International Journal of Agronomy and Agricultural Research (IJAAR)

ISSN: 2223-7054 (Print) 2225-3610 (Online)

http://www.innspub.net

Vol. 13, No. 1, p. 29-38, 2018

INNSPUB

RESEARCH PAPER

OPEN ACCESS

Effectiveness of tank mixture of glyphosate plus metsulfuron for weed control in a juvenile oil palm in Nigeria

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Article published on July 24, 2018

Key words: Species, Biomass, Treatment, Weed, Efficiency

Abstract

Weed management is a serious problem in oil palm cultivation and herbicides mixtures will be pertinent in the control of considerable broad spectrum of weeds in oil palm. In view of this, a study was conducted in 2014 at the Nigerian Institute for Oil Palm Research (NIFOR), Benin City to evaluate the efficacy of tank mixture of glyphosate + metsulfuron on weed control in oil palm. Treatments which consisted of glyphosate + metsulfuron at 1.5 + 0.01 kg a.i. ha^{-1}, glyphosate +metsulfuron at 1.0 + 0.01 kg a.i. ha^{-1}, fluroxypyr at 0.8 kg a.i. ha^{-1}, fluroxypyr at 0.4 kg a.i. ha^{-1}, glufosinate at 0.8 kg a.i. ha^{-1} , triclopyr at 0.36 kg a.i. ha^{-1}, triclopyr at kg a.i. ha^{-1} and a weedy control plot were laid out in a complete randomized complete block design in three replicates. The result showed that among thirty weed species recorded, six families were monocot. and fourteen families were dicot. Plot treated with tank mixtures of glyphosate+metsulfuron at 1.5 +0.01 kg a.i. ha^{-1} sustained weed control up to 12 weeks and reduced weed incidence by 61.67 %. Weed control efficiency was 88.5% and biomass of weed re-growth was 0.1 kg m^{-2} respectively. Fluroxypyr, glufosinate and triclopyr were less efficacious in control of broad spectrum of weed. The study concluded that tank mixture of glyphosate plus metsulfuron, at 1.5 + 0.01 kg a.i. ha^{-1}was sufficient in broad spectrum weeds control in young oil palm.

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Introduction

Weeds generally are major component of oil palm production system. Young oil palm trees are more sensitive to competition from weed because of the wide inter-rows spacing between oil palm. In addition, the inadequate canopy cover provided by the leaves of the young palms is not able to ensure prolong weed suppression after manual slashing or use of non-persistent herbicide. Consequently, keeping the immediate circle of the palms free of weed is been advocated because in daily estate management practices determination of fruit ripening and oil palm loose fruit collection is often hampered by weed problem. Uncollected loose fruits constitute direct reduction on yield and contribute to volunteer oil palm seedlings problem. Therefore, weed control is essential to avoid yield loss and increasing cost of field upkeep.

Chemical weed control is most reliable and has been recognized to be an economical practice in industrial plantations of oil palm trees (Hornus, 1990) and it can reduce the reliance on work force for hand weeding which can delay operations in time of scarcity and increase weed infestation in the plantation. Moreover, manual weeding which is often practice in oil palm tree plantations is more expensive than chemical weeding (Hamel, 1986). Therefore, chemical weeding is a suitable alternative for oil palm production, especially in the humid forest of Nigerian where oil palm is majorly produced and labour for hand weeding is scarced.

Glyphosate as isopropylamine and glyphosate trimesium have been reported to provide control of broad spectrum of weed in the oil palm (Ikuenobe and Ayeni, 1998). Glyphosate trimesium has been shown from previous studies (Ikuenobe, 1992) to be effective for perennial weed control in the oil palm at rates of 1-3 kg a.i. ha^{-1}. However, glyphosate is often preferred for the control of grasses (Lam *et al.*, 1993). Metsulfuron is a systemic herbicide used as selective pre-and post-emergence control against broadleaves weeds and some grasses (Akobundu, 1987). Other herbicides, which are identified to be safe to the palm and effective for weed control, include Folar (Glyphosate + Terbuthylazine), Glyphosate, Velpar k4, 2,4-D, Triclopyr, Triclopyr+ Asulam (NIFOR, 2005; Boum and Hornus 1987; Queneez and Dufor, 1982a;).

The combination of two or more herbicides could reduce application cost (Lich *et al.*, 1997) and delay the occurrence of resistance to both herbicides applied in the combination (Diggle *et al.*, 2003). Herbicide mixtures are commonly used in agriculture to broaden the spectrum of weed species that can be controlled. In some situations, mixtures or combination provide good control at considerable lower dosages than dosages utilized in single applications (Lynch *et al.*, 1970).

However, glyphosate used singly could not as effective in broad spectrum of weed control as glyphosate tank mixed with other herbicides molecules. Metsulfuron is most effective when absorbed through foliage but can be absorbed by the root and it can persist in soil (Akobundu, 1987). Due to the foliage and soil residual activity of metsulfuron, tank mixture of metsulfuron and glyphosate could be beneficial in long term broad spectrum of weed control in oil palm. There is limited information on the effectiveness of tank mixture of glyphosate plus metsulfuron in broad spectrum of weed control in oil palm. Evaluation of the mixture will be pertinent in the management of weeds in oil palm.

The objective of this study was to determine the effective of tank mixture of glyphosate plus metsulfuron for broad spectrum weed control in oil palm.

Materials and methods

The experiment was laid out in a randomized complete block design in three replicates. The gross plot and net plot size adopted was 16,200m^2 (406m x 45m) and 144m^2 (36m x 4m)respectively. Oil palm nursery seedlings of one year old were established in the plot in June 2014 using standard oil palm spacing of 9 m x 9 m in triangular formation.

Treatments consisted of post emergence application of glyphosate + metsulfuron at 1.5 + 0.01 kg a.i. ha^{-1}, glyphosate +metsulfuron at 1.0 + 0.01 kg a.i. ha^{-1}, fluroxypyr at 0.8 kg a.i. ha^{-1},fluroxypyr at 0.4 kg a.i. ha^{-1}, glufosinate at 0.8 kg a.i. ha^{-1} , triclopyr at 0.36 kg a.i. ha^{-1}, triclopyr at kg a.i. ha^{-1} and a weedy control plot . The herbicides as per treatment schedule were applied as post-emergence after the weed has been slashed back one month after transplanting oil palm nursery seedling and left for regrowth up to 4 weeks before application. Manually mounted 15 liters knapsack sprayer fitted with a hand held operated nozzle was used for spraying the herbicides by adopting a spray volume of 240 liters per hectare. The herbicides were applied in the morning during warm temperature and high humidity for enhance absorption and translocation of the herbicides. During the course of the experiment, data were recorded on predominant weed flora, weed density, visual weed control, and biomass of weed growth. Weed control efficiency as per herbicide treatment were assessed by comparing treated plot to the control plot according to scale (Table 1) of the European Weeds Research Council (EWRC) (Marnotte and Tehia, 1992; Mathieu and Marnotte, 2000; Auskalnis, 2003). The optimum herbicide efficiency threshold is 80% on this scale. European Weed Research Society Scale was used for visual rating of phytotoxicity of herbicide (Table 2). Therefore, interpretations of results were based on these scales.

Observation on weeds

Weed density

The weed count was recorded species wise using 1m x 1m quadrat from four randomly fixed places in each plot and the weed falling within the frames of the quadrat were counted, recorded and the mean values were expressed in number m^{-2}. The weed density was recorded 12 weeks after herbicides application to allow for maximum weed emergence.

Weed dry weight

The weed falling within the frames of the quadrat were taken and dried to a constant weight at 80 °C. The dry weight for each treatment was recorded accordingly.

Visual weed control rating.

The visual weed control rating was assessed using the weedy plot as reference and this was done by visual assessment of the percentage reduction of weeds in the treated plot when compared to the weedy plot.

Weed control efficiency

Weed control efficiency was calculated as per the procedure

$$WCE\% = \frac{WD_C - WD_T}{WD_C} X\ 100$$

Where WCE = weed control efficiency (percent)

WD_C =weed biomass (kg m^{-2}) in control plot

WD_T = weed biomass (kg m^{-2}) in treated plot (Budu*et al.*, 2014).

Herbicide toxicity

Plant toxicity due to herbicide was assessed by comparison of the vegetative state of palm tree in the treated and non-treated plots using European Weeds Research Society (EWRS)–scale for visual rating of herbicide phytotoxicity (Table 2).

Statistical Analysis

The data on weeds were statistical analyzed using the analysis of variance in Gen Stat Version 8.1 (2005). Where significant differences existed, critical difference was constructed at five percent probability level.

Results and discussion

Weed flora

The thirty weed species recorded in the study area showed that dicots particularly perennials were the dominant weed species. Although the weed species were monocots and dicots, but only belong to eighteen weed species families (Table 3).

Visual weed control rating.

Glyphosate+metsulfuron at 1.5 +0.01 kg a.i. ha^{-1} significantly reduce weed incidence over control by

90% at 4 to 8 weeks and 61.67% at 12weeks. Similarly, glyphosate + metsulfuron at 1.0 +0.01 kg a.i. ha $^{-1}$ reduced weed incidence by 81.7%, 73.3% and 58.33% respectively at 4, 8 and 12 weeks. Conversely, fluroxypyr at 0.8 kg a. i. ha $^{-1}$, fluroxypyr at 0.4 kg a.i. ha $^{-1}$, glufosinate at 0.8 kg a.i. ha $^{-1}$, glufosinate at 0.4 kg a.i.ha $^{-1}$triclopyr at 0.72 kg a. i. ha $^{-1}$and triclopyr at 0.36 kg a.i ha $^{-1}$ were less efficient in weed incidence reduction (Table 4).

Table 1. Scale of evaluation of herbicide treatments' effectiveness according to the European Weeds Research Council (EWRC).

Note	Coverage rate (%)	Effectiveness rate (%)	Interpretation
1	99	1	No effectiveness
2	93	7	Very low effectiveness
3	85	15	Little marked effectiveness
4	70	30	Poor effectiveness
5	50	50	Weediness 50% decrease
6	30	70	Moderate effectiveness
7	15	85	Acceptable effectiveness
8	7	93	Good effectiveness
9	0	100	Perfect effectiveness

Weed biomass reduction.

Glyphosate+metsulfuron at 1.5 +0.01 kg a.i. ha $^{-1}$ reduced weed biomass over control to 0.002 kg m $^{-2}$ at 4 weeks and 0.1kg m $^{-2}$ at 12 weeks. Furthermore, glyphosate +metsulfuron at 1.0 +0.01 kg a.i. ha $^{-1}$ also reduced weed biomass over control to 0.05 kg m $^{-2}$ at 4 weeks and 0.23 kg m $^{-2}$ at 12 weeks respectively. In effect, fluroxypyr at 0.8 kg a. i. ha $^{-1,}$ fluroxypyr at 0.4 kg a.i. ha $^{-1}$, glufosinate at 0.8 kg a.i. ha $^{-1}$, glufosinate at 0.4 kg a.i.ha $^{-1}$,triclopyr at 0.72 a. i. ha $^{-1}$ and triclopyr at 0.36 kg a.i ha $^{-1}$ had poor weed biomass reduction over control particularly at 8 and 12 weeks (Table 4).

Table 2. European Weeds Research Society –scale for visual rating of herbicide phytotoxicity.

Class	Symptoms of damage
1	No damage/healthy plant
2	Very slight symptoms, weak suppression
3	Slight but clearly visible symptoms
4	Severe symptoms(e.gchlorosis) which do not lead to a negative effect on yield
5	Thinning, severe chlorosis or suppression; yield reduction expected
6	Severe damage up to complete destruction
7	Severe damage up to complete destruction
8	Severe damage up to complete destruction
9	Severe damage up to complete destruction

Weed control efficiency.

Glyphosate+metsulfuron at 1.5 +0.01 kg a.i. ha $^{-1}$ had weed control efficacy of 99.7%, 91.6% and 88.5% respectively at 4, 8 and 12 weeks. Similarly, glyphosate +metsulfuron at 1.0 +0.01 kg a.i. ha $^{-1}$ was also efficacious. Whileplots treated with fluroxypyr at 0.8 kg a. i. ha $^{-1}$, fluroxypyr at 0.4 kg a.i. ha $^{-1}$, glufosinate at 0.8 kg a.i. ha $^{-1}$, glufosinate at 0.4 kg a.i.ha $^{-1}$,triclopyr at 0.72 kg a. i. ha $^{-1}$ and triclopyr at 0.36 kg a.i ha $^{-1}$ had weed control efficacy of less than 70% at 8 and 12 weeks respectively. Furthermore, triclopyr at 0.36 kg a.i ha $^{-1}$ had the least weed control efficacy at 4, 8, and 12 weeks respectively (Table 5).

According to the established EWRC scale (Table 1), only treatments with glyphosate+metsulfuron at 1.5 +0.01 kg a.i. ha^{-1} and glyphosate +metsulfuron at 1.0 +0.01 kg a.i. ha $^{-1}$ were efficacious up to 12 weeks after treatment.

Table 3. Weed species found at the site at herbicides application.

Weed species	Family	Life cycle
Ageratum conyzoides Linn	Asteraceae	A
Amarathus spinosus Linn	Amaranthaceae	A
Alternanthera brasiliana(L.)Kuntze)	Amaranthaceae	P
Aspilia Africana (Pers) C.D. Adams	Asteraceae	P
Axonp plus compressus (Sw) P. Beauv	Poaceae	P
Brachiaria lata (Schumach) C.E. Hubbard	Poaceae	A
Canna indica	Cannacae	P
Commelina benghalensis Linn.	Commelinaceae	P
Centrosema pubescens Benth	Fabaceae	P
Chromolaena odorata (L.) R.M. King & Robinson	Asteraceae	P
Erigerion floribundus (H.B & K)	Asteraceae	A
Euphorbia heterophylla Linn	Euphorbiaceae	A
Ficus exasperate Vahl	Moraceae	A
Icacina trichantha Oliv	Icacinaceae	P
Ipomoea spp	Convolvulaceae	P
Monordica charantia Linn	Cucurbitaceae	A
Palisota hirsuta (Thumb) K. Schum	Commelinaceae	P
Panicum maximum Jacq	Poaceae	P
Peperomia Pellucida (L) H. B & K	Piperraceae	P
Phyllanthus amarus Schum and Thonn.	Euphorbiaceae	A
Portulaca oleracea Linn	Portulacaceae	A
Pueraria phaseoloides (Roxb) Benth	Fabaceae	p
Scoparia dulcis linn	Scrophulariaceae	P
Setaria barbata (Lam) Kunth	Poaceae	P
Setaria longiseta P. Beauv.	Poaceae	P
Sidaacuta Burm. F.	Malvaceae	A
Solenostemon monostachyus (P. Beauv.) Brig. Subsp	Lamiaceae	A
Xanthosoma sagittifolium (L.) Schott)	Araceae	A
Thaumatococcus danielli (Benn) Benth	Marantaceae	p
Talinum triangulare (Jacq) Wild	Portulacaceae	P

Weed density and coverage

At 12 weeks, glyphosate +metsulfuron at 1.5 +0.01 kg a.i. ha $^{-1}$ had the lowest weed weed density (30 m^{-2}) and coverage (15.12%) respectively.

In effect, treatments with fluroxypyr, glufosinate and triclopyr had higher weed density and coverage respectively (Table 6).

Accordingly, on the established European Weeds Research Society toxicity–scale (Table 2);no symptoms of toxicity to the palms due to different herbicides treatment were observed (Table 7). Therefore, good and healthy plants were sustained because herbicides sprays were carefully directed away from the palms.

Discussions

Weed flora

The dominance of dicots over monocots in this study could have resulted from the high annual rainfall, fertile soil and extremes in temperatures between the wet and dry season that are prevalent in the area. Similar results were reported by Sit *et al* (2007) and Traoré *et al* (2010) in oil palm field in India and Côte d' Ivoire respectively.

The dominant of perennial over annual weeds in the field was probably due to the fact that in oil palm cultivation the soil is hardly tilled or disturbed, a practice that could allow perennial weeds to dominate. Ekhator *et al* (2013) had previously reported similar result in oil palm cropping system.

Although dicot.was the most dominant weed species in the field, family of monocot. (Poaceae, Commelinaceae Cannacae, Lamiaceae, Araceae and Marantaceae) posed the greatest management challenges and undesired competitiveness to the crop because of possession of undesirable cuticular wax that resist herbicide penetration and damage.

This characteristic enables these weeds to recover faster after appropriate weed control measures.

Table 4. Effectiveness of selected herbicides on weed control and biomass of weed regrowth in oil palm plantation over 12 weeks after treatment.

Treatment	Rate (kg a.i. ha^{-1})	Visual weed control rating (%)			Biomass of weed growth (kg m^{-2})		
		4 weeks after treatment	8 weeks after treatment	12 weeks after treatment	4 weeks after treatment	8 weeks after treatment	12 weeks after treatment
Glyphosate + Metsulfuron	1.5 + 0.01	90.0a	90.0a	61.67a	0.002e	0.067f	0.1f
Glyphosate + Metsulfuron	1.0 + 0.01	81.7a	73.3b	58.33a	0.005e	0.083f	0.23ef
Fluroxypyr	0.8	71.7b	45.0c	31.67b	0.070ed	0.27e	0.43c
Fluroxypyr	0.4	30.0d	26.7e	15.0	0.23cd	0.57bc	0.63bc
Glufosinate	0.8	56.0c	18.3f	8.33cd	0.15d	0.43c	0.5c
Gufosinate	0.4	23.0d	11.7g	5.00de	0.30c	0.5c	0.62bc
Triclopyr	0.36	30.0d	15.0fg	10.00cd	0.45b	0.61b	0.67b
Triclopyr	0.72	48.3c	36.7d	10.00cd	0.21cd	0.33e	0.47c
Weedy plot	0.00	0.0e	0.00h	0.0e	0.63a	0.87a	0.9a
S.E.		2.0	3.3	2.5	0.008	0.04	0.05

Table 5. Weed control efficiency in young oil palm as influenced by different herbicides.

Treatment	Rate (kg a.i. ha^{-1})	Weed control efficiency (%)		
		4 weeks after treatment	8 weeks after treatment	12 weeks after treatment
Glyphosate + Metsulfuron	1.5 + 0.01	99.7a	91.6a	88.5a
Glyphosate + Metsulfuron	1.0 + 0.01	99.2b	89.6b	73.7b
Fluroxypyr	0.8	88.9c	66.25c	44.0d
Fluroxypyr	0.4	63.5f	28.8g	27.6g
Glufosinate	0.8	76.1d	46.3e	42.5e
Gufosinate	0.4	52.4g	37.5f	28.7f
Triclopyr	0.36	28.6h	23.8h	22.9h
Triclopyr	0.72	66.7e	58.9d	46.0c
Weedy plot	0.00	0.00	0.00	0.00
S.E		0.72	1.95	1.8

Means are significantly different at 5 % probability level.

Visual weed control and Weed control efficacy

The effectiveness of tank mixture of glyphosate plus metsulfuron on weed control up to 12 weeks after treatment could have resulted from the synergies of activities of the herbicides in mixture. Glyphosate controls a cross-section of tropical annual and perennial weeds, while metsulfuron has a broad spectrum of weed control especially for many fallow species. Tank mixing of herbicide has been reported previously by Akobundu (1987) to either be greater (synergistic) or reduce (antagonistic) in plant response.

Faccini and Puricelli (2007) also observed significant weed reduction resulting from the synergistic response of application of different herbicide in mixtures.

Table 6. Emerged weed species, density, and coverage at 12 weeks after herbicides application.

Treatment	Rat (kg a.i. ha)-1	Emerged weeds 12 weeks after treatment	Weed species (density m-2)	Coverage rate (%)
Glyphosate + Metsulfuron	1.5 + 0.01	*Amarahtus spinosus, Commelina benghalensis, Cyperus esculantus, Euphorbia heterophylla, Ficus exasperate, Icacina trichantha, Palisota hirsuta, Panicum maximum, Pueraria phaseoloide, Red amaranthus, Setaria longiseta, Talinum triangulare*	1, 1, 1. 2, 1, 1, 1, , 1, 1, 2, 6, 12 (30)	15.2
Glyphosate + Metsulfuron	1.0 +0.01	*Amarahtus spinosus, Aspilia africana, Chromolaena odorata, Commelina benghalensis, Cyperus esculantus, Ficus exasperate, Ipomoea spp, Mormordica charantia, Palisota hirsuta, Panicum maximum, Peperomia pellucida , Red amaranthus, Setaria longiseta, Talinum triangulare*	1, 1, 1, 1, 4, 1,1, 1,1, 4, 6, 2, 2, 20 (46)	18.5
Fluroxypyr	0.8	*Agerratum conyzoides, Axonopus compressus, Brachiaria lata, Canna indica, Chromolaena odorata, Commelina benghalensis, Cyperus esculantus, Ficus exasperate, Ipomoea spp, Mormordica charantia, Palisota hirsuta, Pueraria phaseoloides, Panicum maximum, Peperomia pellucida , Red amaranthus, Setaria barbata, Setaria longiseta, Talinum triangulare*	2, 4, 5, 2, 2, 2, 58, 1, 1, 1, 1, 2, 4, 4, 2, 4, 28, 4 (127)	44.5
Fluroxypyr	0.4	*Agerratum conyzoides, Cnnaindica, Centrosema pubescens, Chromolaena odorata, Cyperus esculantus, Cyperus rotundus , Ficus exasperate, Ipomoea spp, Mormordica charantia, Palisotahirsuta, Panicum maximum, Peperomia pellucida , Phyllantus amarus, Pueraria phaseoloides, Red amaranthus, Setaria longiseta, Solenosteman mons tachyus, Talinum triangulare, Thaumatococcus daniellii,*	3, 12, 2, 2, 14, 8, 1, 2,2, 1, 3, 4, 3, 2, 2, 60 2, 10, 4 (137)	58
Glufosinate	0.8	*Agerratum conyzoides, Canna indica, Chromolaena odorata, Commelina benghalensis, Cyperus rotundus, Ficus exasperate, Icacina trichantha, Ipomoea spp, Mormordica charantia, Palisotahirsuta, Panicum maximum, Peperomia pellucida , Portula oleracea, Pueraria phaseoloides, Red amaranthus, Setaria longiseta, Scoparia dulcis, Talinum triangulare, Xanthosoma spp*	2, 8, 3, 2, 34, 1, 2 ,3, 2, 1, 5, 6, 4, 3, 3, 1, 12, 2, 5, 3 (102)	49
Glufosinate	0.4	Agerratum conyzoides, Canna indica , Chromolaena odorata, Commelina benghalensis, Cyperus rotundus, Ficus exasperate, Icacina trichantha, Ipomoea spp, Mormordica charantia, Palisota hirsuta, Panicum maximum, Peperomia pellucida, Portula oleracea, Pueraria phaseoloides, Red amaranthus, Setaria barbata, Setaria longiseta, Scoparia dulcis, Talinum triangulare, Xanthosoma spp.,	3, 9, 2, 2, 8, 1, 1, 4, 3, 1, 3, 4, 5, 2, 2, 48, 24, 2, 8, 4 (136)	54
Triclopyr	0.36	*Agerratum conyzoides, Amaranthus spnosus, Aspilia Africana, Chromolaena odorata, Commelina benghalensis, Cyperus esculantus , Cyperus rotundus, Ipomoea spp, Palisota hirsuta, Panicum maximum, Peperomia pellucida, Physalis angulata, Setaria barbata, Talinum triangulare, Xanthosoma spp.,*	4,4, 2, 3, 2, 54, 34, 3, 1, 4, 6, 4, 34, 15, 2 (172)	40.3
Triclopyr	0.72	*Agerratum conyzoides, Amaranthus spnosus, Aspilia Africana Chromolaena odorata, Cyperus esculantus, Ipomoea spp, Setaria longiseta, Palisota hirsuta, Panicum maximum, Peperomia pellucida , Talinum triangulare,*	2, 6, 3, 3, 56, 3, 36,2, 8, 4, 13 (136)	29
Weedy plot	0.00	*Agerratum conyzoides, Amaranthus spnosus, Brachiaria lata, Chromolaena odorata, Cyperus esculantus, Cyperus rotundus, Euphorbia heterophlla, Ipomoea spp, Mormordica charantia, Palisota hirsuta, Panicum maximum, Peperomia pellucida, Phyllantus amarus, Pueraria phaseoloides , Red amaranthus, Scoparia dulcis , sidaacuta, Thaumatococcus daniellii,*	2, 1, 10, 2, 6, 4, 3, 1, 1, 1, 18, 3, 1, 2, 1, 2, 1, 4 (63)	100

In effect, fluroxyprhas been observed to have control some perennial and annual broad leaves only, glufosinate ammonium is a broad spectrum, contact herbicide targeted at some few broadleaves and grasses; while triclopyr controls only broad leaves especially follow species. The low spectrum of weeds controlled by each of the herbicides could have resulted in their various degrees of efficacy. Therefore tank mixing of these herbicides could be appropriate for the control of broad spectrum of weeds in oil palm.

Table 7. Herbicide phytotoxicity assessment.

Treatment	Rate (kg a.i. ha^{-1})	4 weeks after treatment	8 weeks after treatment	12 weeks after treatment
Glyphosate + Metsulfuron	1.5 + 0.01	1	1	1
Glyphosate + Metsulfuron	1.0 + 0.01	1	1	1
Fluroxypyr	0.8	1	1	1
Fluroxypyr	0.4	1	1	1
Glufosinate	0.8	1	1	1
Gufosinate	0.4	1	1	1
Triclopyr	0.36	1	1	1
Triclopyr	0.72	1	1	1
Weedy plot	0.00	1	1	1

Weed biomass

The low weed weight recorded over longer duration of 12 weeks with tank mixture of glyphosate plus metsulfuron indicated minimal competitiveness of weeds with oil palm. Weed weight has been observed previously as the most important parameter in assessing the competitiveness for crop growth and productivity because considerable reduction in weed weight implies less competition from weed (Ramalingam *et al*, 2013).

Weed density and coverage

The reduction in weed density and coverage observed with glyphosate plus metsulfuron in mixture up to 12 week could have indicated low resistance of weeds to the herbicides in mixtures.

These effects could be partly due to the residual effect of the metsulfuron herbicide in mixture.

Conclusion

The study concluded that broad spectrum of weed species abound in oil palm cropping system. Glyphosate plus metsulfuron at 1.5 + 0.01 kg a.i. $ha^{-1}$was acceptably effective and efficient in broad spectrum of weeds control in young oil palm than fluroxypr, glufosinate and triclopyr. Glyphosate +metsulfuron at 1.5 +0.01 kg a.i. ha^{-1} was very efficacious and also sustained weed control up to 12 weeks after treatment.

In this respect, glyphosate and metsulfuroncould serve as choice herbicide combination for broad spectrum of weed control in young oil palm.

Acknowledgments

The authors are grateful INSIS Agrochemical, Ibadan for providing the herbicides materials for this research work. Further thanks goes to our Executive Director R&D/ CEO of NIFOR for support during the research work.

The authors are also grateful to colleagues in Agronomy Division, NIFOR for their support in the field data. In all, we appreciate God almighty for his care throughout the period of this research work.

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