# Dynamics Of Weed Flora In Speargrass (*Imperata Cylindrica* (L.) Raeuschel) Dominated Fallow As Influenced By Chemical Weed Control And Row Spacing In Soybean (*Glycine Max* (L.) Merr).

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**ABSTRACT**
Two Field trials were conducted at Ijorimenger and Asukunya in Tarka Local Government Area of Benue State (07$^o$ 14'N, 08$^o$ 37'E), in 2007 and 2008 cropping seasons, with the objective to determine the influence of chemical herbicides and row spacing on the control of speargrass and population dynamics of weed flora. Pretillage glyphosate at the rate of 2.16 kg a.i/ha followed by hoe weeding at 6 WAP and fluazifop-p-butyl at the rate of 0.25 kg a.i/ha followed by hoe weeding at 6 WAP significantly reduced speargrass density compared with hoe weeding control at 3 and 6 WAP. A total of 22 and 16 weed species were found under fallow and in the soil. The weed flora at preharvest of soybean, was dominated by *Ageratum conyzoides* (L.) and *Rottboellia cochinchinensis* (Lour ), which thrived in plots treated with postemergence fluazifop-p-butyl at the rate of 0.25 kg a.i/ha and pretillage glyphosate at the rate of 2.16 kg a.i/ha respectively. The preponderance of weeds not found under fallow but which emerged after disturbance indicated that there was a change in weed flora composition and density. These results suggest that the use of pretillage glyphosate and fluazifop-p-butyl at 2.16 and 0.25 kg a.i/ha respectively followed by hoe weeding at 6 WAP was effective in suppressing speargrass seedling emergence and change in weed flora composition.

**Keywords:** Weed flora dynamics, glyphosate, fluazifop-p-butyl, speargrass.

## Introduction

Speargrass, *Imperata cylindrica* (L.) is a perennial rhizomatous, strong colonizing and competitive weed which was identified as a common weed of the humid savannah of sub-Saharan Africa (Avav and Okereke, 1997) and has been described among the world's worst weed (Holm *et al.*, 1977). It is a short-lived monocarpic perennial grass which produces mainly vegetatively from underground stems called rhizomes that contain vast amount of carbohydrates. Speargrass over-winters in the soil as perennial roots that regenerate under favourable conditions of germination in the following season. These morphological characteristics lead to high field persistence. Once established, speargrass is difficult to control because of its network of rhizomes. In arable crops and pastures this competitive weed can markedly reduce productivity.

Speargrass competing early in soybean can reduce yields by as much as 50% or more in Benue State which account for about 90% of the total national production (Avav, 1997)

Several control techniques for controlling speargrass in cereals and legumes crops have been used including intercropping cover crops in corn/cassava cropping system (Chikoye *et al.,* 2001) and in maize (Akobundu *et al.,* 2000; Chikoye *et al.,* 2004), hoe weeding in soybean (Kolo *et al.,* 2008) and the use of herbicides (Avav *et al.,* 2002; Lum *et al.,* 2005). Row spacing also influences the competitive relationship between *Glycine max* and weeds (Burnside and Wick, 1969). The use of hoe weeding as the common weed control in Nigeria have resulted in sustainability concerns, however, farmers in the savanna have been rapidly adopting the use of herbicides like glyphosate as pre-plant and fluazifop-p-butyl as post emergence in the control speargrass. These practices are likely to result in greater speargrass management and may provide a shift in the floristic composition of the arable land.

Shading is a major means by which crop plants suppress weeds. Soybean, for example, where grown at appropriate plant population of 400,000 plants/ha (Pepper, 1983) and with early weeding developed close canopy after six to eight weeks, which helped to shed weeds (Ellis-Jones *et. al*, 2003). Plant population densities and row spacings that maximize shading by hastening canopy closure should be considered when planning a crop management programme (Avav, 1997). Decreasing row spacing and increasing crop plant density has been shown to increase competitiveness of many crops (Teasdale, 1991). As a soil conservation measure, canopy closure in narrow rows can provide protection against soil erosion from raindrop impact. Faster canopy closure also may reduce weed germination, growth, and establishment by shading. Soybean planted in 19cm rows reduced total weed biomass, increased soybean yield, and resulted in similar to higher net return compared to soybean planted in 57 cm and 95 cm rows (Reddy 2001).

Successful weed control is difficult to achieve because of continues changes in weed populations. Any weed-control method that removes or suppresses target weed species may result in modification or disruption of the habitat of other organisms (Redoservich *et al.,* 1997). Weed population shifts have occurred most readily after continuous use of a control technique that promotes high selection pressure on the population (Blackshaw *et al.,* 1994; Buhler *et al.,* 1994). A less intensive approach to weed management requires a sound understanding of weed population dynamics so as to avoid unacceptable population growth (Lutman *et al.,* 2008). From long-term population studies, Doucet *et al.,* (1999) reported that weed management intensity, defined as herbicide application frequency, was more important than crop rotation in regards to changes in density and diversity of weed species relative to other control methods. Herbicides have a greater potential to select phenotypes that will persist after

treatment by killing the more susceptible phenotypes in a population or by reducing their reproductive potential. (Cousens and Mortimer, 1995).

The objective of this research therefore was to determine the effects of row spacing and herbicides on speargrass control and weed flora dynamics in a speargrass dominated fallow.

## Materials and Methods

Field studies were conducted at Ijorimenger and Asukunya in Tarka Local Government Area Benue State ($07^0$ 14'N, $08^0$ 37'E), Nigeria. The experiments were established on a sandy loam soil heavily infested with *Imperata cylindrica* with an average of 170 shoots/$m^{-2}$ at fallow. Soybean (cv TGX 1448 2E) was planted on the $10^{th}$ July 2007 and $18^{th}$ July 2008 at 10cm intra-row and thinned to two seedlings per stand at 2 WAP. The treatments were arranged as a 2 x 3 factorial experiment in a randomized complete block design (RCBD) with four replications. The treatments consisted of soybean: spacing narrow spacing (50 x 10cm) and wide spacing (75 x 10cm) and three weed control options including pretillage glyphosate (applied as Sarosate, 2.16 kg a.i. $ha^{-1}$) followed by supplementary hoe-weeding at 6 WAP; Postemergence fluazifop-p-butyl, (applied as Fusilade super 125EC, 0.25 kg a.i. $ha^{-1}$) at 3 WAP and 6 WAP; and Supplementary hoe-weeding at 3 and 6 WAP as the control. Herbicides were applied by knapsack sprayer with a deflector-type impact nozzles and spray volume of 200 l/ha.

The fallow and field weeds at pre-harvest were identified counted and recorded using a ($1m^2$) quadrat thrown at random in each sampling plot. Five samples were randomly collected by taking the topsoil of each sampling plots to a depth of 10cm, weighed and put into wooden germination boxes as described by Fenner (1985) and well labeled. The soil samples were then watered daily for a period of 6 weeks and emerged weeds were termed soil weeds.

Observations were made on the speargrass shoot density at pre-harvest of soybean and percentage frequencies of fallow weed species; field weed species at preharvest of soybean and soil weed species in the seed bank. Frequency of each weed species calculated as the percentage of sites in which the species was present in specific treatment. The data was subjected to Analysis of Variance to test treatment means for significant on speargrass shoot density at pre-harvest of soybean. Means were separated using Least Significant Difference (LSD) at the P = 0.05.

## Results and Discussion

In Table 1, there were 22 different weed species under fallow recorded prior to land preparation in 2007. Combined over locations, there were 16 annual and 6

perennial species. Additionally, 13 were dicots and 9 monocots under fallow weeds. Conversely, the soil seed bank was comprised of 14 annual and 2 perennial with 10 dicots and 6 monocots weed species. The most dominant fallow weed species (*Imperata cylindrica, Andropogon gayanus, Digitaria horizontalis, Panicum maximum and Rottboellia cochinchinensis)* but were not the most dominant in the soil. Similarly, the dominant soil weeds; *Cyperus haspan, C. difformis* and *Eurphobia hyterophylla* are absent under the fallow weed species. A striking feature of the seed bank is the general disparity between the species contained in it and the present-day vegetation (Moore, 1980). Earlier report revealed that the weed species which were found in the soil but not in the field may have belonged to early successional stage following bush fires which were rampant in the study area (Avav *et al.*, 2002).

Weed management influenced the frequency rankings of weeds present at harvest. (Fig 1a) shows frequency ranking of species that were found to escape weed control treatments after speargrass control in 2007 (Table 2). Weed frequencies in the pretillage glyphosate treatment are higher than that of other treatments. Weed that escaped most frequently in this treatment were *R. cochinchinensis*, and *P. maximum* whereas in the post emergence fluazifop-p-butyl treated plots, *A. conyzoides, Eurphobia hirta* and *Tridax procumbens* adapt the plots. The hoe weeded plots exhibited high field persistence of speargrass which suppressed the growth of other weeds. Abdul-wahab and Naib (1972) reported that speargrass inhibits germination and growth of some plants and weed species in their vicinity. Consequently, the competitive ability of ichgrass to colonize the field in the pretillage glyphosate plots after the control of speargrass also indicated the phytotoxic effect of allelochemicals present in itchgrass, since it interferes with the growth of other plant (Lejeune *et al.,* 1994; Kobayashi *et al.,* 2008).

The same weed species; *R. cochinchinensis, A. conyzoides* and *I. cylindrica* represented the most frequent escapes in 2008 in the pretillage glyphosate, post emergence fluazifop-p-butyl and hoe weeded control, respectively (Fig.1b). For example, frequency of escape of *R. cochinchinensis* in pretillage glyphosate was 98 percent. These values were 94 percent for *A. conyzoides* in the post emergence fluazifop-p-butyl and 90 percent for *I. cylindrica* in the hoe weeded control (Table 3). The use of glyphosate to control speargrass led to a subsequent change in the weed flora in which *R. cochinchinensis* colonized the field. This may be attributed to stronger allelopathic potential of speargrass that suppressed the emergence and naturalization of the field with other weed species. Similarly, fluazifop-p-butyl has a pronounced phytoxicity on grasses while broadleaved weeds are unaffected (Akobundu, 1987).

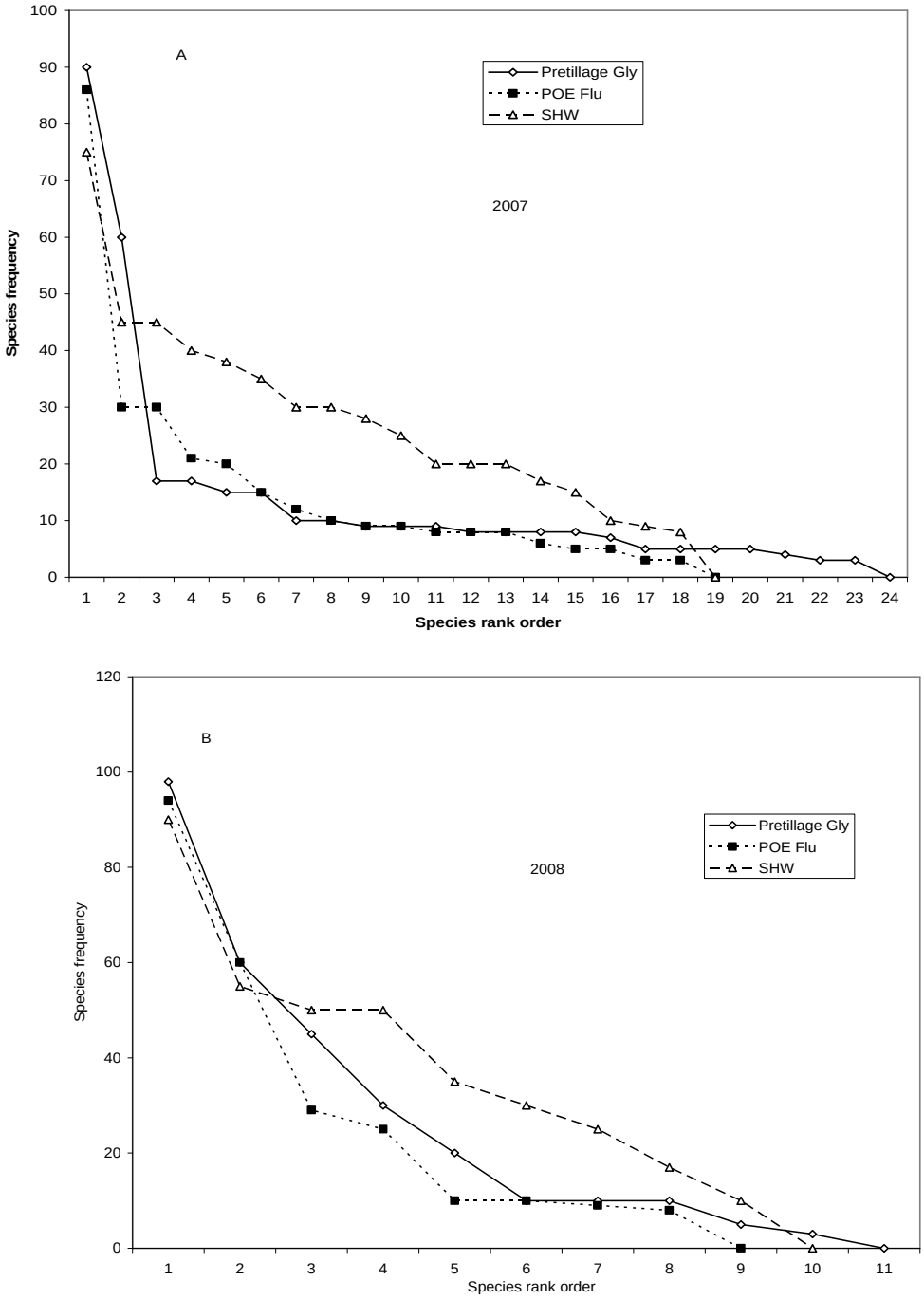



Fig. 1: Frequency of weed species recorded in different treatments at the two locations in 2007 and 2008. Refer to table 2 and 3 for details.

The naturalization of the postemergence fluazifop-p-butyl treated plots by *A. conyzoides* may be due to vigorous growth that suppresses other species or genetic factors that makes the weed to grow more aggressively than others or allelopathy since it out-competed other crop weeds. Xuan *et al.,* (2005) reported that *A. conyzoides* possess a strong allelopathic potential against most crop weeds. The high field persistence of speargrass in the hoe weeded treatment may be attributed to multiplication of the regenerative cuttings during hoe weeding. This also contributes to the weedy characteristics of this species. The change in weed flora species as a result of the herbicides application may be due to the removal of the dominant weeds that may cause minor to become major weeds. When herbicides removed those weeds, any physical and allelopathic protection they may have provided was eliminated, thereby allowing the proliferation of common weeds. The herbicide treatments suppressed dominant species and allowed the development of common species, which manifested itself as high weed flora dynamics in this trial. The objective of weed management should be to reduce the impact of weeds on crop yield by maintaining a diverse community of controllable weed species (Clements *et al.,* 1994) so that any weed species that is difficult to control does not become dominant.

Frequency of diverse weeds is beneficial to indicate changes in weed species composition. Changes in species abundance will result in changes in the complete composition (Scursoni *et al.,* 2006). Understanding the processes underlying weed species shifts is particularly important in determining the long-term sustainability of a management practice. Recognizing the mechanism is also valuable in designing integrated weed management practice that optimize herbicide use and prevent the evolution of resistance to a particular herbicide (Hilgenfield *et al.,* 2004).

In general, treatment of speargrass with pretillage glyphosate and post emergence fluazifop-p-butyl at 3 WAP followed by supplementary hoe weeding at 6 WAP recorded a declined in speargrass shoot density (Fig. 2). Effective control (> 96%) of speargrass in the pretillage glyphosate followed by supplementary hoe weeding at 3 and 6 WAP was obtained in the two consecutive years of control resulting in very low speargrass densities (1-2 shoots $m^{-2}$) in the final crop. With post emergence application of fluazifop-p-butyl at 3 WAP followed by supplementary hoe weeding at 6 WAP, effective control (> 70%) of speargrass density was not significantly different between year , ranging from 4 shoots $m^{-2}$ in 2007 to 11 shoots $m^{-2}$ in 2008. However, in the hoe weeded control, speargrass was highly resilient and still managed to produced 37 to 46 shoots $m^{-2}$ in the two consecutive years, which would be adequate for build-up of future weed infestations. The decreased in speargrass seed bank was responsive to the weed management practices employed in both the current and previous year crops. The ability of the glyphosate to reduce speargrass density may attribute to the time of application. In May and June, all freshly synthesized carbohydrates were retained in shoots, but later

in dry season transport to belowground rhizomes to over-winters. These herbicides controlled about 96-98 percent of the weed (Avav *et al.,* 1995).

**Table 1: Common fallow and soil weed species at Asukunya and Ijorimenger in 2007 wet season.**

| Weed Species | L[a] - M[b] | Fallow | | Seedbank | |
|---|---|---|---|---|---|
| | | Asukunya | Ijorimenger | Asukunya | Ijorimenger |
| | | % Frequency | | | |
| *Ageratum conyzoides* L. | A - D | 10 | 25 | 0 | 10 |
| *Andropogon gayanus* Kunth | P - M | 60 | 55 | - | - |
| *Celosia trigyna* L. | A - D | 0 | 5 | - | - |
| *Commelina benghalensis* L. | P - D | 8 | 5 | - | - |
| *Cyperus difformis* L. | A - M | 20 | 10 | 9 | 17 |
| *Cyperus haspan* L. | P - M | - | - | 30 | 20 |
| *Cyperus tuberosus* L. | P - M | - | - | 12 | 0 |
| *Digitaria horizontalis* Wild | A - M | 65 | 50 | 9 | 0 |
| *Eleusine indica* (L) Gaert | A - M | 10 | 10 | 10 | 0 |
| *Erasgrostis tenella* Hochst | A - M | - | - | 10 | 12 |
| *Euphorbia heterophylla* L. | A - D | 40 | 33 | 17 | 8 |
| *Euphorbia hirta* L. | A - D | 27 | 9 | - | - |
| *Imperata cylindrica* L. | P - M | 98 | 96 | - | - |
| *Kyllinga erecta* Schum | P - M | 0 | 15 | - | - |
| *Ludwigia hyssopifolia* G.Don | A - D | 3 | 5 | 2 | 0 |
| *Ludwigia prostrata* L. | A - D | - | - | 0 | 3 |
| *Metacarpus villosus* (SW) D.C. | A - D | 40 | 33 | 0 | 9 |
| *Oldenlandia herbacea* (L) Roxb | A - D | 0 | 8 | 5 | 0 |
| *Panicum maximum* Jacq | P - M | 60 | 38 | - | - |
| *Pennisetum pedicellatum* Trin | A - M | 15 | 75 | - | - |
| *Plastostona Africana* (P) Beaux | A - D | 5 | 0 | - | - |
| *Phyllanthus amarus* Schum. et Thorn | A - D | 0 | 5 | 0 | 2 |
| *Physalis angulata* L. | A - D | 3 | 3 | 0 | 5 |
| *Rottboellia cochinchinensis* (L) Clayton | A - M | 75 | 60 | - | 10 |
| *Sesame indicum* L. | A - D | - | - | 3 | 5 |
| *Solanum torvum* Swartz | P - D | 7 | 3 | - | - |
| *Tridax procumbens* L. | A - D | 11 | 4 | 0 | 2 |

[a]L: Life cycle – A, annual or P, perennial

[b]M: Morphotype – D, dicotyledonous or M, monocotyledonous

**Table 2: Weeds species recorded preharvest of the soybean crop in both experiments in 2007 at Asukunya and Ijorimenger.**

| Weed Species | L[a] – M[b] | Pretillage Glyphosate | Post emergence fluazifop-p-butyl | Supplementary Hoe weeding |
|---|---|---|---|---|
| | | (% freq) | (% freq) | (% freq) |
| *Ageratum Conyzoides* L | A – D | 17 | 86 | 20 |
| *Andropogon gayanus* Kunth | P – M | 5 | 0 | 38 |
| *Cassia mimosoides* L. | P – D | 9 | 10 | 0 |
| *Chromolaena odorata* (L) R.M.King | P – D | 0 | 5 | 0 |
| *Commelina benghalensis* L. | P – D | 5 | 0 | 10 |
| *Corchorus tridens* L. | A – D | 8 | 0 | 20 |
| *Cypeus haspan* L. | P – M | 15 | 5 | 30 |
| *Daniella oliverii* (Roffo) Hatch & Dalz | P – D | 5 | 0 | 0 |
| *Dissotis erecta* (Guill and Perr.) Dandy | A – D | 0 | 9 | 0 |
| *Dactyloctenum aegyptium* (L) Wild | A – M | 3 | 0 | 0 |
| *Digitaria horizontalis* (Wild) | A – M | 0 | 15 | 30 |
| *Eurphobia heteropylla* L. | A – D | 0 | 20 | 35 |
| *Eurphobia hirta* L. | A – D | 8 | 30 | 25 |
| *Eleusine indica* Gaertn | A – M | 10 | 0 | 0 |
| *Erasgrostis tenella* Hochst | A – M | 5 | 0 | 0 |
| *Fimbristylis littoralis* L. | A – M | 8 | 0 | 0 |
| *Imperata cylindrica* (L) Raeuschel) | P – M | 4 | 21 | 75 |
| *Kyllinga erecta* Schum | A – M | 0 | 3 | 8 |
| *Ludwigia hyssopifolia* G.Don | A – D | 7 | 3 | 25 |
| *Metracarpus villosus* (SW) D.C | A – D | 17 | 8 | 0 |
| *Oldenlandia herbacea* (L) Noxb | A – D | 0 | 0 | 45 |
| *Richardia brasiliensis* L. | P – D | 9 | 0 | 0 |
| *Panicum maximum* Jacq | P – M | 60 | 8 | 45 |
| *Pennisetum pedicellatum* Trim | A – M | 15 | 9 | 28 |
| *Phyllanthus amarus* Schum et.Thorn | A – D | 0 | 0 | 17 |
| *Plastostoma africanum* P. Beaux | A – D | 0 | 8 | 20 |
| *Pycrenus lanceolatus* | P – M | 0 | 0 | 50 |
| *Rottboellia cochinchinensis* Clayton | A – M | 90 | 12 | 43 |
| *Solanum torvum* Swartz | P – D | 9 | 6 | 0 |
| *Sorghum arundinaceous* (Desu) | A – M | 8 | 0 | 0 |
| *Tridax procumbens* L. | A – D | 3 | 30 | 9 |
| *Vernonia ambigua* Kotschy and Peyr | A – D | 10 | 0 | 0 |

[a] L: life cycle – A, annual or P, perennial
[b] M: Morphotype – D, dicotyledonous or M, monocotyledonous.

Glyphosate in plants inhibits the activity of enolpyruvyl shikimate phosphate synthase, which is involved in synthesis of phenolic amino acids (Amrhein *et al.* 1980). A reduction in concentration of phenolic amino acids reduces protein synthesis, eventually

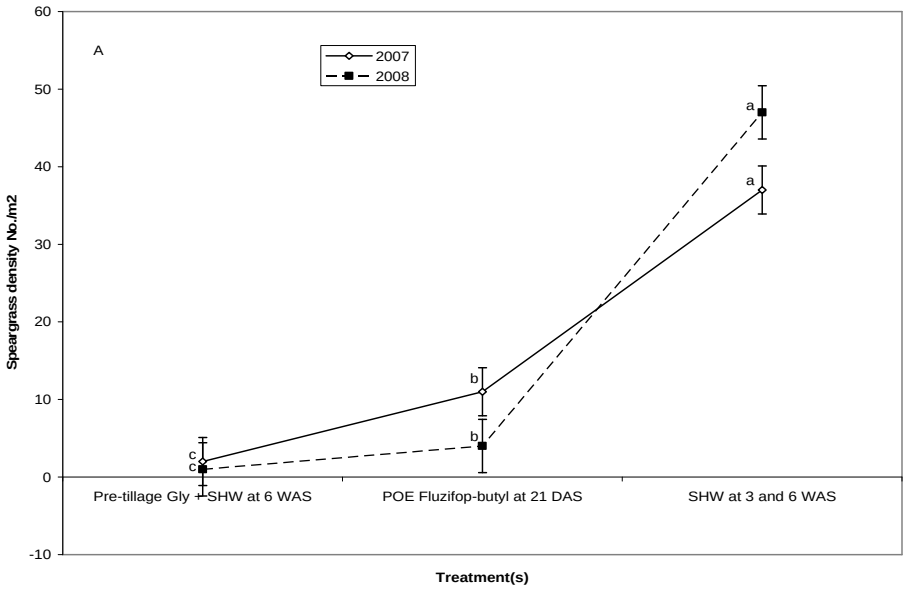
killing the plant (Geiger and Bestman 1990). The application of glyphosate may cause several metabolic changes in speargrass root tissues particularly the depletion of carbohydrate reserves damage, whereas perennials rely on these reserves to over winter (Wilson and Michiel, 2003). The post emergence fluazifop-p-butyl at 3 WAP favoured the escape of this speargrass due to the control measure because at the time of application some of the reproducible cuts were still buried underground during tillage operations and may not be exposed to the herbicides. This delayed germination and emergence is perhaps, one of the simplest explanations for escapes in herbicide management systems. In addition, adverse growing conditions before and after herbicide exposure can as well restrict the transport of herbicide to the site of action (Ruiter and Meinen, 1998). Scursoni *et al.,* (2004) related the percentage of escapes with emergence at the time of glyphosate application and reported that most of the individuals weed had escaped simply by avoiding contact with the herbicide which was buried during tillage operations. Therefore, the time of herbicide application in relation to emergence may be a key to herbicide effectiveness in terms of individual escapes of any weed species.

Row spacing orientation significantly $P \geq 0.05$ affected species weed densities in all the two years (Fig. 3). Speargrass density was significantly difference among crop row orientation and was related to initial speargrass density (ranging from 19 shoot $m^{-2}$ in the wide row plots in 2007 to 14 shoot $m^{-2}$ in the narrow row in 2007). Averaged over location in 2008, speargrass density was significantly higher in the wide row rather than narrow row orientation (20 shoot $m^{-2}$ for wide row and 15 shoot $m^{-2}$ for narrow row). This confirmed the results of (Reddy 2002) where soybean planted in 19 cm rows reduced total weed biomass, increased soybean yield, and resulted in similar to higher net return compared to soybean planted in 57cm and 95cm rows. The canopy architecture of soybeans may reduce the speargrass densities and therefore decrease the competitive ability of weeds in their vicinity.

The between row spacing and weed control indicated that pretillage glyphosate followed by supplementary hoe weeding 3 and 6 WAS and post emergence fluazifop-p-butyl at 3 WAP in narrow row spacing at preharvest of soybean recorded less (2 and 13 shoot $m^{-2}$) speargrass respectively (fig. 5). Similarly, the hoe weeded control in the wide row spacing had significantly highest number of speargrass density (ranging from 42 shoots $m^{-2}$ in 2007 and 53 shoots $m^{-2}$ in 2008). The combination of row spacing and herbicides application could have increased the efficacy of the speargrass control indicated by the high survival of speargrass in the hoe weeded control with less survival in the narrow row treatments. Generally, the herbicide treatments had removed almost all the emerged speargrass population, creating an environment that encouraged seedling recruitment from the soil seed bank. Some vegetation that regenerated from non killed roots may have contributed to the population recovery.

The results of these trials confirmed that reduced row spacing and the application of herbicides appears to improve crop competitive ability against persistence of dominant weeds by reducing their densities and subsequent emergence of common annual weeds which can easily be control by the use of manual hoe weeding.

(a)




(b)

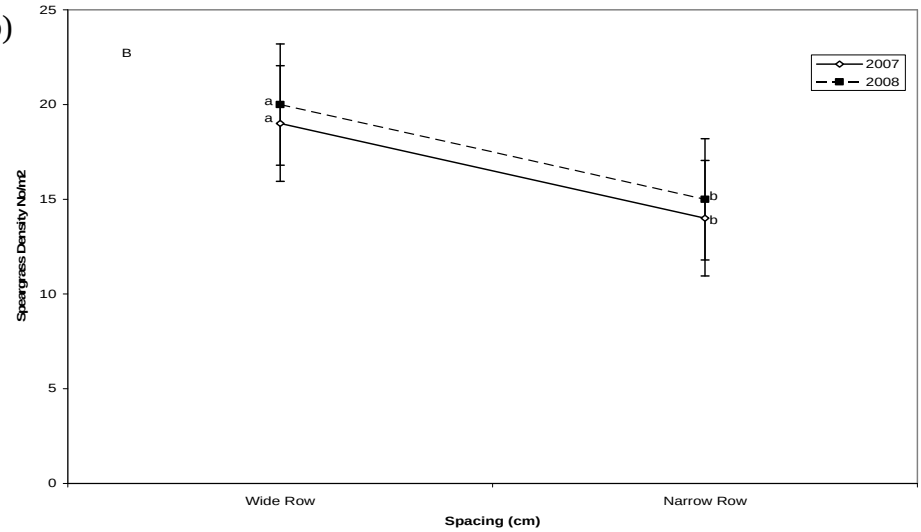



Fig. 2:(a) Effect of weed control methods on density of speargrass at pre-harvest of soybean crop

(b) Effect of row spacing on density of speargrass at pre-harvest of soybean. Means of any set of treatments followed by unlike letters are significantly different at $P<0.05$ LSD. Vertical bars represent S.E of means.

Table 3: Weeds species recorded preharvest of the soybean crop in both experiments in 2008 at Asukunya and Ijorimenger.

| Weed Species | L[a] – M[b] | Pretillage Glyphosate (% freq) | Post emergence fluazifop-p-butyl (% freq) | Supplementary Hoe weeding (% freq) |
|---|---|---|---|---|
| *Ageratum conyzoides* L. | A – D | 25 | 95 | 50 |
| *Andropogon gayanus* Kunth | P – M | 30 | 0 | 30 |
| *Commelina benghalensis* L. | P – M | 10 | 29 | 40 |
| *Cyperus haspan* L. | P – M | 20 | 9 | 0 |
| *Cyperus tuberosus* L. | P – M | 0 | 0 | 25 |
| *Digitaria horizontalis* Wild | A – M | 10 | 20 | 17 |
| *Eurphobia heterophylla* L. | A – D | 10 | 60 | 50 |
| *Imperata cylindrica* L. (Raeuschel) | P – M | 3 | 8 | 90 |
| *Oldenlandia herbacea* L. (Roxb) | A – D | 5 | 17 | 0 |
| *Panicum maximum* Jacq. | P – M | 6 | 0 | 35 |
| *Phyllanthus Amarus* Schum et Thorn | A – D | 0 | 25 | 0 |
| *Rottboellia cochinchinensis* Lour | A – M | 98 | 0 | 55 |

[a] L: life cycle – A, annual or P, perennial

[b] M: Morphotype – D, dicotyledonous or M, monocotyledonous.

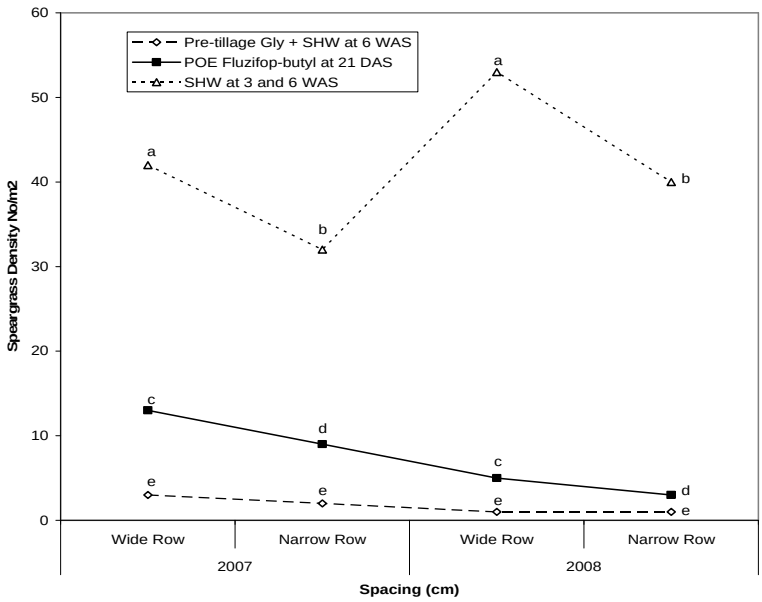



Fig. 3: Interaction of weed control methods and row spacing on speargrass density at pre-harvest of soybean. Means of any set of treatments followed by unlike letters are significantly different at P<0.05 LSD. Vertical bars represent S.E of means

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