Productivity of Finger Millet (*Eleusine coracana* (L) Geartn) as Influenced by Pre-emergence Herbicides in the Northern Guinea savanna of Nigeria

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ABSTRACT

Two field trials were conducted during 2011 and 2012 wet seasons at the Research Farm of the Institute for Agricultural Research, Ahmadu Bello University, Samaru Zaria (Lat. 11^{o} 11^{1}N, Long. 07^{O}38E and 686m above sea level), in the northern Guinea savannah zone of Nigeria, to evaluate the efficacy of pre-emergence herbicides on weed in finger millet. The treatments were atrazine (80WP) at the rates of (0.4, 0.8, 1.2 and 1.6 kg a.i/ha), RafT® (500SC) (Atrazine 250 g/l + Terbuthylazine 250 g/l) at the rates of (0.25, 0.5, 0.75, and 1.0 kg a.i/ha) and Bullet$^{(R)}$ (700SC) (Atrazine 225 g/l + Terbuthylazine 225 g/l + Acetochlor 250 g/l) at the rates of (0.35, 0.75, 1.05 and 1.4 kg a.i/ha), hoe weeded control at 3 and 6 WAS and a weedy check. The treatments were laid out in a Randomized Complete Block Design (RCBD), replicated 3 times. The result shows that all the herbicide treatments significantly reduced weed dry weight than the weedy check. Application of atrazine at 0.8 kg a.i/ha or Raft at 0.5 kg a.i/ha gave lower weed dry weight and weed cover score than the hoe weeded control at 3 and 6WAS.While all the rates of Bullet, Raft at 0.75 and 0.1 kg a.i./ha and atrazine at 1.2 and 1.6 kg a.i./ha resulted in lower weed dry matter production which were comparable to hoe weeded control at 3 and 6WAS. Based on the results obtained from this study, 0.8 kg a.i./ha atrazine or 0.5 kg a.i./ha Raft gave season long weed control over hoe weeded check in finger millet with yield increase of 94.2 and 99.5%, respectively. The weedy checks reduced yield of finger millet by 66.7%.

Key word: Finger millet, weed, pre-emergence, herbicide.

1.0 INTRODUCTION

Finger millet is one of the minor cereals known with several health benefits. These benefits are attributed to its high level of polyphenol, dietary fibre, minerals and essential amino acids. Epidemiological studies have demonstrated that regular consumption of whole grain cereals and their products can protect against the risk of cardiovascular diseases, type II diabetes, obesity, gastrointestinal cancers, anti-tumerogenic, atherosclerogenic effects,

antioxidant and microbial properties and a range of other disorders (McKeown 2002). Despite the important of the crop, it has been reported largely neglected by national and international research centres compared to the research lavished on other cereals particularly in the Sub-Saharan Africa. (Anon.1996; Mgonja, 2005). In West Africa, finger millet is cultivated in a wide geographical zone stretching from Senegal, Niger and Northern Nigeria. (Burkill, 1985). In Nigeria, Finger millet is grown in very few states such Kaduna and Plateau in the northern parts of the country with an average yield of 580-785kg/ha. (Anon., 1996). This low yields on farmers field in Nigeria and elsewhere have been attributed to poor agronomic management practices such as poor weed management, inadequate population density, soil fertility among others. A yield loss due to uncontrolled weeds in the first 6 weeks of finger millet growth was reported to be 78.2, 82.2 and 83.1% in 1997, 1998 and 1999 respectively (Bulus, 2002).The common weed control methods used by farmers include manual hoe weeding and hand pulling which are laborious, time consuming and expensive. Therefore, the need to carry out research on alternative weed control methods such as the use of appropriate dose of herbicides that can selectively give season long weed control in finger millet with reduce drudgery and crop injury associated with manual weeding, increase weed control efficacy, reduced cost of weed control and ultimately increase crop yield, necessitated the research. The study was therefore conceived to evaluate other cereal based herbicides for weed control in finger millet without supplementary weeding.

2.0 MATERIALS AND METHODS

Two field trials were conducted during the 2011 and 2012 rainy seasons, at the research farm of the Institute for Agricultural Research (IAR), Ahmadu Bello University, 2012, Zaria. (lat. 11^0 11^1 N, long 07^0 38^1 E, 686m above sea level) northern Guinea savannah, ecology of Nigeria. Treatments consist of Atrazine 80WP at rate of (0.4, 0.8, 1.2 and 1.6 kg a.i./ha), Bullet ® 700SC (Atrazine 225g/l +Terbuthylazine 225g/l +Acetochlor 250 g/l) at rate of (0.35, 0.70, 1.05 and 1.40 kg a.i./ha), Raft® 500SC (Atrazine 250 g/l + Terbuthylazine 250 g/l) at rate of (0.25, 0.5, 0.75 and 1.0 kg a.i./ha), hoe weeded control at 3 & 6 WAS and a weedy check. This was laid in a randomized complete block design (RCBD) with 3 replicates. The Gross and net plots were 13.5m^2 and 10.5m^2. Sowing was done manually by dibbling at a spacing of 20cm by 10 cm respectively. Spraying was done immediately after sowing, using Knapsack sprayer fitted with a flat fan nozzle and volume of spray (250 L ha-1) was determined by calibration using water on treatment basis. Basal application of Inorganic fertilizer at 90kg N, 45 kg P_2O_5 and 45 kg K_2O per hectare, was applied by broadcast. N was applied in two equal split doses with second half of N was applied as top dressing at 6WAS using urea (46% N).The crop was harvested at maturity when the panicle turned brownish in colour, indicated by free threshing of the grains when the heads fingers are squeezed by hand. It is cut about 5cm above the ground using knives, dried for 3days before threshing on a floor by beating with sticks and winnowed to remove the straws, foreign material and unfilled grains. The following observations were recorded during the course of the investigation; weed composition, days to emergence, emergence count per plot crop vigour, weed cover score, crop injury score, weed dry weight**,** stand count at harvest, days to 50% heading and grain yield at harvest. All data collected were subjected to

statistical analysis of variance (ANOVA) as described by Gomez and Gomez (1984). The significant means were compared using Duncan's Multiple Range Test (Duncan, 1955).

3.0 Results

3.1 Weed Composition

The common weed samples at both experimental sites were collected at 6 and 12 WAS to assess the types of weed species, classified into grasses, broadleaves and sedges (table 1). The extend of the classification was based on low, moderate and high population.

Table 1: List of weed species observed in 2011 and 2012 experimental sites during the wet season

Type of Weeds		**Levels of Infestation**	
Grasses	**Family**	**2011**	**2012**
Cynodon dactylon (L.) pers.	Poaceae	+++	+
Rottboellia cochinchinensis (Clayton)	Poaceae	+++	+
Eleusine indica Gaertn	Poaceae	+++	+++
Digitaria horizontalis Willd	Poaceae	+	++
Panicum maximum jacq	Poaceae	+	++
Chloris pilosa Schumach.	Poaceae	++	+
Dactyloctenium aegyptium (Linn.) P. beauv	Poaceae	++	++
Broadleaves			
Commelina benghalensis Linn.	Commelinaceae	++	+++
Euphorbia heterophylla Linn.	Euphorbiaceae	+++	+++
Ageratum conyzoides Linn.	Asteraceae	+++	+++
Acanthospermum hispidium DC	Asteraceae	++	+++
Sedges			
Cyperus esculentus Linn.	Cyperaceae	++	+
Cyperus rotundus Linn	Cyperaceae	+	+

+ = Low Intensity, ++ = Moderate Intensity, +++= High Intensity

3.2. Days to Emergence Count

The significant difference in days to emergence of finger millet observed during the weed management practice in both years is shown in (table 2.). Across the two years, the application of bullet consistently increased the number of days to emergence of finger millet with increasing concentration from 0.35 – 1.40 kg ai/ha than all other herbicide treatments, hoe weeded control and weedy check which were statistically similar.

3.3 Emergence Count

The effect of weed control treatments on the emergence count of finger millet in both years

are shown on (table 2). Weed control treatments had significance effect on the emergence count of finger millet in the two years. In both years, application of atrazine at 0.4 kg a.i/ha, raft at 0.25 kg a.i/ha, hoe weeded control and weedy check gave significantly higher emergence count of finger millet than all other treatments. Bullet at all concentrations, raft at 0.75 kg a.i/ha and 1.0 kg a.i/ha at 2012 gave the least emergence count.

3.4 Crop Injury Score

The effect of weed control treatments on crop injury score of finger millet was significant in both years (table 2). Across the two years, application of bullet at all concentration and rates at 1.0 kg a.i/ha consistently resulted in higher crop injury score of finger millet than all other herbicide treatments. The hoe weeded control and weedy consistently gave least crop injury score.

3.5 Weed Cover Score

The influenced of weed control treatments was significant on weed cover score of finger millet in both sampling periods (table 3). In 2011, weedy check and raft at 1.0 kg a.i/ha produced significantly higher weed cover score of finger millet than all the other herbicide treatments. The hoe weeded control consistently gave least weed cover score. In 2012, weedy check significantly resulted in consistently higher weed cover score of finger millet than all other herbicide treatments.

3.6 Weed Dry Weight g/m^2

The effects of weed control treatments on weed dry weight were significant across the two years. (table 3). Generally, in 2011, the weedy check consistently resulted in significantly higher weed dry weight than all other herbicide treatments at 6WAS. The hoe weeded control at 3 and 6 WAS consistently gave least weed dry weight in the two years. In 2012, weedy check resulted in significantly higher weed dry weight than the hoe weeded control at 3 and 6 WAS and all the other herbicide treatments but were comparable to atrazine at 0.8 kg a.i /ha.

3.7 Crop Vigour Score

The influence of weed control treatment on crop vigour score across the two years is presented in (table 2). Weed control treatment had significant effect on crop vigour score of finger millet in both years. Hoe weeded control at 3 and 6WAS gave the highest crop vigour score in both years which was comparable with atrazine at 0.4 and raft at 0.5 kg a.i/ha at 2011. This was followed by atrazine at 0.80 in both years and atrazine at 0.40, 0.8 and 1.2 kg kg a.i/ha, bullet at all rates gave the lowest and comparable crop vigour score in both years.

3.8 Stand Count at Harvest

The stand count at harvest differed significantly due to weed control treatments across the years (table 3). In 2011, the application of atrazine at 0.4 and 0.8 kg a.i/ha, raft at 0.25 and

0.5 kg a.i/ha and hoe weeded control produced significantly higher stands of finger millet at harvest than all the other herbicides treatments. This was followed by weedy check, bullet at all rates gave the least per cent stand count in the study. While in 2012, hoe weeded control resulted in significantly higher stands of finger millet than all other herbicide treatments. Bullet at 0.35 and 1.40 kg a.i/ha gave comparable but the least stands of finger millet.

3.9 Days to 50% Heading

The effect of weed control treatments significantly influenced days to 50% heading in both years (table 3). In 2011, the application of bullet at all rates took longer days to 50% heading of finger millet than all other herbicide treatments. This was followed by raft at 0.75 and 1.0 kg a.i /ha. Atrazine at 0.40 and 0.80kg a.i/ha, raft at 0.25 and 0.5 kg a.i/ha and hoe weeded control at 3 and 6 WAS took shorter days to 50% heading of finger millet which was comparable with weedy check. Similarly, at 2012, the application of bullet at 1.4 kg a.i/ha and raft at 1.0 kg a.i/ha took significantly longer days to 50% heading of finger millet than all other herbicide treatments. This was followed by bullet at 0.70 and 1.05 kg a.i/ha. Hoe weeded control at 3 and 6 WAS, raft at 0.25, 0.50 and 0.75 kg a.i/ha, atrazine at 0.40 and 0.80 kg a.i/ha and weedy check gave comparable but least number of days to 50% heading of finger millet.

3.10 Grain Yield kg/ha

The grain yield of finger millet as influenced by weed control treatments in the two years are presented in (table 3). The effect of weed control treatment on grain yield of finger millet was significant in both years. In 2011, among the herbicides treatments evaluated, application of atrazine at 0.8 kg a.i/ha. Raft at 0.5 and hoe weeded control, produced significantly higher grain yield which were statistically at par. This was followed by atrazine at 0.4 and raft at 0.25. Raft at 1.0 and all the rates of bullet produced comparable and lower grain yield. In 2012, hoe weeded control gave significantly higher grain yield than weedy check and all herbicides treatments, this was followed by raft at 0.50 and 0.75. All the bullet treatments, this was followed by raft at 1.0 kg a.i /ha which produced consistently lowest grain yield across the two years.

Table 2: Effect of weed control treatments on days to emergence, emergence count per plot, weed cover score, weed dry weight and crop injury score of finger millet in 2011 and 2012 wet season

Treatment	Rate(Kg a.i./ha)	**Days to Emergence** 2011	2012	**Emergence Count Per Plot** 2011	2012	**Crop Injury Score[4]** 2011	2012	**Weed Cover Score[5]** 2011	2012	**Weed Dry Weight (g/m^2)** 2011	2012
Atrazine	0.40	4.0d[1]	4.0d	1350.0a	1350.0a	1.3f	1.6f	4.7b[1]	7.0b	39.4ef	40.9.0 c
Atrazine	0.80	4.0d	4.3d	1125.0b	1165.0bc	3.0e	2.7d	2.7cd	7.0b	27.1fg	13.7c
Atrazine	1.20	4.0d	4.3d	1026.0c	1130.0c	4.7d	4.0d	2.3de	4.0c	42.7ef	20.5c
Atrazine	1.60	4.0d	4.0d	945.0c	1022.0d	5.0cd	4.7c	3.3c	4.0c	81.8c	30.2c
Raft	0.25	4.0d	4.0d	1350.0a	1350.0a	1.3e	1.4e	4.7b	4.7b	63.5d	80.2b
Raft	0.5	4.0d	4.0d	1148.0b	1238.0b	3.0e	2.3f	2.0ef	4.1b	53.0de	100.3b
Raft	0.75	4.3d	4.0d	841.0d	901.0e	6.7c	5.0c	1.7efg	2.3c	54.0de	99.1b
Raft	1.0	4.3d	4.3d	270.0e	405.0f	8.7ab	8.5ab	1.3fg	2.0d	107.8b	100.1b
Bullet	0.35	11.0c	10.3c	226.0ef	338.0f	8.3b	7.9b	2.0ef	2.3e	105b	114.2b
Bullet	0.70	11.3c	11.0b	180.0ef	315.0f	8.7ab	8.4ab	2.0ef	2.0d	108.5b	109.5b
Bullet	1.05	12.7b	11.3ab	135.0f	270.0f	8.3b	8.1b	1.0g	1.3e	108.3b	98.5b
Bullet	1.4	14.0a	11.7a	135.0f	293.0f	9.0a	8.8a	1.0g	1.0e	96.0bc	105.9b
Hoe Weeded at 3 and 6 WAS[2]		4.0d	4.3d	1350.0a	1350.0a	1.0f	1.0g	2.0ef	2.0f	8.9g	12.9c
Weedy Check		4.0d	4.0d	1350.0a	1350.0a	1.0f	1.0g	8.7a	7.7a	281.5a	171.0a
SE±		0.22	0.17	21.87	30.11	0.19	0.18	0.24	0.22	5.6	7.2
Significance		*[3]	*	*	*	*	*	*[3]		*	*

[1]means within a column of treatments followed by unlike letter(s) are significantly different at 5% level of significance using DMRT. [2]week After Sowing [3]Significance at 5% level of probability .Raft (Atrazine + Terbuthylazine), Bullet (Atrazine + Terbuthylazine + Acetochlor). Crop injury score[4] using a scale of 1-9, where 1=no crop injury and 9= most injured crop. Weed cover score[5] using a scale of 1-9, where 1 =least weedy plot and 9=most weedy plot

Table 3: Effect of weed control treatments on crop vigour score, stand count at harvest, days to 50% heading and grain yield of finger millet in 2011 and 2012 wet season

		Crop Vigour Score[4]		**Stand Count at Harvest**		**Days to 50% Heading**		**Grain Yield at Harvest (Kg/ha)**		
Treatment	Rate (Kg a.i./ha)	2011	2012	2011	2012	2011	2012	2011	2012	Combined
Atrazine	0.40	8.0ab[1]	5.7bc	1314.0a	1080.0b	76.7f	75.3de	1610.3b	1345.0	1477.7b
Atrazine	0.80	7.7bc	6.3b	1219.0a	1036.0b	76.0f	75.7de	1832.3a	1900.8ab	1866.6a
Atrazine	1.20	4.7c	6.3b	855.0c	828.0c	80.3d	76.0d	1370.0c	1112.6d	1241.3cd
Atrazine	1.60	6.0d	4.3d	853.0c	752.0d	80.3d	76.0d	1040.0d	1305.4c	1172.7d
Raft	0.25	6.7c	6.3b	1310.0a	1036.0b	76.7f	75.0e	1588.0b	1262.0c	1425.0b
Raft	0.5	8.7ab	5.0d	1269.0a	1071.0b	76.0f	75.0e	1936.5a	1789.7b	1863.1a
Raft	0.75	2.7f	2.3f	766.0c	666.0e	80.0b	75.3de	1327.1c	1389.8c	1359.5bc
Raft	1.0	6.7c	2.0f	280.0d	415.0g	80.0b	78.7a	242.6f	209.8e	226.2f
Bullet	0.35	1.7fg	2.0f	226.0de	338.0h	86.7abc	77.0c	182.4f	216.6e	199.5f
Bullet	0.70	1.7fg	2.0f	135.0e	450.0fg	87.0abc	78.0b	262.6f	265.4e	264.0f
Bullet	1.05	1.0g	1.7f	130.0e	496.0f	87.0abc	78.0b	238.5f	248.4e	243.5f
Bullet	1.4	1.0g	2.0f	129.0e	334.0h	88.7a	78.7a	194.9f	208.6e	201.8f
Hoe Weeded at 3 and 6 WAS[2]		9.0a	9.0a	1320a	1306.0a	76.0f	75.0e	1945.5a	1960.5a	1953.0a

Weedy Check	4.7e	3.3e	1076.0b	1080.0b	77.0ef	75.3de	611.0e	223.4e	417.2e
SE±	0.31	0.27	27.41	24.3	0.39	0.23	42.0	45.8	43.9
Significance	*	*	*[2]	*	*	*	*	*	*

[1]means within a column of treatments followed by unlike letter(s) are significantly different at 5% level of significance using DMRT. [2]week After Sowing [3]Significance at 5% level of probability .Raft (Atrazine + Terbuthylazine), Bullet (Atrazine + Terbuthylazine + Acetochlor).Crop vigour score[4] using a scale of 1-9, where 1 =least vigourous plot and 9=most healthy plot

4.0 **DISCUSSION**

4.1 EFFECT OF WEED CONTROL TREATMENTS ON WEEDS

The major weed species that were found at the two sites of the trials included*; Cyperus dactylon, Cyperus spp, Roettbollia cochinchinensis, Eleusine indica, Digitaria horizontalis, Acnthospermus hispidum, Commelina benghalensis, Euphorbia heterophylla* and *Ageratum conyzoides.* These weed species were observed to have more intensity in 2012, which invariably led to more competition for growth factors and lower yield. This aggressive nature of these weeds further confirmed the report by DAS (2008) who observed that finger millet productivity was low since weeds pose one of the major constraints during the production of the crop owing to initial slow growth of the crop, which favours weed growth and caused more competition for sunlight, nutrient water and space at the early growth stage of the crop.

Weed control treatments reduced weed infestation than the weedy check in both years. Application of atrazine at 0.8 and raft at 0.5 kg a.i/ha resulted in lower weed cover score and weed dry weight than the hoe weeded control at 3 and 6 WAS. This may be due to the suppressive effect of the herbicides phytotoxicity on weeds that prevented any weed interference with the crop. This further confirmed the report by Baker (2003) that for good weed control in pearl millet production, atrazine as a preplant incorporated or pre emergence treatment at rates of 0.5 – 1.0 kg a.i/ha gave best weed control.

The higher dose of raft at 0.75 and 1.0kg and atrazine at 1.2 and 1.6kg, evaluated in these trials, resulted in lower weed dry matter production which were comparable to hoe weeded control at 3 and 6 WAS and all the bullet treatments. This observation can be attributed to the fact that herbicides exhibit their herbicidal effect with higher concentration and increase in dosage which resulted not only in the drastic reduction of susceptible plants species but also reduced dry matter accumulation through photosynthesis inhibit ion. Several researchers have reported reduction in weed dry matter production due to herbicide application in various crops (Ghosheh, 2004, Ishaya, 2004, Mahadi, 2011 and Tunku, 1997).

Consistently throughout the growing period of the crop and across the years, herbicide treatments containing all bullet treatments and raft at 1.0 kg a.i/ha, had significantly higher crop injury score which severely injured the crop seedlings. Plant either failed to emerge from treated soil or delayed germination or severely twisted shortly after emerging, recording very few stands per plot, shorter plants, lowest crop vigour score and longer days to 50% heading compared to the hoe weeded control. This resulted in very poor yield than the weedy check.

This could be attributed to the presence of acelochlor in bullet which slowly metabolized in finger millet a small seeded grain. This is in line with the report by Anon. (1996) that small seeded cereal tolerance to acetochlor depends on it rates of metabolism and that acelachlor can only be used for weed control in corn with the uses of a safener. This further confirms the company's report that 18months waiting period should be observed before introducing another crop to that field where bullet was used. Also raft at 1.0 kg a.i/ha was toxic to the crop. This could be a higher rate which was not tolerated to be the crop. Shebayan (1982) reported pre-emergence application of atrazine at higher dose of 4 kg a.i/ha which reduced stand count of sorghum.

4.2 EFFECT OF WEED CONTROL ON GRAIN YIELD OF FIGER MILLET

It was observed that, application of atrazine at 0.80 and raft at 0.50 kg a.i/ha produced grain yield with and increased of 94.2 and 90.5%, respectively, when compared to hoe weeded control treatment at 3 and 6 WAS. This herbicides demonstrated low phytotoxicity effect on the crop, better manifestation of growth, good selectivity performance and better utilization of available growth resource, hence highest grain yield was produced. This is in conformity with the findings of Yadav (1971) who observed that atrazine applied at the rate of 1.0 kg a.i/ha as premergence reduced dry weight of weeds by 67% and increased the grain yield of sorghum by 103%. Hand weeding and application of 0,5 kg a.i./ha of atrazine were next best giving increases in yield of 95 and 91% respectively. Also Das (2008) reported that some herbicides have growth regulatory action on the crop plants and can boost their growth and subsequently yield better than in weed-free check or hand weeding. Jain *et al*. (1976) found atrazine applied at 0.75 to increase the yield of pearl millet. Prusty *et al*. (1988) reported that herbicides boost crop yield due to effective control of the weeds.

Generally the results observed with the application of atrazine at 0.80 and raft at 0.50 kg a.i/ha, is an indication that these herbicides rates can replace twice or thrice hoe weeding during finger millet cultivation. This agrees with Akobundu (1987) who reported the use of herbicide is said to be less strenuous, less labour demanding and do not disturb the soil which reduces erosion.

All bullet, treatments and raft at 1.0 kg a.i/ha produced lowest yield than even the weedy check. This could be due to the fact that, these herbicide rates were highly phytotoxic to the crop, resulting to a very few stands count per plot. This finding is in line with Joshua *et al*., (2001a) who reported that, atrazine at (2.0-3.0 kg a.i/ha), Primextra and Dual (2.0-2.5 kg a.i/ha) controlled weeds more effectively but reduced yields in millet and consequently reduced grain yields, Ndahi (1981) reported that atrazine, a common herbicide used in sorghum production, appeared to have depressed the grain yield of millet when applied at the rate of 2.42 kg a.i/ha. In 2012, hoe –weeded control gave higher grain yield than all the herbicide treatments evaluated and the weedy check. This could probably due to the fact that weed interference was prevented from the crops therefore, better utilization of growth factors by the crops hence promoted greater growth and yield. This is in conformity with the finding of Kulmi (1999) that yield increases with effective weed control which reduced weed interference and enhanced the formation of more tillers, an important attribute of grain yield.

5.0 CONCLUSION

Based on the results obtained from this study, 0.8 kg a.i./ha atrazine or 0.5 kg a.i./ha Raft gave season long weed control over hoe weeded check in finger millet with yield increase of 94.2 and 99.5%, respectively. The weedy checks reduced yield of finger millet by 66.7%.

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