EFFICACY OF SELECTED HERBICIDES FOR WEED CONTROL IN RAIN-FED UPLAND RICE IN THE NIGERIAN NORTHERN GUIDEA SAVANNA

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Abstract

Field trials were conducted to evaluate various herbicids and herbicide mixtures for weed control in rain-fed upland rice at the Institute for Agricultural Research Farm, Samaru during the wet seasons of 1996 and 1997. Thirteen herbicide treatments were evaluated and compared with hoe-weeded control and a weedy check in a randomized complete block design with three replications. All the weed control treatments and hoe weeding significantly reduced weed growth and resulted in higher paddy rice yields than the respective weedy check. Among the various herbicide treatments tested pre-emergence application of dimethymetry at 1.0 kg a.i./ha; diflufenican at 0.3 kg a.i./ha; relof (piperophos + propanil) at 3.0 kg a.i./ha; oxidiazon at 1.0 and 1.5 kg a.i./ha; consistently combined effective weed control with good crop growth and high paddy rice yields comparable to the hoe-weeded control in both years. Unrestricted weed growth throughout the crop life cycle resulted in 53 and 73% reduction in potential paddy rice yields in 1996 and 1997 wet seasons, respectively.

Key words: Weed control, herbicide treatments, upland rice, Nigerian savanna.

INTRODUCTION

Rice is considered the most important staple food in the world as it supplies the major food requirement for more than one half of the world's population. This crop has become an important staple food whose demand is always on the increase in Nigeria largely due to increasing urbanization. As a staple food, rice has also provided more calories per hectare than other cereal crops (De Datta, 1981).

In spite of its diversified uses and high acceptability both as food and cash crop, the production of rice is constrained by a number of factors. These include problems of insect pests, diseases and weeds. Of all the constraints limiting the production of this crop, weeds, appear to have the most deleterious effect causing between 75 and 100% reduction in potential paddy rice yield (Akobundu, 1987; Imeakparice, 1989; Lavabre, 1991). Yield reduction due to weed competition is greater in direct-seeded than in transplanted rice. Inadequate land preparation, use of short-stature early maturing cultivars and increased fertilizer use have resulted in severe weed problems in direct – seeded rice. The limited data available indicate that production losses can reach 30-40% for fields that are poorly weeded (Anon 1988). With direct seeding, the germination of rice seeds and the emergence of weeds take place almost at the same time. Therefore weed control at the early stages of the crop growth is important (Nojima, 1966).

Traditional manual weeding is the most popular method of weed control in Nigeria. This is however, time consuming, labor-intensive and generally expensive. It is estimated that about 40-60% of production cost is spent on manual weeding (Remison, 1979). Rice being a closely sown crop also makes mechanical weeding difficult and some degree of crop damage is unavoidably involved in manual weeding. In addition hand weeding allows weeds with similar morphological characteristics to rice to escape detection and hence removal in direct-seeded rice fields. Besides, weeding cannot be done at a time when labour is available but this may not coincide with the optimum weeding time for minimizing weed competition. Medium and large scale farmers are particularly affected by lack of labour for hand weeding which to be affective, must take place early in the crop life cycle. If weeding is delayed beyond 20 days after emergence, irreparable damage may be done to rice crop. During early establishment, weeds make 20-30% of their growth while the crop makes 2-3% of its growth (Moody, 1990).

Hence in large scale rice production in Nigeria, chemical weed control represents a practical and economical alternative to hand weeding (Akobundu , 1987) because the use of herbicides ensures effective weed control during the period of labour shortage when weeding coincides with other farm work.

Previous reports by various workers (Ahmed and Moody, 1982; Bayer and Hill, 1989); Castin and Moody, 1989; Diop and Moody, 1989; Moody, 1991; Moody, 1992; Akobundu, 1981, Akobundu and Fagade, 1978; Imeokparia, 1989; Imeokparia and Okunsanya, 1997) have indicated that weed control with herbicides is feasible. However season-long weed control has been difficult to obtain. Differences in weed flora and their pattern of emergence during crop growth can influence the performance of herbicides. In the Nigerian savanna with its diverse weed flora, selective herbicides with wide spectrum of activity will be required for profitable rice production. This study was therefore conducted to evaluate suitable herbicides for selective and season-

long weed control in rice in the Nigeria Northern Guinea savanna ecological zone.

MATERIALS AND METHODS

Field trials were conducted at the Institute for Agricultural Research Farm, Samaru (Lat. $11^0 11^1$N, Long. 07^0 38^1E) in the Nigeria Northern Guinea savanna ecological zone during the wet seasons of 1996 and 1997. The soils of the experimental site were deep freely drained sandy loan with 4.0 – 6.8% organic matter content. In both trials the land was ploughed and disc harrowed at a two-week interval.

Thirteen herbicide treatments including dimenthymetryne at 1.0 kg a.i./ ha, diflufenican at 0.3 kg a.i./ha, relof at 3.0 kg a.i./ha, oxadiazon at 1.0, 1.5 and 2.0 kg a.i./ha, metolachlor + atrazine at 1.0 + 1.0 kg a.i/ha, metolachlor + prometryne at 0.5 + 0.5; 0.75 + 0.75 and 1.0 + 1.0 kg a.i./ha pendimethalin at 1.0; 1.5 and 2.0 kg a.i./ha were evaluated and compared with hoe-weeded and weady check in both years of experimentation. All treatments were laid out in a randomized complete block design with three replications. Herbicide treatments were applied pre-emergence one day after sowing rice (Var ITA 257) seeded at 20 x 10cm spacing. Herbicides were applied with knagsack (CP3) sprayers filled with green deflector nozzle at a spray volume of 200 – 250 litres/ ha. Fertilizers at the rate of 90 kg N/ha, 45 kg P_2O5/ha and 45 kg K_2O/ha were applied by broadcast using NPK 20:10:10 as source of fertilizer. The gross and net plot sizes were (5 x6) m^2 and (5 x 3) m^2, respectively.

Data collected included weed cover score, weed dry matter production, crop vigour score, number of tillars per stand and paddy rice yield. The crop vigour score was taken by visual observation based on a scale of 0 to 10, where 0 represented complete crop kill and 10 represented the most vigorously growing healthy crop. Similarly, weed cover score was taken by visual observation based on a scale of 0 to 10, where 0 represented no weed cover and 10 represented full weed cover. All data obtained were subjected to statistical analysis. The treatments effect were tested for significance using "F" test while treatment means were compared using Duncan Multiple Range Test (DMRT) where "F' was significant.

RESULTS

Weed survey showed that the experimental plots at both sites were infested mainly with annual grasses, some broad leaved weeds and sedges. The most common grasses where *Cynodon dactylon* (L) Pers; *Chloris pilosa* Sohum; *Dactyloctenum aegyptium* (L) Richt' *Digitaria horizontalis* (Willd) Koch; *Eleusine indica* (L) and *Eragrostis tremula* (L); while the dominant broad-leaved weeds were *Solanum nigrum* (L); *Amaranthus spinosus* (L); *Euphorbia heterophylla* (L); *Portulaca oleracea* (L) and *Vernonia galamensis* (Cass) Less. *Cyperus rotundus* (L) and *Cyperus esculentus* (L) were the commonest sedges.

All the herbicide treatments and hoe weeded control significantly reduced weed growth and resulted in higher paddy rice yields compared to the weedy check in both years of experimentation. Among the various herbicide treatments tested in this study pre-emergence application of dimethymetryne at 1.0 kg a.i./ha; diflufenican at 0.3 kg a.i./ha; relof at 3.0kg a.i./ha; oxadiazon at 1..0 and 1.5 kg a.i/ha were the most promising herbicide treatments because they consistently combined effective weed control with good crop growth and high paddy rice yields comparable to the hoe-weeded control in both years of study (Tables 3 and 4). In addition, pre-emergence application of pendimethalin at 1.0 and 2.0 kg a.i,/ha gave effective weed control and paddy rice yields comparable to the hoe-weeded control in 1997 wet season.

Inspite of effective weed control obtained with pre-emergence application of oxadiazon at 2.0 kg a.i./ha; metolachlor + atrazine at 1.0 + 1.0 kg a.i/ha; rice paddy yields obtained with these treatments were not significantly different from that of the weedy check which resulted in 53 and 73% reduction in potential paddy rice yields in 1996 and 1997 wet seasons, respectively.

DISCUSSION AND CONCLUSION

Weeds compete aggressively with rice resulting in severe yield reduction at harvesting. The upland rice crop is generally more exposed to weed competition than the flooded rice and weeds pose a more serious threat in the system. This is because both weed and rice germinate at the same time. The success of direct-seeded rice production is fundamentally dependent on weed control with herbicides (Day, 1974) because the use of herbicides ensures effective weed control during periods of labour shortage when weeding coincides with other farm work and the critical period of weed competition. Maximum yields can only be obtained if weeds are controlled early because most damage is done when crop plants and weeds are small. The performance of herbicides in this study is generally influenced by the weed flora encountered, the level of their infestation as well as dynamics of their emergence. In the Northern Guinea savanna, both grass weed killer as well broad-leaved weed killer are important to obtain wide spectorum control of weeds.

In this study, unweeded plots produced between 15.5 and 22.5 t/ha of weed dry matter. Inspite of the high weed dry matter production acceptable weed control with consequent high rice paddy yields comparable to the hoe weeded control were obtained with a number of the herbicides tested in this study. The most promising herbicide treatments were pre-emergence application of dimethymetryn at 1.0 a.i./ha and oxadiazon at 1.0 and 1.5 kg a.i./ha. These treatments reduced hoe weeding requirements and produced higher rice paddy yields of

between 200 and 330% than the weedy check. The performance of the herbicide treatments could be attributed to the effective control of both grasses and broad-leaved weeds and their selectivity on the crop. Moody (1993) earlier indicated that the use of bensulthron-methyl, bentazon butachlor, 2,4 – D, MCPA, pretilachlor and propanil among others, resulted in effective weed control and high rice paddy yield. More recently, Imeokporia and Okusanya (1997) reported that dimethymetryn in mixture with either pretilachlor at 0.5 + 1.5 kg a.i./ha or oxadiazon at 0.5 – 1.0 kg a.i./ ha combined effective weed control with high paddy rice yields similar to that of hoe-weeded control in the Nigeria Southern Guinea savanna.

Unrestricted weed growth throughout the crop life cycle resulted in 53 and 73% reduction in potential rice paddy yields in 1996 and 1997 wet seasons, respectively indicating that when rice fields are not weeded, rice grain yields are severely reduced making its production unprofitable. Akobundu (1981) also reported yield reduction of 55, 66 and 40% in 1976, 1977 and 1978 wet season, respectively, Akobundu and Fagade (1978) reported that no grain yield was obtained when weeds were removed in the crop. Similarly Ineokpara and Okusanya (1997) reported when rice fields are not weeded, rice grain yields are severally reduced making rice cultivation unprofitable.

In conclusion, the results of this study confirms earlier reports by Akobundu (1981) and Imeokparia (1989) about the possibility of controlling weeds in rice with herbicides without adverse effect on the crop. Herbicide treatments showing great promise for weed control in upland rice in this trials are pre-emergence application of dimethymetryn at 1.0kg a.i./ha; diflufenican at 0.3 kg a.i./ha; relof at 3.0 kg a.i./ha and oxadiazon at 1.0 and 1.5 kg a.i./ha. These treatments followed by one supplementary hoe-weeding at 6 weeks after sowing combined effective weed control with high rice paddy yields comparable to the hoe-weeded control.

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Tab. 1. : Physico-Chemical Characteristics Soil taken from Experimental Sites

Soil Properties 0-15cm depth	**1996**	**1997**
Sand (%)	56.00	61.25
Silt (%)	35.35	32.05
Clay (%)	8.05	6.00
Organic carbon (%)	0.60	0.70
Textural class	Sandy loam	Sandy loam
PH 1:1 (H_2O)	5.05	5.90
PH 1:25 (0.0 ml$CaCl_2$	4.85	5.70
CEC (Meg/100g soil)	6.10	3.80

Tab. 2. : Common Weed Species at the Experimental Sites (1996-1997)

Types of Weeds	**Level of Occurrence**	
A. Broad-leaved Weeds	**1996**	**1997**
Ageratum conyzoides (L)	+++	++
Acanthospermum, hispidium (D.O)	++	++
Amaranthus spinosus (L)	++	++
Commelina benghalensis (L)	++	++
Euphorbia heterophylla (L)	+	+
Euphorbia hirta (L)	+	+
Ipomea spp	+	+
Portulaca oleracea (L)	+	+
Trianthema poetulacastrum (L)	++	+
Vernonia galamensis (Cass) Less	++	++
B. Grasses		
Cynodon dactylon (L) Pers	+++	+++
Dactylodenum aegyptium (L) Beau	+	+
Digitaria horizontalis (Willd)	++	++
Eleusine indica (L) Gaert	++	++
Eragrotis tremular Hochst	+	+
C. Sedges		
Cyperus rotundus (L.)	+	+
*Cyperus esculentus (*L.*)*	+	+

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Tab. 3. : Effect of herbicide treatments on weeds, crop growth and yield of upland rice at Samaru during the wet season in 1996

Herbicides Treatment	**Rate (kga.i./ha)**	***Weed cover score (6WAS)**	**Weed dry Matter Production (t/ha)**	****Crop vigour score (9WAS)**	**Number of tillers per stand at (9WAS)**	**Rice paddy yield (kg/ha)**
Dimethymetryne	1.0	3.7d	9.3d	9a	21a	645ab
Diflufenican	0.3	4.0c	10.0c	9a	18bc	645ab
Relof	3.0	4.7b	11.8b	9a	17bc	615ab
Oxadiazon	1.0	4.0c	10.0c	9a	20ab	72a
Oxadiazon	1.5	3.3e	8.3e	9a	18bc	615ab
Oxadiazon	2.0	3.0f	7.5f	8ab	16cd	215c
Metolachlor + atrazine	2.0	2.0g	5.0h	3e	8e	105d
Metolachlor + prometryne	1.0	2.0g	5.0h	5d	13d	105d
Metolachlor + prometryne	1.5	2.0g	4.0i	7h	18bc	135d
Metolachlor + prometryne	2.0	2.0g	6.0g	6c	15cd	135d
pendimethalin	1.0	2.0g	4.8i	7b	17bc	150d
Pendimethalin	1.5	3.3e	8.3e	6c	14d	180d
Pendimethalin	2.0	3.3e	8.5e	7dc	15cd	165d
Hoe-Weeding (3x)	-	1.0h	2.8k	9a	18bc	735a
Weedy check	-	6.0a	15.5a	3e	8e	345c
SE (+)		0.12	0.3	0.98	2.5	120

WAS = Weeks after sowing
Kg a.i./ha = Kilogram active ingredient per hectare
Means followed by the same letter(s) within the same column and treatments are not significantly different at 5% level of probability (DMRT)
* Weed cover score is by visual observation on a scale of 0 to 10 where 0 represents no weed and 10 represents full weed cover.
** Crop vigour score by visual observation on a scale of 0 to where 0 represented complete crop kill and 10 represents fully grown, healthy crop.

Tab. 4.: Effect of herbicide treatments on weeds, crop growth and yield of upland rice at Samaru during the wet season in 1997

Herbicides Treatment	**Rate (kga.i./ha)**	***Weed cover score (6WAS)**	**Weed dry Matter Production (t/ha)**	****Crop vigour score (9WAS)**	**Number of tillers per stand**	**Rice paddy yield (kg/ha)**
Dimethymetryne	1.0	2.0b-d	5.0f	8.3ab	25a	1095ab
Diflufenican	0.3	2.7a-c	6.8d	9.0a	23ab	645ab
Relof	2.0	1.7b-d	4.3f	9.0a	20cd	1225a
Oxadiazon	1.0	1.3c-d	3.3fg	8.7ab	20cd	851abc
Oxadiazon	1.5	3.3b	8.3bc	8.0a-c	18de	787abc
Oxadiazon	2.0	3.0b	7.5cd	6.7a-c	17ef	983abc
Metolachlor + atrazine	2.0	1.3d	3.0g	3.7c	9h	128e
Metolachlor + prometryne	1.0	1.3d	3.5fg	6.3a-c	16ef	139e
Metolachlor + prometryne	1.5	1.3d	3.3fg	5.0bc	13fg	354de
Metolachlor + prometryne	2.0	1.0d	2.5g	5.0bc	12g	352de
pendimethalin	1.0	2.7c	6.8d	6.0a-c	13fg	697abce
Pendimethalin	1.5	3.3b	8.3bc	8.3ab	21bcd	321de
Pendimethalin	2.0	3.7b	9.3b	9.0a	22bc	666a-d
Hoe-Weeding (3x)	-	3.3b	3.3g	9.0a	23ab	809a-c
Weedy check	-	9.0a	22.5a	3.0d	8h	330d-e
SE (+)		0.5	1.25	0.96	2.4	120

WAS = Weeks after sowing
Kg a.i./ha = Kilogram active ingredient per hectare
Means followed by the same letter(s) within the same column and treatments are not significantly different at 5% level of probability (DMRT)
* Weed cover score is by visual observation on a scale of 0 to 10 where 0 represents no weed and 10 represents full weed cover.
** Crop vigour score by visual observation on a scale of 0 to where 0 represented complete crop kill and 10 represents fully-grown, healthy crop.