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Weed control in malting barley (*Hordeum vulgare* L.) under irrigation in the Sudan savanna zone of Nigeria

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ABSTRACT

Objective: To evaluate the efficacy of herbicides in the control of weeds in barley under irrigation.

Methodology and results: Two barley cultivars (Ketch and Berenice) and fifteen weed control treatments {12 herbicides, hoe – weeding at 4 and 8 weeks after planting (WAP), weed free (weeded weekly) and unweeded check} were laid out in a split – plot design with four (4) replications; assigning varieties in main–plots and weed control treatments in sub–plots. Among the herbicides evaluated, chlortoluron either applied alone (0.5 or 1.5 kg a.i/ha) or in combination with antor (0.5 + 0.5 and 0.5 + 1.0 kg a.i/ha) were most superior in controlling weeds. The maximum yields (2.09 and 2.99 t/ha) were recorded with chlortoluron + antor at 0.5 + 0.5 kg a.i/h and chlorbromuron + antor at 0.5 + 1.0 kg a.i/ha in 2001 and 2002, respectively. Methabenzthiazuron at both rates (1.0 and 1.5 kg a.i/ha) failed to effectively control weeds and did not increase crop yield when compared to the hoe – weeded check.

Conclusions and application of findings: The study results demonstrate that the herbicide chlortoluron alone at (0.5, 1.5 kg a.i/ha) or in combination with antor (0.5 + 0.5 and 0.5 + 1.0 kg a.i/ha) can be applied pre or post emergence to provide good weed management in irrigated barley to reduce the tedious, time – consuming and expensive manual hoe – weeding method that is commonly practiced.

Key words: Malting barley, weed control efficacy, grain yield

INTRODUCTION

Barley (*Hordeum vulgare* L.) is presently not cultivated on large scale in Nigeria even though it is the most suitable cereal for brewing, due to its enzymatic content. Since the ban on importation of barley malt by the Federal Government in 1985, most of the industries that utilize barley malt have geared their effort towards seeking an alternative source of malt through local production of barley and other cereals that could be used as substitutes. In order to produce the crop locally and provide the needed raw material, barley cultivars were introduced into Nigeria by the Netherlands Engineering and Development Company (NEDECO) to determine whether the crop can be successfully grown under Nigerian conditions. The cultivars screened and evaluated at Kadawa and Samaru between 1975 and 1984 grew satisfactorily and the grain yield was comparable to those of the countries leading in barley production. To further support this self reliance initiative information is desired on all aspects of barley husbandry in Nigeria environment including weed control.

Weeds growing in barley fields are strong competitors for nutrients, light and moisture, and when allowed to compete with the crop up to harvest, they can deplete up to 91.2, 19.4 and 77.5 kg of N, P and K per hectare, respectively (Yadav *et al*., 1985). Control of weeds can prevent the drain of such a large amount of nutrients that could be utilized more efficiently by the crop. Weed competition to barley usually occurs from the two–leaf stage to the onset of reproductive growth, leading to reduction in tillering, ear formation and in stem weight and height, and eventual poor grain filling (Smith & Levick, 1974; Lemerle *et al*., 1979) Yield losses in barley from weed competition ranged from 30 to 72%, depending on weed density (Wilson & Peters 1982; Morishita & Thill, 1988). Lack of weed control also reduces harvesting efficiency and the quality of the harvested barley crop. In northern parts of Nigeria, the low temperatures from November to January are unfavourable for germination and growth of weeds, until the season warms up in February. The late emerged weeds grow faster and continue with vegetative growth after the barley crop has senesced, hence becoming a hinderance to the harvesting and threshing operations.

In other regions of the world, chemical weed control in barley is a common practice and many herbicides have been shown to be effective in the control of broad–leaved weeds and grasses. Among these, bromoxynil 2, 4–D; MCPA; bentazon; diclofop–methyl; difenzoquat; isoproturon, chlortoluron, metoxuron and terbutryn are well known herbicides in barley production areas. Tag–El– in *et al*. (1989) reported that treatments containing bromoxynil (Brominal plus, Buctril M, Pardner and Brominal, each at 2.5 l/ha) were effective in controlling broad–leaved weeds, improved barley growth and yield besides being safe and selective. Use of 2, 4–D/MCPA at 1.0 l/ha showed good control of broad–leaved weeds but with slight symptoms of crop phytotoxicity and did not improve the barley growth or yield. The use of 2, 4 – D has been reported for the control of weeds in barley growing regions of the world (Sagir & Aquiquallah, 1970; Conn, 1990; Schreiber & Schonherr, 1992). However, because of tomato crop cultivation at the irrigation schemes, 2, 4 – D cannot be used on barley in Nigeria. Therefore, the present work was conducted to evaluate the efficiency of other more acceptable herbicides for use in the control of weeds in barley.

MATERIALS AND METHODS

Study site: The experiments were conducted at Irrigation Research Station, Kadawa, Kano State (11° 39'N; 08° 02'E) in 2001 and 2002 on sandy loam soil with 63% sand, 23% silt, 14% clay, 0.5% organic carbon, 6.2 pH, and exchange capacity of 5.2 mg/100g.

Experiment layout: The treatments consisted of two cultivars (Ketch and Berenice) and fifteen weed control treatments (12 herbicides, hoe weeded at 4 and 8 WAP, weed free (weekly weeding) and unweeded check), laid out in a split–plot design with four replications; keeping varieties in the main–plots and weed control treatments in the sub–plots. All the herbicides were applied post–emergence 21 days after sowing (DAS) using Knapsack (CP-3) sprayer with spray volume of 250l/ha. Weed-free plots were maintained so by weekly hand pulling of weeds until the panicle stage of the barley crop. In the two trial years, planting was done on the 15th November in rows 20cm apart using a tractor–drawn seed drill (after plowing and harrowing), at a seed rate of 100kg/ha. The gross and net plot sizes were 8 and 3 m^2, respectively. The crop was then irrigated at weekly intervals throughout the season, until two weeks before harvest.

Data recording and analyses: Observations were made on the weed cover score (using a scale of 0 – 10, where 0 represents no weed while 10 represents complete ground cover); length of spikes, number of grains per spike and grain yield. Data were subjected to analysis of variance and means compared using the Least Significant Difference (LSD) test at 5% level of probability.

RESULTS AND DISCUSSION

Survey of weed flora infesting the experimental field at the time of crop harvest revealed that *Chenopodium* spp .L., *Solanum nigrum* and *Eleusinee indica* were the dominant weed species. Besides these, other weeds were *Physalis peruviana*, *Euphorbia hirta* .L. *Portulaca oleracea* L. and *Convolvulns arvensis* L.

The effect of various treatments on weed cover score at harvest in the two years was not significant (Table 1). The late emergence of weeds coupled with shading by closely sown barley crop resulted in reduced weed challenge. Although not significant, the trend indicates that chlortoluron either alone or in combination with Antor (0.5 + 0.5 or 0.5 + 1.0) were superior to hoe–weeding in controlling the weeds. The poor efficiency of hoe–weeding as compared to these herbicides may be attributed to the fact that only some of the inter–row weeds were eliminated, and the intra–row weeds escaped hoe–weeding. The hoe may also have damaged some of the crop stand (Gautam & Mani, 1975). Earlier researchers have reported good biomass reduction of the main annual weeds of up to 96% when tria sulfuron and chlortoluron mixture were applied either pre– or post–emergence on barley crop (Knezevic *et al*., 2003). In terms of weed control, the unweeded check was similar to the treatments that received methabenzthiazuron at both rates (1.0 and 1.5 kg a.i/ha).

Table 1: Effect of various treatments on weed cover score and spike length of malting barley cultivars at Kadawa, Nigeria.

Treatments	Rate ka a.i/ha (Post emergence)	Weed Cover[1] Score at Harvest		Spikes/m row length	
		2001	2002	2001	2002
Varieties					
Ketch		2.0	2.1	98	106
Berenice		2.9	3.0	105	112
		NS	NS	NS	NS
Weed Control					
Methabenzthiazuron[2]	1.0	3.0	3.0	84^b	99^b
Methabenthiazuron	1.5	2.0	3.0	89^b	102^b
Chlortoluron	0.5	0.5	0.5	120^a	128^a
Chlortoluron	1.5	1.0	0.5	115^a	116^a
Chlorbromuron	0.5	1.5	1.5	109^a	121^a
Chlorbromuron	1.5	1.5	1.0	118^a	123^a
Butachlor[3]	1.5	2.0	2.5	99^b	98^b
Butachlor	2.5	2.5	2.0	88^b	90^b
Chlortoluron + Antor[4]	0.5 + 0.5	1.0	1.5	112^a	103^b
Chlortoluron + Antor	0.5 + 1.0	0.0	1.0	114^a	102^b
Chlorbromuron + Antor	0.5 + 0.5	0.5	2.0	102^a	89^b
Chlorbromuron + Antor	0.5 + 1.0	0.0	0.5	98^b	98^b
Hoe – weeding at 4 & 8WAP	-	2.0	2.0	86^b	92^b
Weed free	-	0.0	0.0	102^a	112^a
Unweeded check (Control)	-	3.5	4.5	108^a	118^a
LSD (0.05)		NS	NS	20	18
Interaction					
V x WC		NS	NS	NS	NS

Means on the same column with the same superscript are not significantly different (P>0.05). 1 = Weed cover score; where 0 = No weed and 10 = Complete ground cover; 2 = Methabenzthiazuron = N-(benzothiazol – 2 – yl) N – N, N^1 – dimethylures; 3 = Butachlor = N – (butoxymethyl) 2 – chloro – 2^1, 6^1 – diethylacetanilide; 4 = Antor = 50% $^W/_V$ of Diethanthylethyl. Weed free = weekly weeding.

The number of spikes/m row length was significant in the two years in response to the various treatments (Table 1). However, the two cultivars were not statistically different from each other. In the two years, both rates of Butachlor (1.5 and 2.5 kg a.i/ha); Methabenzthiazuron (1.0 and 1.5 kg a.i/ha) and plots that were hoe – weeded at 4 and 8 WAP gave lower spikes/m row length when compared to all other treatments. In both years, the maximum yields were recorded with chlortoluron + antor at 0.5 + 0.5 kg a.i/ha and chlorbromuron + antor at 0.5 + 1.0 kg a.i/ha. These treatments increased the grain yield significantly over other herbicides, hoe – weeding and the unweeded control (Table 2).

The maximum yields obtained in these trials (2.09 and 2.99 t/ha) were close to those obtained in other parts of the world (yield average of 2.34 t/ha) (Oerke & Dehne, 2003). More spikes per unit area as a result of effective weed control were presumably responsible for a significant increase in crop yield. Methabenzthiazuron at both rates in the two years (1.0 and 1.5 kg a.i/ha) failed to increase crop yield over hoe–weeding probably because of its inefficiency in controlling the weeds. This was similarly manifested by treatments that received Butachlor at both rates of 1.5 and 2.5 kg a.i/ha.

In the two years, cultivars did not differ significantly in terms of grain yield, though cv. Ketch gave better grain yield. Due to the fact that in Nigeria tomato crop is also grown within the irrigation schemes, 2,4-D cannot be used on barley because of crop phytotoxicity and the increased risk of exposure to tomato consumers. This work was able to identify a number of herbicides that did not have any phytotoxic effect on the barley crop, that gave good weed control efficacy and improved grain yield.

Information gained from this study will be used to further evaluate both pre- and post-emergence herbicides for weed control in barley under irrigation.

Table 2: Effect of various treatments on yield components and grain yield of malting barley at Kadawa, Nigeria.

Treatments	Rate ka a.i/ha (Post emergence)	Numbers of grain/spike		Grain Yield (kg/ha)	
		2001	2002	2001	2002
Varieties					
Ketch		20.5	19.0	1570	2295
Berenice		25.0	22.0	1454	2141
		NS	NS	NS	NS
Weed Control					
Methabenzthiazuron[2]	1.0	23.0	21.5	1334[c]	2077[c]
Methabenthiazuron	1.5	22.0	21.0	1416[c]	1954[c]
Chlortoluron	0.5	20.0	19.0	1750[b]	2572[b]
Chlortoluron	1.0	20.0	18.0	1666[b]	2446[b]
Chlorbromuron	0.5	20.5	18.5	1584[b]	2329[b]
Chlorbromuron	1.0	20.5	19.0	1750[b]	2472[b]
Butachlor[2]	1.5	20.0	19.5	1500[c]	1974[c]
Butachlor	2.5	22.0	19.5	1416[c]	2010[c]
Chlortoluron + Antor[3]	0.5 + 0.5	22.0	23.0	2105[a]	2985[a]
Chlortoluron + Antor	0.5 + 1.0	17.0	17.0	1710[b]	2580[b]
Chlorbromuron + Antor	0.5 + 1.0	23.5	24.0	2085[a]	2905[a]
Chlorbromuron + Antor	0.5 + 1.0	16.0	17.0	1660[b]	2410[b]
Hoe–weeding at 4 & WAP	-	23.0	22.5	1416[c]	2077[c]
Weed free	-	23.5	22.5	1416[c]	2349[b]
Unweeded check	-	20.0	19.0	1334[c]	1974[c]
LSD (0.05)		NS	NS	185	272
Interaction					
V x WC		NS	NS	NS	NS

Means on the same column with the same super script are not significantly different (P>0.05); 1 = Methabeazthiazuron = N – (benzothiazol – 2 – yl) N – N, N[1] – dimethylures; 2 = Butachlor =N = (butoxymethyl) 2 – chloro – 2[1] 6[1] – diethylacetanilide; 3 = Antor = 50% $^{W}/_{V}$ of Dimethathylethyl. Weed free = weekly weeding.

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