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Improving weed management in the draft animal-based production of early pearl millet in The Gambia

Keywords: Survey of annual weeds in pearl millet; estimation crop losses; yield advantage in early control of weeds within-the-row.

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Abstract. Production of the early varieties of pearl millet (*Pennisetum americanum* (L.) K. Schum.) is increasing because of their earliness and drought tolerance in the face of a shortening and decreasing rainy season. Weeds were considered as a major constraint on improving yields. To improve weed management in millet, the major weeds have been identified in on-farm surveys as a pre-requisite to identifying appropriate weed control recommendations. Grain yield losses incurred by farmers' weeding practices were found to range from 27 to 36%. Early control of weeds within-the-rows, either by handhoeing or by band application of low rates of atrazine or propazine, increased yields by more than 50% in 1985 and by more than 30% in 1986 over farmers' practice. The band herbicide treatment was, however, more cost-effective and easier-to-accomplish than handweeding of weeds within-the-rows.

Introduction

Farmers in the Gambia produce millet, sorghum, maize and rice as the basic staple crops. Since the onset of drought in the early eighties there has been a significant shift from the production of the preferred late millet, sorghum and maize to production of early types of pearl millet (*Pennisetum americanum* (L.) K. Schum). Early millet is drought tolerant and its short life cycle is more adapted to a decreasing and shortening rainy season.

Although the area of early millet under production has increased from 15 000 ha. in 1982 to over 22 000ha in 1984 (Ministry of Agriculture 1984), grain yields have peaked at around 700 kg/ha in spite of sustained efforts to improved yields through crop improvement and fertilizer use. The major cause of poor yields is the inadequacy of traditional weeding practices to combat the intense weed competition in the initial stages of crop growth arising from poor land preparation. Planting of the crop is usually done after the first significant rainfall of the season by dibbling or seeding with animal-drawn seeders into seedbed prepared by just slashing and burning of previous vegetation. Only a small proportion of the crop may be seeded into reasonably clean seedbed giving rise to a problem where weed would emerge before or simultaneously with the crop. Consequently, weed competition is intense in the beginning of the crops' growth.

Furthermore, the first weeding takes the form of cultivating weeds between-the-rows with animal-drawn cultivators at 10 to 15 days after planting. No efforts are made to control weeds within-the-row until 2 to 3 weeks later, after the farmer has completed the establishment of the priority cash crop of groundnuts or cotton. Even so, the control of weeds within-the-rows is by handhoeing, a practice which is not only prodigal of labour (15 man-days/ha) but also inherently slow and therefore exacerbates weed competition leading to high crop losses.

There was an urgent need, therefore, to seek alternative methods of controlling weeds within-the-row more efficiently before yields of early millet could be improved. Improving weed management in early millet was recognized as a research priority in the CILSS (Interstate Committee for Drought Control in the Sahel) executed Integrated Pest Management (IPM) Project in the Gambia. The objectives of the weed management programme of IPM were as follows:

(i) To determine the predominant groups of weeds present during the growth period of millets in farmers' fields as a pre-requisite to indentifying appropriate weed control recommendation.
(ii) To estimate crop losses caused by farmers weeding practices.
(iii) To evaluate improved weed management practices.

Materials and methods

Studies on weeds in early millet fields

The surveys were conducted in 1984 at the five observation posts established by the IPM project in the country to monitor and survey major pests and collect local meteorological data. At each post, five farmers' fields of millet were chosen at random. In each field, five quadrats, each measuring 1 m by 1 m, were staked out with one plot in the centre and the rest on the four diagonals 10 m distance from the central plot, forming a St Andrew's cross.

Observations on weeds were made at forth-nightly intervals commencing before the first weeding. Weeds were uprooted in the five quadrats at each interval and separated into groups of grasses, sedges (cyperaceae), legumes and broadleaved weeds, and counted.

Crop losses caused by farmers weeding practices

The objectives were to estimate grain yield losses caused by weed competition after the farmer has effected his weeding practices, and to demonstrate the benefits to be derived from timely and frequent weedings. Five farmers' fields were chosen at each of the test sites of Karantaba and Nema Fula during the 1985 and 1986 seasons. A test level of timely weedings were randomly superimposed over what the farmers do in their fields. Four plots, each measuring 3 m by 3 m, were staked out at random in each selected field and weeded as follows:

(i) 1st weeding, within 3 weeks after crop emergence; between-the-row cultivation plus hand weeding within-the-rows.
(ii) 2nd weeding, 3 weeks after the first and consisted of cultivating weeds between-the-rows.
(iii) 3rd weeding, handhoeing of late emerging weeds especially the parasitic weed *Striga hermonthica* at 4 weeks following the second weeding.

Grain yields were determined within the staked plots and compared with yields in adjacent plots of same size but weeded in the farmers' own way. Analysis of variance was carried out on the data with the test level of weeding and farmers' practice as treatments and the four plots as replicates in each field.

Evaluation of improved weed management practices in draft animal-based production of early millet

The trial was carried out on the Agricultural Research Station at Sapu in the 1985 and 1986 seasons. The objective was to evaluate the economic advantages of early control of weeds within-the-rows, either by handweeding or by the use of band application of low rate of pre-emergence herbicide, over the traditional farmers' practice of controlling between-the-row weeds first before within-the-row weeds are controlled.

The design of the trial was of randomized complete block with two replications. Plot size was 20 m by 20 m and the treatments were as follows:

(1) Farmers' practice of seeding with animal drawn Eco-seeder in no-tilled seedbed. Between-the-row weeds were cultivated using animal drawn tine-cultivator at 12 days after planting. Handweeding of weeds within-the-row was done at 3 weeks following the tine-cultivation. Compound fertilizer was broadcast basally at a dose of 30 kg/ha N, 30 kg/ha P_2O_5 and 30 kg/ha K_2O.
(2) Criss-cross tine-cultivation of seedbed prior to seeding. Seeding, fertilizer application and weeding were as in treatment (1).
(3) Bands of 20 cm width and 90 cm apart were cultivated prior to seeding. Seeds were jab planted 50 cm apart within-the-rows. Basal fertilizer was side-dressed along the seed rows at same rate as in treatments 1 and 2. Weeds within-the-rows were handweed 12 days after planting. Between-the-row weeds were left until 20 cm tall and tine-cultivated.
(4) Seeding in rows 90 cm apart with animal-drawn Eco-seeder. Basal fertilizer side placed along the seed rows. Pre-emergence application of atrazine in 1985, and propazine in 1986 at 0.8 kg a.i./ha in 20 cm bands over crop rows. Between-the-row weeds left until 20 cm high and then cultivated.

Counts of weed species and fresh weight of weeds were determined in five quadrats of size 90 cm by 90 cm in each plot. Grain yield, labour input and costs of inputs were also determined for the treatments.

Results and discussion

Studies on weeds in early millet fields

Results of the survey showed that the most important group of weeds was the annual grasses. Annual grasses were dominant in the early stages of the crop's growth except where there were heavy infestation of the legume *Cassia obtusifolia* Linn. They provided the bulk of competition throughout the critical period which had been established in millet to be from emergence to 7 weeks after emergence (Oppal *et al.* 1969, Icrisat 1976). The five most common annual grass species were *Digitaria ciliaris* (Retz.) Koel, *Paspalum scrobiculatum* Linn, *Dactyloctenium aegyptium* (Linn.) P. Beauv. *Setaria pumila* (Poir.) Roem. & Schult. and *Brachiaria distichophylla* (Trin.) Stapf. (Terry 1981). Of these, *D. ciliaris* was by far the most difficult to control by farmers' practices because of its stoloniferous habit and quick regenerating powers.

The next important group of weeds was the annual broadleaved weeds. These emerged earlier or at the same time as the grasses but only becoming dominant and competitive after most of the grasses have been eliminated and died down. Five of the most common species were *Mitracarpus villosus* (S.w.) DC., *Acanthospermum hispidum* DC., *Synedrella nodiflora* Gaertn., *Hyptis suaveolens* Poit. and the parasitic *Striga hermonthica* (Del.) Benth (Terry 1981).

Although species belonging to the family Cyperaceae were as numerous as grasses and broadleaved weeds at some posts, they were usually of small stature and therefore posed less of a problem from competition. The notorious *Cyperus rotundus* Linn. was rarely observed.

Among the legumes, *Cassia obtusifolia* Linn. was very dominant and the first weed to emerge where it existed. This weed, together with *Sesbania pachycarpa* DC., were fast becoming the dominant species in fallow and range land because of their immense generative capacity and the fact that they were not palatable to livestock.

Crop losses caused by farmers' weeding practices

Grain yield losses incurred by farmers' weeding practices ranged from 21 to 35% with an overall mean of 29% at Karantaba in the Lower River Division during the 1985 season (Table 1). Comparative losses were much higher the following season as a result of onset of drought soon after the crop was established. Grain losses in 1986 ranged from 15 to 67% with a mean of 36% (Table 1).

Calculated yield losses at Nema Fula in the MacCarthy Island Division was from 10 to 44% in the 1985 season, and from 27 to 35% in the following year (Table 2). The overall mean losses were 27% in 1985 and 30% in the 1986 season. Two of the farmers carried out their first weeding within-the-rows at the same time as the test plots were weeded in 1985, but failed to carry out a third weeding. This might explain the slight improvement of the test treatment over the farmers' practice.

Crop losses or for that matter grain yield losses caused by uncontrolled weeds have been estimated as high as 70% in India (ICRISAT 1976), between 36 and 71% in Nigeria (Choudhary and Lagoke 1981) and 78% in the Gambia (CPS

Table 1. Grain yield losses caused by farmers' weeding practices in Millet at Karantaba, 1985–86

Farmer	1985 Season			1986 Season		
	Farmer practice (kg/ha)	Improved weeding (kg/ha)	% Yield increase	Farmer practice (kg/ha)	Improved weeding (kg/ha)	% Yield increase
1	1262	1687	34*	449	597	32*
2	561	697	24	672	830	23
3	1089	1326	21	980	1392	42*
4	524	689	31*	713	1194	67*
5	759	1028	35*	961	1105	15
Mean	839	1085	29	755	1025	36

* Significant at the 5% level of probability

Table 2. Grain yield losses caused by farmers' weeding practices in early millet at Nema Fula, 1985–86.

Farmers	1985 Season			1986 Season		
	Farmer practice (kg/ha)	Improvement weeding (kg/ha)	% Yield increase	Farmer practice (kg/ha)	Improved practice (kg/ha)	% Yield increase
1	1055	1466	38**	1288	1638	21
2	1458	1694	16*	883	1260	30*
3	805	1165	44**	1291	1652	28*
4	1375	1514	10	1149	1499	30*
5	—	—	—	1191	1610	35**
Mean	1173	1459	27	1160	1532	30

* Significant at the 5% level of probability.
** Significant at the 1% level of probability.

Annual Report 1978). These estimates were, however, derived from experiments in which plots kept weed free were compared with unweeded plots. As such they were grossly exaggerated since most farmers practiced some form of weed control in the course of the crop's growth.

The approach used in this study was more realistic in that it attempted to estimate losses due to weeds after farmers have effected their weed control; in other words, the benefits to be derived from more timely and frequent weedings. Furthermore, the trials were carried out in farmers' fields rather than on-station where conditions of weed fauna and management practices were usually totally different.

It has been shown that yields of early millet could be increased 27 to 35% by improved weed management. Such increases could mean a lot to the economy when it is considered that over 30000 tonnes of the crop were produced in 1985. The basic difference between the test weeding regime and farmers' practice was in the time of weeding within-the-row weeds. This was done at the same time as the first cultivation of weeds growing between-the-rows in the test treatment i.e. about 12–15 days after seeding. On the other hand, farmers carried out the first weeding of cultivating between-the-rows with animal-drawn cultivators at 12 to 15 days after seeding. Handweeding of weeds within-the-row was postponed until about 3 weeks after the initial cultivation and not before the establishment of their high value or priority cash crops of groundnuts, maize or cotton. This was too late to prevent crop losses being caused by intense competition within-the-rows.

A second cultivation of weeds between-the-rows was carried out 3 weeks after the first one in the test treatment. This second cultivation was also done by most farmers. What farmers did not do was to carry out a late handhoeing of late emerging weeds and particularly the parasitic weed *Striga hermonthica.*

The question now is, would farmers be attracted by the demonstrated benefits of timely control of within-the-row weeds and change their weeding habits? Under the present circumstances with demand for labour peaking at the beginning of a short rainy season and farmers having to establish three or more crops, it is most likely that they would persist in postponing the labour-intensive task of hoeing within-the-row weeds. The likely solution, then, would be to introduce less labour-intensive and easier-to accomplish methods of controlling within-the-row weeds.

Evaluation of improved weed management practices in draft animal-based production of early millet

The yield data presented in Tables 3 and 4 showed that treatments involving early control of within-the-row weeds produced at least 50% more grain in the 1985 season and over 30% more in the 1986 season in on-station trial conducted at the Sapu Agricultural Station. These yield advantages were significant in comparison with farmers' weeding practice.

The inherent advantages of early control of within-the-row weeds either by handweeding or by herbicide were two-fold. In the first instance, the absence of any form of

Table 3. Evaluation of weed control practices in early millet at Sapu, 1985

Treatment	Yield in kg/ha	Wt. of fresh weeds in kg/per 9 m²	% increase in yield over farmer practice	Incremental income in dalasis/ha
Farmer practice, zero-tillage, later followed by intra-row weeding	1074	1.60	—	—
Cultivation, Inter-followed by intra-row weeding	1385	1.90	29	112.33
Handweeding 20 cm band followed by inter-row weeding	1615	0.40	50	211.73
Herbicide in 20 cm band followed by inter-row cultivation	1657	0.30	54	336.12
L.S.D. 5%	233	1.10	—	—

Table 4. Evaluation of weed control practices in early millet at Sapu, 1986

Treatment	Yield in kg/ha	% Increase in yield	Incremental income in dalasis/ha
Farmer practice zero-tillage, late, followed by intra-row weeding	1078	—	—
Cultivation, Inter-row, followed by intra-row weeding	1341	24	67.04
Handweeding 20 cm band followed inter-row cultivation	1462	36	128.52
Herbicide in 20cm band followed by inter-row cultivation	1439	33	198.83
L.S.D. 5%	113	—	—

land preparation other than slashing and burning of previous vegetation, and the fact that the crop was usually seeded after the first significant rain of the season, resulted in weeds either germinating before, or simultaneously with, the crop. Weed competition was, as expected, severe in the first few weeks of crop's growth particularly within-the-rows where crop plants were spaced more closely. Consequently, any delay in removing weeds within-the-row would result in far more yield loss than corresponding delay in cultivating between-the-row weeds. This fact has also been observed experimentally in sorghum (Korwar and Friesen 1985).

Secondly, a lot of dead mulch was generated *in situ* by allowing between-the-row weeds to grow up to 20 cm tall before being cultivated. The mulch helped to smother further weed growth and most likely improved the water-holding capacity and fertility of the soil. It could also be contended that the tall weeds growing between the rows could serve as 'trap' or 'catch' crops for the parasitic weed *Striga hermonthica* and thereby help to deplete the soil's bank of seed.

There was not much difference in yield and the degree of weed control between early handweeding of the 20 cm bands and band herbicide application. Even though the band herbicide treatment did not control weeds as efficiently as handweeding with regards to grasses, it did suppress them sufficiently enough to enable the crop to establish faster and form an early canopy in the rows. Economic assessment of the two treatments clearly showed the band herbicide application to be more cost-effective because it was less labour intensive and easier to accomplish. Gains in income for the band herbicide application over handweeding of bands were more than D120.00 and D70.00 in 1985 and 1986, respectively.

Tillage of seedbed prior to seeding improved grain yields over farmers' practice of zero-tillage with significant effect in the 1986 season. It was most probable that cultivation delayed emergence of weeds and lessened weed competition. However, since the aim of most farmer was to take time from land preparation for the establishment of their cash crops, it would be difficult to see how this practice will be adopted.

Initial reaction of farmers to band herbicide treatment was very favourable. This practice was also one of the impact points of the pilot demonstration of integrated crop management package for early millet in fifteen farmers' fields in 1985 season. The results showed distinct yield advantages where ever the band herbicide application was employed and farmers accepted the practice as a significant improvement over their previous practice (Manser 1985).

Early millet was ideally suitable to this kind of herbicide management. The crop has a low cash value relative to the other crops and hence a blanket pre-emergence treatment would be uneconomical. Its seedling vigour and tillering ability also helps to form an early canopy within-the-rows which obviated the need for supplementing the herbicide action with weeding.

The next logical step in the programme will be to develop equipment for ground application which can be attached to the Eco-seeder so that seeding and band herbicide appli-

cation, in that order can be done in the same operation. Another flaw of the band herbicide treatment was that neither the atrazine applied in 1985, nor the propazine applied in 1986 controlled the already emerged grasses such as *Digitaria* and *Setaria* spp. It would be useful to include paraquat in a mixture with the pre-emergence herbicide so as to improve the killing action on already emerged weeds.

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References

CHOUDHARY, A. H. and LAGOKE, S. T. O., 1981, Weeding Control in pearl millet in the savanna zone of Nigeria. *Tropical Pest Management* **27**, 465–471.

CROP PROTECTION SERVICE DEPT., 1978. Annual Report Ministry of Agriculture, Yundum, The Gambia.

ICRISAT, 1976. Weed management systems. pp. 175–177. In *ICRISAT Annual Report 1975–76*. International Crop Research Institute for the Semi-Arid Tropics, Hyderabad, India.

KOWAR, G. R. and FRIESEN, G. H., 1985. In-the-row weed management in sorghum. *Tropical Pest Management* **31**, 24–26.

MANSER, P., 1986. Report of the integrated crop management project at the village level in the Gambia, Banjul, FAO (Mimeo) 9 pp.

MINISTRY OF AGRICULTURE, THE GAMBIA, 1984. *Report on the 1984/85 integrated fertilizer demonstration and related activities in the Gambia* (Mimeo) 19 pp.

TERRY, P. J., 1981. Weeds and their control in the Gambia. *Tropical Pest Management* **27**, 44–52.