensured. Row spacing of 20cm x 20cm, 25cm x 25cm, and 30cm x 30cm suppressed weed growth better than the 40cm x 40cm spacing. Grain yield was highest with 30cm x 30cm spacing and lowest with 40cm x 40cm spacing.

INTRODUCTION

Tillage can simply be defined as cultivating the land for the purpose of planting crop. In the past two decades, new reservoir of knowledge in soil science has set off a revolution in tillage practices for many crops for the purpose of increasing yield at the lowest production cost. Thus, various tillage practices have been described. Baeumer and Bakermans (1973) described minimum tillage as the least possible soil manipulation necessary to create suitable soil condition for seed germination and crop growth. Minimum tillage for any particular situation may therefore fall anywhere within the broad range of conventional tillage to the complete zero-till system, with many variations. For example zero tillage has been considered as a specific form of minimum tillage (Baeumer and Bakermans 1973, Bowen, 1982).

In recent years land has become scarce due to population pressure, forcing many farmers particularly in the tropics to continually cultivate available pieces of agricultural land. It is also now apparent that most rice cultivation, particularly under large scale production would be on permanent agricultural land in the future because the room for shifting cultivation even in the tropics is getting smaller with the passage of time. The role of minimum tillage as a soil conservation technique under continuous upland rice cropping as highlighted above would be particularly vital in view of the fact that most tropical soils are highly erodible and are chararacterized by low water and nutrient retention capacities.Moreover, rice fields tend to be more prone to erosion than fields of closed canopy crops like the legumes, rice being an open canopy crop. The poor soils and food shortage in developing regions of the world where the demand for rice is increasing and irrigation facilities are inadequate in supply call for urgent research on upland rice soil management practices. Information on tillage practices for upland rice is meager.

One of the serious obstacles in successful adoption of minimum tillage for crops is weed growth. Effective weed management practices in minimum tillage is highly essential for good results. Appropriate plant spacing in dryland rice is deemed probable to improve crop establishment, enhance crop competition with weeds and increase rice yield in the system. This work was therefore designed to evaluate the effects of different tillage practices and spacing on weed growth and yield of upland rice.

MATERIALS AND METHOD

Two field experiments were conducted at the university of Ilori Teaching and Research Farm during the 1994 and 1995 wet seasons to evaluate the influence of four tillage and four spacing treatments on weed growth and yield of an upland rice cultivar (Faro 11), on a Typic, Haplustaf, loamy, sand, soil (pH, 6,7; organic carbon 1.49kg -1 ; total N 1.9kg-1 ; exchangeable K and Ca, 0.69 and 1.52 C - mol(+)kg-1 soil; available p, 6.8mgkg-1.

The experimental plot was under weed fallow for about six month after groundnut before the commencement of the experiment. The major weed species in the plot included *Vernonia cinerea* (L) less.; *Cleome rutidosperma* DC; *Euphorbia heterophylla* L; *Digitaria horizontally* Wild; *Paspalum scrobiculatum* L; *Rottboellia cochinchinensis* (Lour.) clayton; *Echinochloa colona* L. (Link).

The spacing treatments were: 20cm x 20cm, 25cm x 25cm, 30cm x 30cm, 40cm x 40cm. The seeding rate of 100kg seeds ha-1 was maintained for all spacing treatments.

The tillage treatments tested were: conventional tillage and minimum tillage which included zero tillage, reduced tillage and dry soil mulch augmented with preplant herbicide. Details of the tillage treatments are as follows:

Minimum Tillage

(a) Zero Tillage (ZT): Paraquat (1,1-dimethyl, 4,4-bipyridinium dichloride) was applied at the rate of 3 kg a.i. ha-1 to the existing weeds one week before planting (WBP). The decicated weeds were trampled under feet at the time of planting, leaving the weed mulch on the soil surface.

(b) Reduced Tillage (RT): The plots were sprayed with paraquat at the rate of 3 kg a.i.ha-1 one WBP. The plots were then harrowed once one day before planting (DBP).

(c) Dry Soil Mulch augmented with preplant herbicide (DSM + PH): The plots were ploughed once and harrowed once at the end of the cropping season of the previous year, just before the dry season set in (that is, late in October, 1993). By May 1994 the plots were sprayed with paraquat at the rate of 3 kg a.i.ha-1 one WBP, for the first experiment.

Conventional Tillage

The plots were ploughed once and harrowed twice, using the disc plough and harrow, respectively.

The design of the experiment was split plot in randomized complete block. The main plots and sub-plots represented tillage practices and spacing, respectively. Each treatment combination was replicated four times. The unit sub-plot size was 3m x 6m. The treatments were repeated on the plots in 1995.

Fertilizers were applied at the rate of 100:30:30 kg ha-1 of N, P_2O_5 and K_2O, respectively. All P and K were applied before planting but one third of N was applied along the crop rows two WAP. The other two thirds of N was applied at panicle initiation (8 WAP).

Seedling establishment was estimated at three weeks after planting (WAP) from two 1m x 1m quadrats, randomly placed in each plot. The number of newly germinated weeds at two and three WAP and weed biomass at six WAP were estimated from similar number of quadrats.

All plots were handweeded once at six WAP after the weed biomass was taken. Yield components were determined as described by Gomez (1972). Grain yield was obtained from the inner 10m2 per plot, adjusted to 12% moisture content and weighed.

RESULT AND DISCUSSION

Seedling establishment was significantly lower under the minimum tillage techniques than it was under conventional tillage; it was comparable in zero, reduced and dry soil mulch tillage practices, (Table 1). Field observations showed that seedling emergence in the minimally tilled plots was not as vigorous as it was in conventionally tilled plots.

Surface mulch appeared to hamper emergence and growth of the seedlings. The seedlings were overcrowded by weeds, particularly by existing weeds that survived the preplant application of paraquat within 4 weeks of planting. The number of crop seedlings established per unit land area increased as spacing became closer, but spacing closer than 25cm x 25cm did not further improve crop establishment count. The least number of established seedlings, was recorded in the widest spacing of 40cm x 40cm.

Higher number of panicles m-2 was recorded in conventional tillage than in the three minimum tillage treatments (Table 1). This could be attributed partly to the lower crop establishment in minimum tillage techniques. The number of filled grains panicle-1 was however higher in the minimum tillage plots than it was in conventional tillage. Stiffer competition among established plants for the limited soil water and nutrients resources could be a major factor limiting the number and viability of spikelets and the filling of grains in conventionally tilled soils as compared to untilled soil. Works have shown that the number of tilled grains depends on the number of fertilized spikelets, the level of available nutrients and water resources for plant growth and other factors influencing the deposition of carbohydrates in the grains (Parao, undated). Non-fertilized spikelets could be due to non-effective pollen, malfunctioning of pistil,drying of spikelets or other obstacles in reproductive organs, which could be caused by nutritional imbalance and moisture stress. Parao (ibid.) observed that high percentages of sterility in rainfaed rice areas is often due to moisture stress and high temperatures. The number of spikelets and filled grains panicle-1 are yield components of high capacity in rice grain yield determination. It is therefore logical to infer from the results on number of filled grains panicle-1 that with minimum tillage more grains could be produced. The results indicate that prospects for attaining the yield potential of given upland rice is more promising with minimum than with conventional tillage. Lal and Dinkins (1979) reported higher number of productive tillers per unit area for an upland rice under zero tillage than on conventionally tilled soil. The problems of poor crop establishment and weed infestation in minimum tillage system need serious attention in order to attain the yield potentials of improved rice varieties under minimum tillage practices. Comparable number of panicles per unit area were obtained from 20cm x 20cm, 25cm x 25cm and 30cm x 30cm spacing (Table 1). Spacing wider than 30cm x 30cm resulted in significantly lower number of panicles per unit area. The number of filled grains panicle-1 was appreciably higher in the wider row spacing of 40cm x 40cm than it was in the narrower row spacing of 20cm x 20cm, 25cm x 25cm and 30cm x 30cm, which were comparable. The interactions between tillage methods and spacing were not significant for any of the yield component data. The insignificant interactions suggest that spacing that is appropriate under conventional tillage was also appropriate under the minimum tillage treatments.Spacing wider than 30cm x 30cm resulted in significantly lower grain yield (Table 1) and higher weed biomass (Table 2). Grain yield was markedly higher in conventional tillage than in the three minimum tillage treatments. Significant negative correlation (r= -0.981) between grain yield and weed biomass at 6 WAP was recorded. Weed infestation thus explained a substantial proportion of the yield differences among the tillage treatments. These findings emphasize the importance of adequate and timely weed control measures in dryland rice culture, particularly under minimum tillage practices. The lower grain yield under minimum tillage could also be due in part to poor crop establishment.

Significantly higher number of weed seedlings emerged under conventional tillage than in minimum tillage at 2 and 3 WAP (Table 2). Weed biomass at 6 WAP was however markedly higher in the minimally tilled plots than it was in conventional tillage. Field observations showed that most of the weeds in minimum tillage plots were made up of existing weeds which either escaped or survived the preplant paraquat applications. The weed growth at 6 WAP in the minimally tilled plots was so much that some more crop stands were damaged while the plots were being handweeded and the damage was much more in narrower rows. This would further explain the lower grain yield recorded under the minimally tilled plots. Spacing did not significantly influence the number of weed seedlings that emerged within 3 weeks of planting. The 20cm x 20cm, 25cm x 25cm and 30cm x 30cm row spacing compared favorably in terms of weed suppression. Significantly lower weed weights were recorded in these 3 row spacing than in the 40cm x 40cm spacing. The 40cm x 40cm row spacing had no advantage with respect to suppression of weed growth.

REFERENCES

BAEUMER,K and W.A.P. BAKERMANS, 1973. Zero tillage. Advances in Agronomy 25:77-123

BOWEN, J.E. 1982. Minimum tillage: Fit it to your crops and soils. World Farming 24(3):6

GOMEZ, K.A. 1972. Techniques for field experiments with rice. International Rice Research Institute, Philippines. p.35-37.

LAL, R. and E.L.DINKINS. 1979. Tillage systems and crop production on an ultisol in Liberia. In "Soil Tillage and Crop Production." R. Lal(ed). IITA Proc. Series 2. Ibadan, Nigeria. p.221-234

PARAO, F.T. Undated. Yield components of rice. International Rice Research Institute, Los Banos, Philippines.

Table 1. Seedling establishment, yield components and grain yield of FARO 11 as affected by different tillage treatments and spacing. +

Treatments	Seedling ++ Establishment At 3 WAP (no m^{-2})	Yield Components ++ Panicle number (no m^{-2})	Filled grains (no/panicle)	weight of 100 grains(g)	Grain ++ yield (t/ha^{-1})
Tillage					
Conventional tillage	197a	270a	72c	2.1a	2.5a
Minimum tillage					
Zero tillage	124b	196c	97a	2.3a	1.0c
Reduced tillage	130b	215bc	86b	2.2a	1.3c
Dry soil mulch+ herbicide	152b	219b	83b	2.0a	1.8b
Spacing (cm)					
20cm x 20cm	204a	228a	73c	2.1a	1.7b
25cm x 25cm	179a	232a	84b	2.2a	1.6b
30cm x 30cm	130b	226a	92a	2.2a	2.0a
40cm x 40cm	90c	210b	89a	2.1a	1.3c

++ Means in a column under tillage or spacing followed by the same letters are not significantly different at 5% level (Duncans Multiple Range Test).
+ Tillage x Spacing interactions not significant; average for two experiments.
WAP: Weeks after planting.

Table 2. Weed population at 2 and 3 weeks after planting rice and weed dry weight at 6 WAP as affected by tillage and spacing treatments in an upland rice field.

Treatments	Weed Population (No M-2)++ 2WAP	3 WAP	Weed Dry Weight (kg ha-1)++
Tillage:			
Convenctional tillage	147a	187a	480c
Minimum tillage:			
Zero tillage	75b	119b	4310a
Reduced tillage	77b	116b	3280b
Dry soil multch + herbicide	83	125b	3010b
Spacing			
40cm x 40cm	99a	141a	3430a
30cm x 30cm	95a	137a	2550b
25cm x 25cm	97a	135a	2510b
20cm x 20cm	91a	134a	2510

++ Means in a comlumn under tillage or spacing folowed by the same letters are not significantly different at 5% level of DMRT.
\+ Tillage X Spacing interactions not significant
WAP Weeks after planting.