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Effect of glyphosate on weed control and growth of oil palm at immature stage in Ghana

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Abstract

Chemical weed control is recognized to be an economical practice in oil palm plantations as it can reduce reliance on manpower for hand weeding. A study was conducted at the Benso Oil Palm Plantation to evaluate the efficacy of "Glisat" a glyphosate with trade name "GLISAT 480SL" with that of "Ceresate" an approved glyphosate on the market on a plot planted to two year old oil palm trees. Treatments consisted of untreated plot, different doses of Glisat at 0.8 L/ha, 1.4 L/ha, 2.8 L/ha, 4.3 L/ha and Ceresate 1.5 L/ha. Result showed that Glisat dose at 1.4 - 2.8 L/ha is as effective as Ceresate 1.5 L/ha in controlling weeds, however, the efficacy differs slightly in the first two weeks after treatment. No significant differences was observed between Ceresate 1.5 L/ha and Glisat at 1.4 L at 8 weeks after treatment (WAT). Herbicide efficacy of Glisat 1.4 L/ha was higher than Ceresate 1.5 L/ha for grasses, but no difference was observed for the broadleaves. Both Glisat and Ceresate reduced dry weights of weeds significantly, and 4 WAT was the optimum period to observe high weed mortality. Glisat was effective in controlling both broadleaves and grasses even though the effect on grasses was higher. Glisat and Ceresate had no adverse effect on the oil palm and significantly improved vegetative parameters by reducing competition with weeds for nutrients and other growth resources. Glisat could be applied at 2.8 L/ha as its effects was comparable to Ceresate 1.5 L/ha at 4 WAT.

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Introduction

Weeds are of economic importance in oil palm production systems. Improved oil palm varieties start production within three years after planting however, growth, development and yield of the crop are adversely affected by weeds which compete with the oil palm for nutrients, moisture and sunlight and eventually cause growth and yield depression (Corley and Tinker, 2003, Pride, 2010, Lam *et al.*, 1993). Essandoh *et al.* (2011) identified one hundred and thirty six weed species belonging to 33 dicotyledon families, 3 monocotyledon families and 8 families of Pteridophyta in oil palm plantations in Ghana.

Chemical weed control is recognized to be an economical practice in oil palm plantations (Hornus, 1990) and it can reduce reliance on manpower for hand weeding which can delay operations in time of scarcity. There are very few herbicide options available for weed control in oil palm in Ghana. Significant percentage of common broad-spectrum herbicides available on the Ghanaian market are glyphosate-based with different formulations. All these herbicides are foliar applied and glyphosate is classified as being systemic (Chang and Liao, 2002). The most common types include Ceresate, Weedout and Roundup. Traore *et al.* (2010) reported that Roundphos and Roundup both with similar glyphosate active ingredients, and applied at the same rate have similar effectiveness. Considerable work has been conducted on weed management in Ghana using glyphosate on different tree crops (Oppong *et al.,* 1999) and on oil palm (Baidoo-Addo *et al.*, 2000). Larbi *et al.* (2013) studied the growth and yield response of maize (*Zea mays L.)* in response to different herbicides including glyphosate in the coastal savannah eco-zone of Ghana.

However information on the effect on weed management and growth of the juvenile oil palm is scanty. Keeping all these aspects in view, an attempt was made to find out the effect of Glisat on weed control under immature oil palm plantation and its effect on the growth of the immature oil palm. GLISAT 480SL is a herbicide with glyphosate isopropylamine salt 480g/L as the active ingredient. The objective of this study therefore were to evaluate the efficacy of "Glisat" alongside "Ceresate" a glyphosate that has been approved by the Environmental Protection Agency, Ghana in controlling weeds under young oil palm plantation; and examine whether the product residue has any toxic effects on the growth of the young oil palm.

Materials and methods

Experimental site

The experiment was conducted at the Benso Oil Palm Plantation at the Adum Banso estate (6°05' N; 0 ° 05' W), located 175 km north-west of Accra in the forest zone of Ghana. The area is in a zone characterized by relatively high rainfall in two seasons (bi-modal). The mean annual rainfall is 1645mm. Temperatures are generally high and uniform throughout the year. Mean monthly temperatures range from 24 – 30 °C. The relative humidity is generally high in the morning, about 90%, at 0600 hours and reducing to between 60 and 70% in the afternoon (1500 hours). Generally, in the wet season relative humidity is high (about 95%), but low (about 40%) in the dry season. Some chemical properties of soil used which belongs to the Omappe series are as follows: pH (1:1 soil: water) 4.9, total N 0.13%, Available P= 11.8 mg/kg, Available K = 187.48 mg/kg, Organic carbon = 1.33%, ECEC = 4.66 cmol/kg). The experimental site had been cultivated to Oil palm variety (D x P) at a density of 145 palms ha^{-1}. The trees were two years at the time of the study.

Experimental design

0Twenty four experimental plot size each of the following dimensions 5m x 21m were set up. Six treatments were adopted as follows Glisat (0.8, 1.4, 2.8 and 4.3 L ha^{-1}) and Ceresate 1.5 L ha^{-1} and untreated control plots (water only) in a randomized complete block experimental design with four replications.

Spray calibration

A CP knapsack sprayer fitted with AN 2.5 deflector nozzle was used to deliver 200 L ha^{-1} of herbicide solution. Spray calibration was conducted to determine forward speed, spray width (swath), flow rate and application rate as described by Turner and Gillbanks (2003).

Initial vegetation analysis

Weed samples were collected by randomly placing a 0.5 by 0.5 m square quadrant at 10 locations per stratum. Weeds were counted in 3 quadrates to determine their species, density and dominance of each species expressed in relative terms, using the formula below (Derksen *et al.,* 1993):

$$Relative\ (X) of\ a\ species = \frac{Absolute\ (X) of\ the\ species}{Total\ absolute\ (X) of\ all\ species}$$

where, X = density or dominance

All the above ground weed vegetation were harvested and separated by weed type; sun dried for 4 days and dried in an oven at 80°C for 48 hours and their dry weight was recorded (for dominance evaluation) (Felix and Owen, 1999).

Effects of herbicides on weed population

The effects of the herbicides on total weed population were measured as the percentage of weed killed, weed dry weight, growth reduction and duration of their effective control of the weeds relative to the control treatment. Destructive samples were taken using the quadrant at 2 and 4 and 8 weeks after treatments (WAT). The criteria used were: species killed (complete brown leaves), chlorotic (yellowing), still remaining green (alive). Plants killed meant that all tissues from growing point to the soil surface were completely dead. The weed dry weight was determined by drying in an oven at 80°C for 48 hours.

The percent growth reduction is the ability of a treatment to suppress weed growth and was calculated using the formula (Chuah *et al.*, 2004):

$$\%\ \text{growth reduction} = \frac{\text{Dry weight from treated plot}}{\text{Dry weight from untreated plot}} \times 100$$

Efficacy of Glisat is the power or capacity of Glisat to produce desired effect.

The efficacy (E) of herbicide by mass of weeds was calculated by the following formula:

$$\mathrm{E} = \frac{\mathrm{M1} - \mathrm{M2}}{\mathrm{M1}} \times 100$$

Where;

M_1 = Weed mass per m^2 on untreated plots;

M_2 = Weed mass per m^2 on plots treated with herbicides.

(Auskalnis, 2003)

Effects of herbicide on oil palm growth

The effects of herbicide residues on oil palm development and production as the result of herbicide spraying to control weeds were determined based on the oil palm plant height, number of fronds, Rachis length and radius of spread. These parameters were determined at the start of the trial and at 8 weeks after treatment (WAT). Plant height was measured from the soil surface to the highest part of fully opened frond. The number of frond was counted from the base of the fresh-green to the first fully-opened frond. Rachis length was determined by measuring with a tape measure, the length from the point of insertion of the lowest rudimentary leaflets (the last leaflets) to the tip where the last pair of differentiated leaves is attached. The spread of canopy was taken in two directions, east-west and north-south, with a measuring tape and the average calculated.

Statistical analysis

The treatment effects were tested by analysis of variance. The least significant difference was used to separate the means. Two statistical packages: Genstat ® for Windows ™ (NAG, 1996) and Microsoft Excel were used for the data analysis. The Genstat statistical software was used for the analysis of variance.

Results and discussion

Initial vegetation analysis

The initial weed vegetation analysis is needed to determine the weed species present, their density and dominance of growth at the site of the experiment. Krueger *et al.* (2000) observed that one of the factors needed for a successful post-emergent weed management strategy is the knowledge of weeds present in the field, and the density of each species. The results showed that, the weed population at the site consisted of a composite of mixed weeds of broadleaves and grasses, with broadleaves being more dominant over the grasses. Broad-leaved weeds such as *Aspillia africana, Pueraria phaseoloides, Baphia nitida, Justicia flava* and *Melanthera scandens* and grasses such as *Panicum lineatum,* were dominant at the site in the young oil palm plantation (Table 1). The weed species observed at the site has been reported earlier (Essandoh *et al.*, 2011) as dominant weed species under young oil palm plantations in Ghana. The weed species observed at the site, therefore is a true representative of the weed species under young oil palm plantation in Ghana.

Table 1. Dominant weed species at the experimental site at start of trial.

Weed species	Type*	Relative abundance (%)	Relative dominance (%)
Justicia flava	B	23.01	7.11
Commelina erecta	B	6.33	1.07
Aspillia africana	B	20.66	14.97
Melanthera scandens	B	1.07	0.60
Panicum lineatum	G	27.09	19.69
Pueraria phaseoloides	B	17.80	55.01
Baphia nitida	B	1.07	0.64
Diplazium sammatii	B	2.97	0.09
LSD ($P \leq 0.05$)		0.9	2.1

B: broadleaf; G: grass.

The weed composition consisted of 7 broadleaf species and 1 grass species. The dominance of the broadleaves is reflected in their total relative abundance of 72.91% and relative dominance of 80.31%. *Pueraria phaseoloi*des, the cover crop species used in the area was the most dominant species at the site with relative dominance of 55.01% followed by the grass species (Table 1). Among the broadleaves, *Pueraria* was followed by *Aspillia africana*. In terms of the relative abundance, *Panicum lineatum* was the most abundant species followed by the broadleaf species *Aspillia Africana* (Table 1). The least dominant species include *Melanthera scandens*. The situation, therefore, calls for the use of general post- emergent herbicides for chemical weed management in the locality (Mohamad *et al.,* 2010).

Table 2. Weed dry weight and growth reduction after treatments with Glisat and Ceresate.

Treatments	Dry weight (g/0.25m2)*			Growth reduction (%)*		
	2 WAT	4 WAT	8 WAT	2 WAT	4 WAT	8 WAT
Untreated plot	195.5 a	206.5 a	213.5 a	0	0	0
GLISAT @ 0.8 L/HA	112.5 b	80.8 b	158.7 b	42.45c	60.87d	25.67d
GLISAT @ 1.4 L/HA	122.7 b	79.9 b	153.8 b	37.24d	61.31d	27.96d
GLISAT @ 2.8 L/HA	98.0 c	50.5 bc	109.0 c	49.74b	74.87b	48.95b
GLISAT @ 4.3 L/HA	79.3 d	19.7 c	82.8 d	59.44a	90.46a	61.21a

CERESATE @ 1.5 L/HA	92.2 c	62.7 b	116.0 c	52.84b	69.64c	45.67c

NB. Figures followed with same letters were not significantly different.

Effect of herbicides on weed dry weight

Application of Glisat and Ceresate at all doses significantly reduced dry weight of weeds at 2 and 4 WAT (Table 2), indicating the effectiveness of the treatments in reducing the productivity of the weeds compared to the untreated plot**.** Glisat doses at 0.8, 1.4, and 2.8 L/ha was less effective in reducing dry weights of the weeds at 2 WAT, compared to Ceresate 1.5 L/ha, however Glisat 4.3 L/ha reduced weed dry weight more than the Ceresate 1.5 L/ha. Glisat dose at 0.8, 1.4 and 2.8 L ha^{-1} induced weed dry weight reduction of 19%, 20% and 27% respectively at 2 WAT and 42%, 50% and 62% respectively at 4 WAT. Ceresate 1.5 L ha^{-1} induced a 36% decrease in weed dry weight at 2 WAT and 57% at 4 WAT. For the untreated plot, weed dry weights increased by 6% and 12% at 2 and 4 WAT respectively. Thus the weed dry weight for Glisat 1.4 L/ha and 2.8 L/ha was comparable to that of Ceresate 1.5 L/ha at 4 WAT, while Glisat 4.3 L/ha significantly reduced dry weight more than the Ceresate 1.5 L/ha. Thus Glisat 1.4 and 2.8 L ha^{-1} can be recommended for weed control for weed species of the type observed at the site. This result is similar to earlier observations of Wibawa *et al.* (2009) who observed similar reductions in dry weight at the 8, 12 and 16 WAT, when they applied different broad spectrum herbicides. Daubenmire (1968), observed that weed dry weight showed productivity of weed community measured and indicated the level of weed growth. There were differences in the weed dry weight reduction between Glisat and Ceresate, although they are both glyphosate products. This difference could be due to the formulation of the product as a result of differences in the addition of additives by the manufacturers. Significant reduction in weed dry weight by the application of glyphosate based herbicides has been observed by earlier workers (Traore *et al.*, 2010).

Table 3. Effect of Glisat on percent herbicide efficacy on Broadleaves and Grasses at BOPP.

Treatments	Herbicide efficacy (%)					
	2 WAT		4 WAT		8 WAT	
	Broadleaves	Grasses	Broadleaves	Grasses	Broadleaves	Grasses
Untreated plot	0.00	0.00	0.00	0.00	0.00	0.00
GLISAT @ 0.8 L/HA	17.00	35.18	44.02	58.38	10.89	61.22
GLISAT @ 1.4 L/HA	18.75	39.15	53.55	61.81	26.79	67.79
GLISAT @ 2.8 L/HA	21.10	41.21	66.47	89.78	38.64	75.89
GLISAT @ 4.3 L/HA	17.78	100.00	79.71	100.00	37.22	96.56
CERESATE @ 1.5 L/HA	56.79	41.93	68.43	83.90	25.39	28.82
LSD ($P \leq 0.05$)	1.43	7.80	1.84	8.16	1.21	4.57

The percentage of weed growth reduction and duration of effective weed (Mohamad *et al.*, 2010) plays an important role in the evaluation of herbicide efficacy. The growth reduction (%) increased from 2 to 4 WAT, suggesting effective weed control by all the treatments (Table 2). Based on the dry weight, weed growth reduction was observed to be significantly affected ($p<0.05$) by treatments at 2, 4, and 8 WAT relative to the untreated control (Table 2). Application of Glisat at 2.8 L/ha and Ceresate 1.5 L/ha treatments recorded almost similar results in growth reduction at 4 WAT, which ranged between 49.74 to 74.87% and 52.84 to 69.64%, respectively, for the 2 and 4 WAT. However, the Glisat at lower dose, 0.8 L/ha and 1.4 L/ha treatment recorded lower growth reductions of 42.45 to 60.87% and 37.24 to 61.31%, respectively. The results also showed the tendency of weed growth recovery for all the treatments from the 4 to 8 WAT.

The regrowth of weeds after the 4 WAT was observed by percentage increases in weed dry matter at 8 WAT compared to 4 WAT. A 100% weed regrowth was observed in the Glisat 0.8 and 1.4 L ha^{-1} treatments (Table 2). Observations at the 8 WAT also indicate that treatments with lower Glisat rates may have a faster regrowth duration than the higher Glisat application rates due to their relatively higher dry weights at 8 WAT. A high growth reduction value indicates effective weed control, while a lower value suggests weed regrowth. The difference in growth reduction between 4 and 8 WAT, expressed as percentage were as follows 48; 52; 53; 119; 137; for Glisat 4.3 L/ha; Ceresate 1.5 L/ha, Glisat 2.8 L/ha, 1.4 l/ha and 0.8 L/ha respectively.

Table 4. Changes in oil palm vegetative parameters# at 8 weeks after treatment (%).

Treatments	Changes in some vegetative parameters of the young oil palm (%), at 4 WAT			
	Frond number	Rachis length	Plant height	Radius of Spread
UNTREATED PLOT	16.5	10.8	8.2	6.8
GLISAT @ **0.8** L/HA	13.0	20.4	10.7	11.0
GLISAT @ **1.4** L/HA	17.5	18.3	11.9	14.5
GLISAT @ **2.8** L/HA	25.8	20.8	12.7	15.6
GLISAT @ **4.3** L/HA	27.9	31.2	25.2	28.7
CERESATE @ 1.5 L/HA	18.2	17.7	30.7	22.0
LSD ($P \leq 0.05$)	5.18	2.38	2.64	2.21

#= (Final vegetative parameter – Initial vegetative parameter)/Initial Vegetative parameter x 100.

This result shows differences among the treatments as far as regrowth is concerned, and that no significant difference was observed between Ceresate 1.5 L/ha and Glisat 2.8 L/ha. However, Ceresate 1.5 L/ha was much better in inducing relative persistence on weed regrowth compared to Glisat 1.4 l/ha and 0.8 L/ha. Significant reduction in weed dry matter by the application of glyphosate based herbicides was observed by earlier workers (Sharma and Singh, 2007).

Herbicide efficacy in controlling weeds

Herbicide efficacy was determined as the ratio of the change in weed dry weights of untreated and treated plots to the weed dry weight of untreated plot and increased with increasing herbicide dose. At 2 WAT herbicide efficacy ranked in the order Glisat 4.3 L ha^{-1} > Ceresate 1.5 L ha^{-1} > Glisat 2.8 L ha^{-1} > Glisat 1.4 L ha^{-1} > Glisat 0.8 whiles at 4 WAT, the order changed to Glisat 4.3 L ha^{-1} > Glisat at 2.8 L ha^{-1} > Ceresate at 1.5 L ha^{-1} > Glisat at 1.4 L ha^{-1} > Glisat at 0.8 (Table 3). Herbicide efficacies of 89.90, 74.0, and 67.70% were recorded by the Glisat treatment dose at 4.3, 2.8 L ha^{-1} and Ceresate at 1.5 L ha^{-1} respectively at 4 WAT, which was over 100% higher than the herbicide efficacy recorded at 2 WAT respectively. Therefore the optimum period to observe highest herbicide efficacy for the weed species is 4 weeks.

This result is however, different from earlier reports by Mohamed *et al.* (2010) who reported maximum weed reduction at 8 WAT. Herbicide efficacies recorded at the Glisat 1.4 and 0.8 L ha^{-1} levels were lower than 70 (Table 3).

Herbicide efficacy of Glisat treatments for grasses was more than 100% higher than efficacy for broadleaves Application of Ceresate 1.5 L/ha also induced herbicide efficacy higher for grasses than broadleaves at 4 WAT (Table 3). For Glisat, the dose at 4.3 L ha^{-1}, resulted in a 100% weed control of all grasses in the plots at 4WAT. The efficacy of the herbicides at 8 WAT was lower than that of 4WAT, indicating weed regrowth. The effect of the treatment on regrowth as indicated by herbicide efficacy varied among the Glisat doses; lower for low Glisat dose and lower for broadleaves compared to grasses. These findings prove that the treatments of less efficacy could cause weed to grow and recover faster or in shorter times (Mohamed *et al.*, 2010). Herbicide efficacy was similar for Glisat 1.4 l/ha and Ceresate 1.5 L/ha for broadleaves at 8 WAT, but efficacy on grasses was higher for Glisat 1.4 L/ha than Ceresate 1.5 L/ha. Furthermore, the efficacy was much higher for the higher Glisat doses, compared to Ceresate 1.5 L/ha. This results show significant effect of both Glisat and Ceresate (glyphosate) in controlling the weeds. Glisat seems to be more effective in controlling grasses than Ceresate1.5 L/ha, except for the 0.8 L/ha treatment at 8 WAT. The results confirm earlier observations by Faccini, and Puricelli (2007), that weed species vary in their susceptibility to herbicides. Kataoka *et al.* (1996), found that the complete translocation of glyphosate herbicide confers remarkable efficacy on most weeds, whether annual broadleaves and grasses, perennial broadleaves and grasses or sedges. Similar observations in the control of both broadleaved and grass by glyphosate at 2 and 4 WAT have been reported (Wibawa *et al.*, 2009; Mohamad *et al.*, 2010). Collins (1991) stated that glyphosate is a systemic herbicide and it is much more effective against weeds with well developed root systems or underground storage organs. Differential effectiveness of herbicides applied and dosage could cause shift in weed composition, which then affect their similarity (Wrucke & Arnold, 1985; Swanton *et al.*, 1993). The ability of glyphosate to control a wide range of species was shown in a review about weed control in transgenic crops (Schütte *et al.*, 2004). Low application rate of 370 g ha^{-1} has sometimes been used to control grass and broadleaf weeds without adverse effects for immature oil palm as long as it was not sprayed directly to the plant (Turner & Gillbanks, 2003). Herbicide treatments, in general, are affected by dominance of weed species, crop cultivated and environment, whereby they can be effectively controlled for several months (Hoerlein, 1994).

Glisat and Ceresate were not biologically effective in controlling the only predominant woody growth species in the area. The weed had woody stems and cuticular covering of leaves were waxy and thick. The low control of perennial species by glyphosate has been observed in earlier studies (Bradley *et al.*, 2004, Whaley & Vangessel, 2002).

Effect of herbicides on vegetative growth of palms

The effects of Glisat and Ceresate application on percentage change in some vegetative parameters of the young oil palms at 8 weeks after treatment are presented in Table 4. These results showed that the herbicides used at all the doses were safe to use as long as the chemicals were not sprayed directly at the plant. Generally, the measured parameters of the young oil palm were enhanced with increasing doses of Glisat application. The Glisat dose of 4.3 L ha^{-1} application induced marked percentage changes in frond number, rachis length, and radius of canopy spread which were 69%, three- and four- fold respectively higher than the untreated plot. This may be attributed to less competition for growth resources such as nutrients, light and soil moisture from the weeds, thus making these growth factors available to the young oil palm trees for growth. Ceresate application at 1.5 L ha^{-1} however, exerted maximum effect on plant height and was four- fold higher than the plant height of the untreated plot. It is well known that weeds cause severe loss to yield and deplete soil nutrients considerably. These nutrient losses caused by weeds could be effectively tackled either through the use of effective herbicides or effective weed management treatments. Wibawa *et al.* (2007), reported higher vegetative and fresh fruit bunches compared to the untreated plot, when they used paraquat, glufosinate ammonia and glyphosate at different doses in controlling weeds in an old oil palm plantation whiles Wibawa *et al.* (2009) observed no significant improvement in vegetative parameters in mature oil palms by the application of a herbicide. Agrawal and Kumar (1998) also observed enhanced growth and yield of wheat through herbicide application. Shekara and Nanjappa (1993) reported a reduction in nutrients removal by weeds with their control. Larbi *et al.* (2013) observed enhanced dry matter yields of maize in response to application of different herbicides including glyphosate and 2, 4-D. The improvement in dry matter was observed by the application of 2, 4- D at 2 weeks after treatment.

Conclusion

This study has showed that the application of Glisat at the different doses significantly reduced the weed growth and increased the vegetative growth of the oil palm trees. The effect of Glisat in controlling weeds under the young oil palm was comparable with that of Ceresate the recommended glyphosate. However, the efficacy of the two products differed considerably with time and weed species. Herbicide efficacy at 4 WAT was ranked as follows; Glisat dose at 4.3 L ha^{-1} > Glisat at 2.8 L ha^{-1} > Ceresate 1.5 L/ha > Glisat 1.4 L/ha > Glisat 0.8 L/ha. Glisat did not adversely affect vegetative growth of the oil palm. Glisat was effective in controlling both broadleaves and grasses even though the effect on grasses was higher. Higher dosages of Glisat significantly improved vegetative parameters by reducing competition with weeds for nutrients and other resources. Glisat could be applied at 1.4 L/ha and 2.8 L/ ha and may therefore be recommended for the control of broad spectrum of weeds at BOPP.

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References

Agrawal KK, Kumar KJ. 1998. Weed control studies in wheat. World- weed **5,** 1- 2.

Auskalnis A. 2003. Experience with "Plant Protection on line" for weed control in Lithuania. *Proceedings of the crop protection conference for the Baltic Sea Region.* Poznane, 166-175 p.

Baidoo-Addo K, Nuertey BN, Asamoah TEO. 2000. Use of Round Up (glyphosate) in weed control under oil palm: some cost implications. Journal of the Ghana Science Association **2(2),** 94- 98.

Bradley KW, Hagood ES, Davis PH. 2004. Trumpetcreeper (*Campsis radic*ans) control in double-Crop glyphosate-resistant soybean with glyphosate and conventional herbicide systems. Weed Technology **18,** 298-303.

Chang SY, Liao CH. 2002. Analysis of glyphosate, glufosinate and aminomethylphosphonic acid by capillary electrophoresis with indirect florescence detection. Journal of Chromatography **A959,** 309-315.

Chuah TS, Salmijah S, Ismail BS. 2004. Efficacy of tank-mix combination of glyphosate and gramicides on the control of glyphosate resistant and susceptible biotypes of goosegrass *(Eleusine indica (L.) Gaertn.*). Plant Protection Quarterly **19,** 130-133.

Collins SC. 1991. Chemical control of grassy weeds. *In* F.W.G. Beker and P.J. Terry (eds.). Tropical Grassy Weeds. CAB International, 73-84.

Corley RHV, Tinker PBH. 2003. Palm The Oil, 4th Edition**.** Wiley- Blackwell. 592 p.

Daubenmire R. 1968. Plant communities, Harper and Row, New York 300 p.

Derksen DA, Lafond GP, Thomas AG, Loeppky HA, Swanton CJ. 1993. Impact of agronomic practices on weed communities: Tillage system. Weed Sience **41,** 409-417.

Essandoh PK, Armah FA, Odoi JO, David O, Yawson DO, Ernest KA, Afrifah EKA. 2011. Floristic composition and abundance of weeds in an oil palm plantation in Ghana. ARPN Journal of Agricultural and Biological Science **6(1),** 21- 23.

Felix M, Owen MDK. 1999. Weed population dynamics in land removed from the conservation program. Weed Science **47,** 511-517.

Hoerlein G. 1994. Glufosinate (phosphinothricin), a natural amino acid with unexpected herbicidal properties. Review of Environmental Contamination and Toxicology **138,** 73-145.

Hornus PH. 1990. Désherbage chimique des ronds de palmiers adultes: Technique de bas volume. Oléag. **45(6),** 295-299.

Kataoka H, Ryu S, Sakiyama N, Makita M. 1996. Simple and rapid determination of the herbicides glyphosate and glufosinate in river water, soil and carrot samples by gas chromatography with flame photometric detector. Journal of Chromatography **A726,** 253-258.

Krueger DW, Wilkerson GG, Gold HJ. 2000. An economic analysis of binomial sampling for weed scouting. Weed Science **48,** 53-60.

Lam CH, Lim JK, Badrulisan J. 1993. Comparative studies of Paraquat mixtures and glyphosate and or its mixtures on weed succession in plantation crops. The Planter. **69,** 525-535.

Larbi E, Ofosu-Anim J, Norman JC, Anim-Okyere S, Danso F. 2013. Growth and yield of maize (*Zea mays* L.) in response to herbicide application in the coastal savannah ecozone of Ghana. Net Journal of Agricultural Science **1(3),** 81-86.

Mohamad RB, Wibawa W, Mohd GM, Adam BP, Abdul SJ, Yahya A, Mohammad BML. 2010. Management of Mixed Weeds in Young Oil-palm Plantation with Selected Broad-Spectrum Herbicides. Oil-palm Plantation with Selected Broad-Spectrum Herbicides. Pertanika J. Trop. Agric. Sci. **33(2),** 193 – 203.

NAG (Numerical Algorithms Group). Genstat ® for Windows ™ , Second Edition. The Numerical Algorithms Group Limited. Oxford United Kingdom.

Oppong FK, Osei-Bonsu K, Amoah FM. 1999. The Efficacy of Low Volume Application of Roundup (Glyphosate) on weed suppression in some plantation crops in Ghana. Journal of Ghana Science Association (Special Edition) **2(3),** 40-48.

Pride D. 2010. Environmentally friendly weed control in Oil Palm Plantations. Available at http:/www. Palm Oil Truth Foundation.com. Accessed on 15th April.

Schütte G, Stachow U, Werner A. 2004. Petra Apel, Berlin (Ed.), Agronomic and environmental aspects of the cultivation of transgenic herbicide resistant plants. 111 p.

Shekara BG, Nanjappa HV. 1993. Nutrients uptake by crop and weeds and economics of different weed control treatments in soybean. Indian J. Weed Sci. **25,** 40-43.

Swanton CJ, Clement DR, Derksen DA. 1993. Weed succession under conservation tillage: A hierarchical framework for research and management. Weed Technology **7,** 286-297.

Traore K, Soro D, Camara B, Sorho F. 2010. Effectiveness of glyphosate herbicide in a juvenile oil palm plantation in Côte d'Ivoire. Journal of Animal & Plant Sciences **6(1),** 559- 566.

Turner PD, Gillbanks RA. 2003. Oil Palm Cultivation and Management, p: 633. The Incorporated Society of Planters, Kuala Lumpur, Malaysia.

Whaley CM, Vangessel MJ. 2002. Horsenettle (*Solanum carolinense*) control with a field corn (*Zea mays*). Weed Technology **16,** 293-300.

Wibawa W, Mohamad R, Omar D, Juraimi AS. 2007. Less hazardous alternative herbicides to control weeds in immature oil palm. Weed Biology and Management **7,** 212-247.

Wibawa W, Mohamad R, Abdul SJ, Dzolkhifli O, Mohayidin MG, Begum M. 2009. Weed control efficacy and short term dynamic impact of three non-selective herbicides in immature oil palm plantation. International Journal of Agriculture and Bology. **08(289),** 145- 150.

Wrucke MA, Arnold WA. 1985. Weed species distribution as influenced by tillage and herbicides. Weed Science **33,** 853-856.