Malays. Appl. Biol. (2015) 44(2): 75–84

ASSESSMENT OF PHYTOTOXIC POTENTIAL OF OIL PALM LEAFLET, RACHIS AND FROND EXTRACTS AND POWDERS ON GOOSEGRASS (*Eleusine indica* (L.) Gaertn.) GERMINATION, EMERGENCE AND SEEDLING GROWTH

CHUAH, T.S.* and LIM, W.K.

School of Food Science and Technology, University of Malaysia Terengganu,
21030 Kuala Terengganu, Terengganu, Malaysia
**E-mail: chuahts@umt.edu.my*

ABSTRACT

In order to achieve higher yields and protect crops from competition with weeds, various herbicides are widely employed in plantations and farms. However, the excessive use of herbicides has caused adverse impact to agricultural areas and water sources through the process of leaching and water infiltration besides causing herbicide resistance in weeds like goosegrass (*Eleusine indica* (L.) Gaertn.). This study aimed to determine the phytotoxic potential of oil palm residue extracts and residues on goosegrass under laboratory and glasshouse conditions. Crude extracts of oil palm residues, viz; leaflet, rachis or frond was applied onto Petri dishes containing goosegrass seeds. Leaflet, rachis or frond powder was manually applied as mulching on the soil surface sown with goosegrass seeds. Rachis powder was the most effective treatment where it reduced emergence and growth of goosegrass seedlings by approximately 20 and 50% at 4 t ha^{-1}, respectively, while the rachis extract provided complete inhibition of goosegrass germination at a concentration of as low as 1.0% (w/v). These results suggest that oil palm rachis powder has the potential to be an alternative to commercial herbicides for goosegrass control.

Key words:

INTRODUCTION

Goosegrass, an annual grassy weed, is widely distributed in the tropical countries such as in Africa, Asia, South America and the southern parts of North America. It is considered as one of the five most troublesome weeds in the world which greatly affects 46 different crop species production in over 60 countries (Stecker, 2010). It is tolerant to a wide range of salt stress and pH (Chauhan & Johnson, 2008) and water stress (Ismail *et al.*, 2003; Ismail *et al.*, 2002). In addition, goosegrass seed burial at 20 cm depth still exhibited 79% viability after two years (Chuah *et al.*, 2004a). Goosegrass can be found in immature oil palm plantations, vegetable farms and orchards (Chuah & Ismail, 2010). Herbicide usage has increased in both zero tillage and conventional systems because it provides an effective and cheap method of weed control and is less labour intensive. Herbicides such as glyphosate in combination with fluzifop or sethoxydim (Chuah *et al.*, 2004b) and ametryn in combination with glufosinate (Chuah *et al.*, 2008a) have been demonstrated to provide good control of goosegrass. However, a mixture of glyphosate and glufosinate is not recommended for goosegrass due to antagonistic activity (Chuah *et al.*, 2008b). Although these herbicides play a vital role in enhancing adoption of zero tillage system, over reliance on herbicides has exacerbated the risk of herbicide resistance in weeds. For example, the population of goosegrass has evolved resistance to different groups of herbicides (Heap, 2013). Goosegrass has been documented to evolve resistance to glyphosate (Lee & Ngim, 2000), fluazifop (Marshall *et al.*, 1993), paraquat (Itoh *et al.*, 1990), and glufosinate (Chuah *et al.*, 2010) in 8 of 13 states in Malaysia (Chuah & Ismail 2010). This incident has caused serious problems for local growers because few herbicides are available in the market for the control of goosegrass weed.

Organic mulching which is a layer of organic protective covering that is applied onto the soil surface to conserve moisture, suppress weeds, prevent erosion and improve soil structure and fertility (Chalker-Scott, 2007) may be an alternative

* To whom correspondence should be addressed.

for goosegrass control. A variety of materials derived from plants and animals have been used as mulches including shredded leaves, tree bark, wood chips, peanut hulls, grass clippings, peat moss, pine needles, straw, sawdust and ground corn cobs, animal manure, recycled wood and paper and composted sewage sludge (Herms, 2001). However, limited information is available on the potential of oil palm leaflet, rachis and frond residues for weed management although these residues are usually left as mulch between oil palm trees for weed suppression and nutrient recycling purposes (Berger, 2003). Thus, this research is aimed to evaluate the phytotoxic potential of oil palm residue crude extracts on the germination of goosegrass and to determine the phytotoxic effect of oil palm residues on seedling emergence of goosegrass weed.

MATERIALS AND METHODS

Plant materials

Fully expanded oil palm fronds (*Elaeis guineensis* var. tenera) were collected from a mature oil palm plantation in Setiu, Terengganu. The oil palm fronds were clean and dried under full sunlight for a week and then kept in an oven at 50ºC for another week. The fronds were then separated into leaflet and rachis before being ground into powder form (< 2 mm) by using a mill grinder, packed into separate labeled plastic bags and stored in a chiller at 5ºC before use.

Goosegrass seeds (*Eleusine indica*) were collected along the roadsides of Gong Badak, Kuala Terengganu, Malaysia. The viability of goosegrass seeds was tested to ensure that the seeds had a germination percentage of higher than 90%. A total of 3,000 goosegrass seeds were used and the seed coats were removed by using sand paper. Then, the naked seeds were soaked in 0.2% potassium nitrate solution for 24 hours to break seed dormancy. The seeds were rinsed with distilled water before being subjected to treatments.

Growth medium

Sandy loam soil (3.0% clay, 26.8% silt, 70.2% sand; organic carbon 3.5%; pH 5.5) was collected from a site at Rhu Tapai Department of Agriculture, Setiu in Terengganu. The soil was sun-dried and sieved to remove any unwanted plant debris under glasshouse conditions with a relative humidity of 85% and a temperature of 39ºC with 12 h photoperiod at a light intensity of 800–1000 $\mu Em^{-2} sec^{-1}$. Two kilograms of soil was filled into a pot measuring 8 cm diameter by 10 cm high containing 7 gm commercial chicken dung, which is equivalent to 4 t ha^{-1}.

Laboratory bioassay

The experiment consisted of two factors, (i) parts of oil palm residues: leaflet, rachis and frond and (ii) 6 aqueous extract concentrations: (0.0, 0.125, 0.25, 0.5, 1.0 and 2.0%). Each 35 gm oil palm residue sample was transferred into respective conical flasks containing 250 ml distilled water and agitated using an orbital shaker (Tech-lab T 05-100) for 72 hours at a speed of 300 rpm at 25ºC, then filtered with muslin cloth followed by centrifugation (HERMLE Z 36 HK) at a speed of 6000 rpm for 15 min at 4ºC. The extracts were further filtrated by Whatman # 1 filter paper (Whatman International Ltd., England) using a vacuum pump. The extracts were freeze-dried and kept in a chiller at 10ºC before use. Each treatment was replicated four times in a complete randomized design.

Each 8 cm diameter glass Petri dish was lined with 2 pieces of 7 cm diameter Whatman # 1 filter paper and into which 5.0 ml of the extract was added. To serve as control, distilled water was used. 15 goosegrass seeds were placed onto the filter papers and the Petri dishes were sealed with parafilm. The Petri dishes were incubated in a seed germinator [GC-1050 (Protech, Malaysia) at 30/20ºC (day/night) with 12 hr of photo period] for a week. The germination, radicle and shoot length of seedlings were recorded and expressed as percentages of their respective control seedlings. Seeds are considered germinated when the radicle lengths are >2 mm.

Glasshouse study

The experiment consisted of two factors, (i) parts of oil palm residues: leaflet, rachis and frond powder, (ii) 4 rates of oil palm residues: (0.0, 2.0, 4.0 and 8.0 tons ha^{-1}). 25 seeds of goosegrass were sown evenly onto the soil surface. Then, each type of oil palm residue was applied at 0, 2, 4 or 8 t ha^{-1} onto the soil surface, respectively. The soils containing the oil palm residues were watered twice a day at 90% of field capacity under glasshouse conditions as described previously. 7 gm commercial chicken dung was applied on the soil surface at 1 week and 3 weeks after sowing the goosegrass seeds. Goosegrass seedlings were harvested on 30 DAT (day after treatment). The aboveground tissues of goosegrass seedlings were harvested and weighed by using a portable electronic balance. The data were expressed as percentages of their respective controls. Emergence of goosegrass seedlings was counted and recorded. The treatments were replicated ten times in a complete randomized design. Seedlings are considered emerged when the shoot lengths are >2 mm.

Statistical analysis

The data were tested for the normality and homogeneity of variance before being subjected to one- way ANOVA, followed by Tukey's test to compare the treatments at the 5% significant level.

RESULTS AND DISCUSSION

Phytotoxic effect of oil palm leaflet, rachis, and frond crude extracts

The phytotoxic effect of oil palm leaflet (OPL), rachis (OPR), and frond (OPF) extracts on goosegrass seed germination is shown in Figure 1. The OPL, OPR, OPF extracts at a concentration of 0.5% (w/v) reduced goosegrass germination by 20 to 30%, respectively. Interestingly, when the concentration of oil palm residue extract was increased to 1.0% (w/v), the OPR extract gave 100% inhibitory effect, followed by the OPF and OPL extracts which had about 90 and 70% inhibition of germination, respectively. Figure 2 shows the phytotoxic effect of oil palm residue extracts on goosegrass shoot growth. At a concentration of 0.125% (w/v), the OPF and OPL extracts provided stimulatory effects on the shoot growth while the OPR extract remained unaffected. Only 1.0% (w/v) of the OPR extract was required to inhibit shoot growth of goosegrass by 100% while the OPL and OPF extracts required 2.0% (w/v) of concentration to provide the same inhibitory effect. The phytotoxic effect of oil palm residue extracts on goosegrass root growth is presented in Figure 3. Goosegrass root growth was not affected by the OPL and OPF extracts at the concentrations ranging from 0.125 and 0.25% (w/v). Stimulatory effect was observed when goosegrass seeds were treated with the OPR extract at 0.125% (w/v). 1.0% (w/v) OPR extract provided 100% inhibition of root growth while both OPF and OPL extracts were able to provide 70% reduction of root length at the same concentration.

Oil palm leaflet (OPL), rachis (OPR) and frond (OPF) crude extracts had an increasingly inhibitory effect on germination, shoot and root growths of goosegrass when the concentration of each type of the extract was increased from 0.125 to 2.0% (Fig. 1-3). This concentration-dependent response of bioassay species implies that the extracts might contain allelochemicals. These results are in agreement with the findings of Kato-Noguchi (2001) who has demonstrated that the water-soluble extract of lemon balm (*Melissa officinalis* L.) shoot inhibited the germination, root and shoot growth of timothy (*Phleum pratense* L.), cress (*Lepidium sativum* L.), crabgrass (*Digitaria sanguinalis* L.), cockscomb (*Amaranthus caudatus* L.), lettuce (*Lactuca sativa* L.) and ryegrass (*Lolium multiforum* Lam.). On the other hand, OPR extract showed greater inhibition of root growth than the shoot growth of goosegrass as documented by Chung *et al.* (2001) who examined the phytotoxicity of rice shoot on barnyard grass. In addition, OPR extract required 1.0% (w/v) to provide complete inhibition of goosegrass germination while in another study by Chuah *et al.* (2011), it has been shown that 2.0% (w/v) chili leaf and 3% (w/v) chili stem extracts were needed to give the same inhibition of goosegrass germination, respectively. This suggests that the OPR extracts is more phytotoxic than chili leaf and chili stem extracts.

Phytotoxic effect of oil palm leaflet, rachis, and frond powder

The 8 t ha^{-1} oil palm rachis (OPR) powder exhibited the greatest suppressive effect which gave about 40% inhibition of goosegrass emergence while both oil palm leaflet (OPL) and frond (OPF) powder were only able to provide approximately 25% suppression at the same rate (Fig. 4). Figure 5 shows the effects of oil palm residues on goosegrass seedling growth. Application of 2 t ha^{-1} OPL powder had negligible effect on goosegrass shoot growth but both 4 and 8 t ha^{-1} OPL powder were equally effective in suppressing the shoot growth of goosegrass by 30-50%. Similarly, the OPF powder reduced shoot fresh weight of goosegrass seedling by 40-50% regardless of any application. Meanwhile, the increase in the application rate of OPR powder from 2 to 8 t ha^{-1} showed an increasingly inhibitory effect on the goosegrass seedling growth ranging from 40-70%.

In the present study, OPR powder provided great suppressive effect on goosegrass emergence and seedling growth being inhibited by 40–70% when the application rate was increased from 2 to 8 t ha^{-1}. This is likely due to the physical barrier or the release of allelochemicals from the OPR powder. Similarly, leaf and stem residues of rice plants with different rates from 3 to 6 t ha^{-1} caused varying degrees of inhibition of goosegrass biomass where higher rates provided more inhibitory effect under glasshouse conditions (Chauhan & Abugho, 2013). Batish *et al.* (2007) also reported that *Anisomeles indica* leaf applied as mulch at 1 and 2 t ha^{-1} significantly reduced the emergence of *P. minor* and other weeds of wheat crop similar to the effect provided by herbicide. The result is also supported by the research done by Cheema and Khaliq (2000), where sorghum stalk residue applied on the soil surface as mulches at a rate of 6 t ha^{-1} resulted in 41% weed reduction.

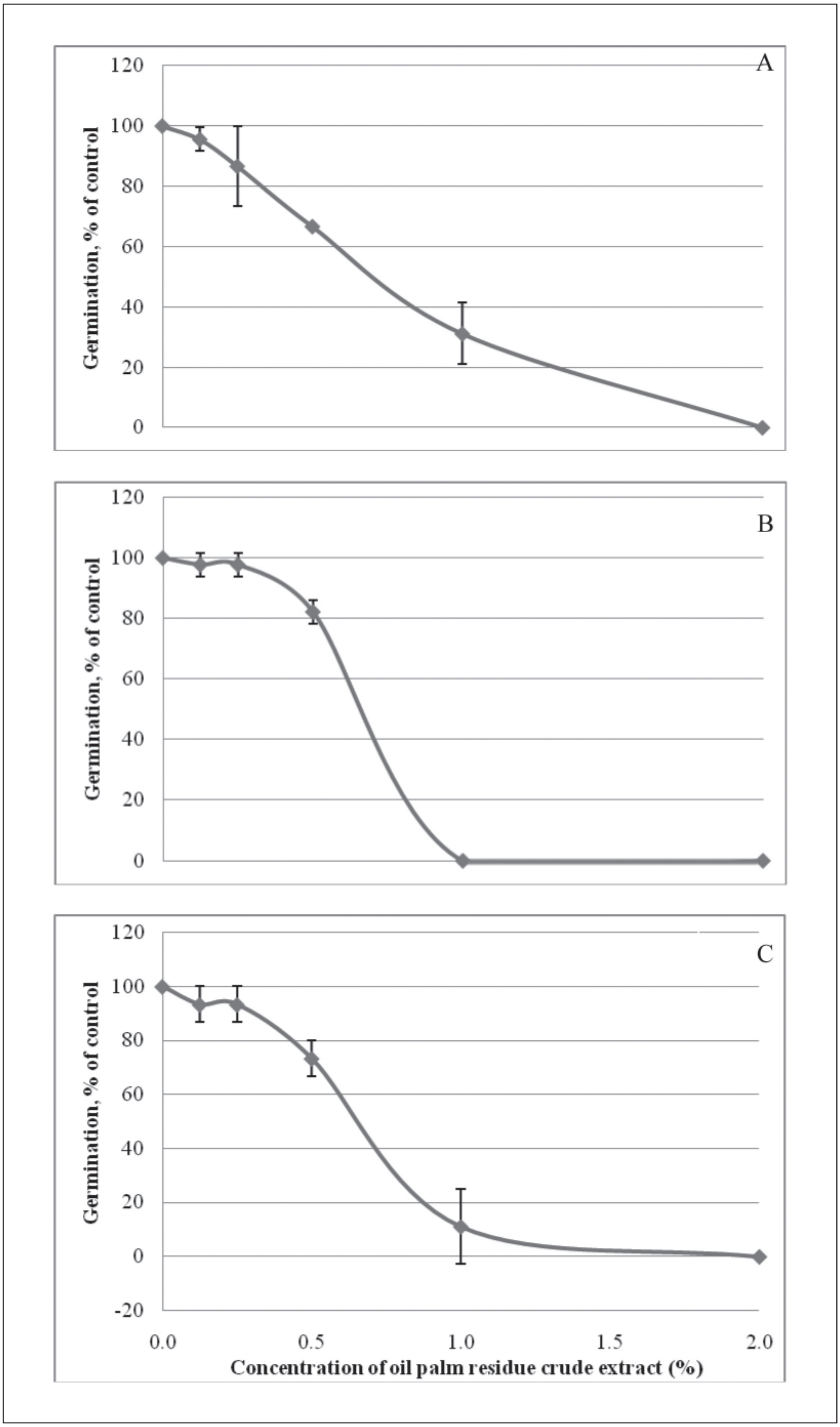

Fig. 1. Effects of oil palm leaflet (A), rachis (B), or frond (C) crude extracts on germination of goosegrass (*Eleusine indica*).

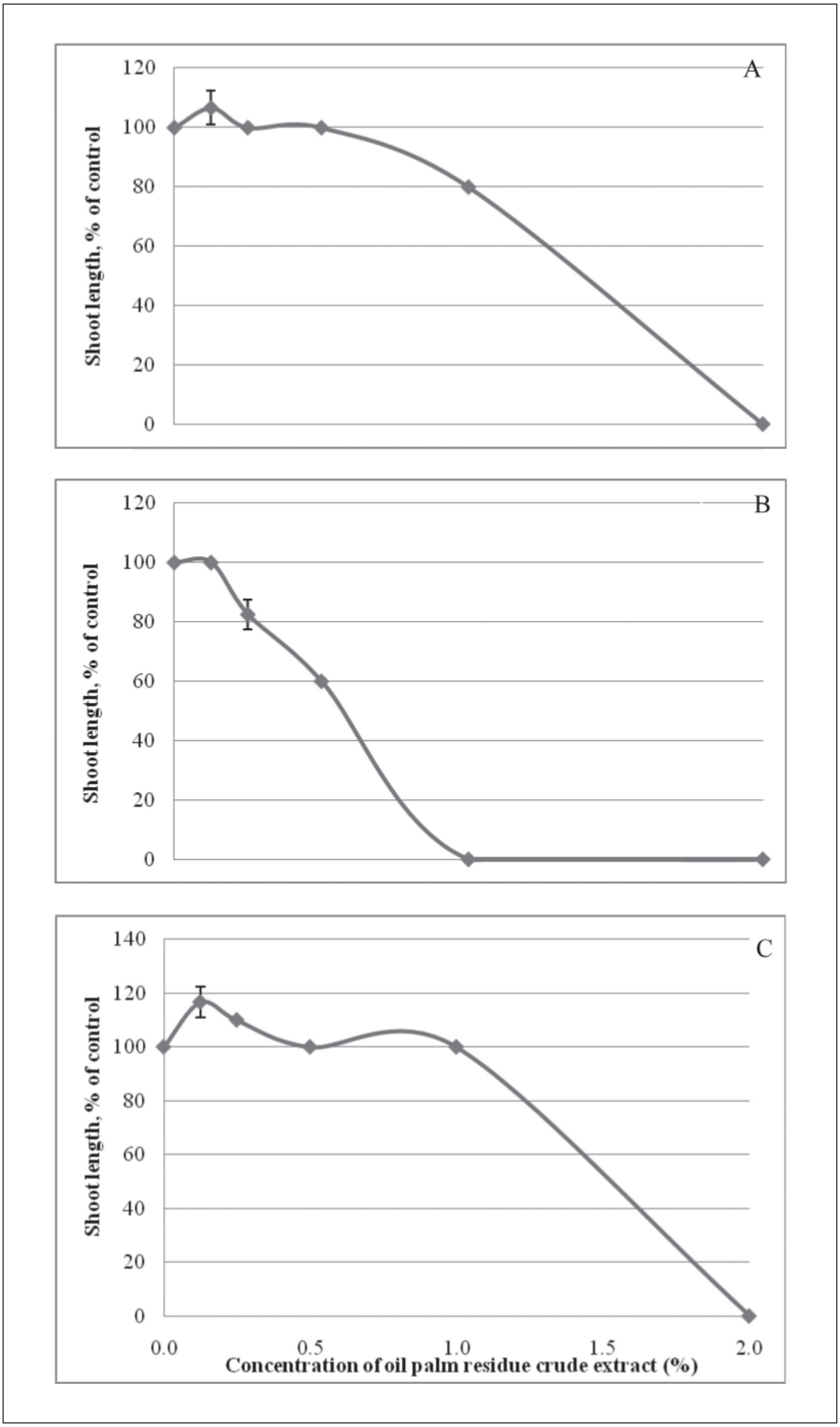

Fig. 2. Effects of oil palm extract of leaflet (A), rachis (B), or frond (C) crude extracts on shoot growth of goosegrass (*Eleusine indica*).

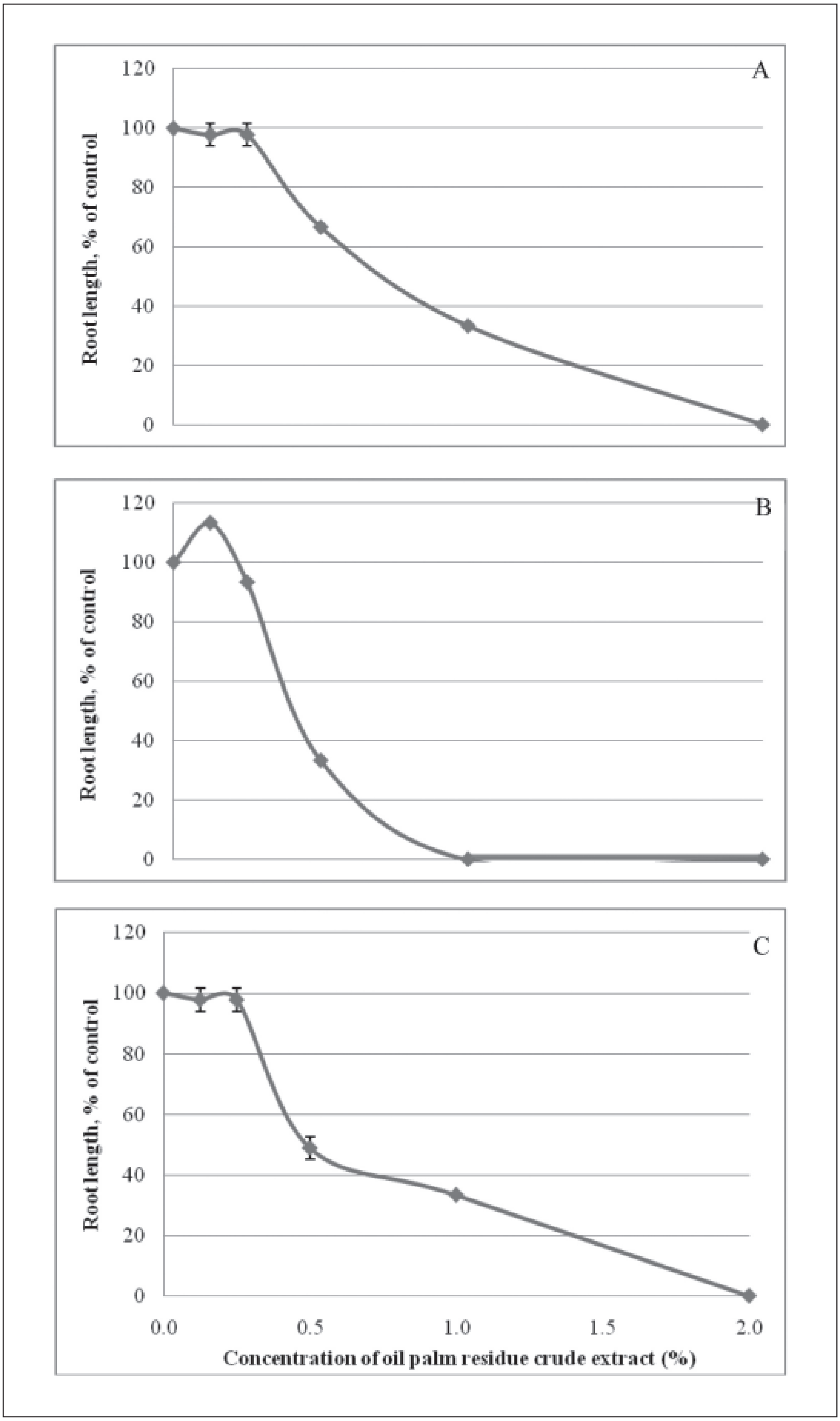

Fig. 3. Effects of oil palm leaflet (A), rachis (B), or frond (C) crude extracts on root growth of goosegrass (*Eleusine indica*).

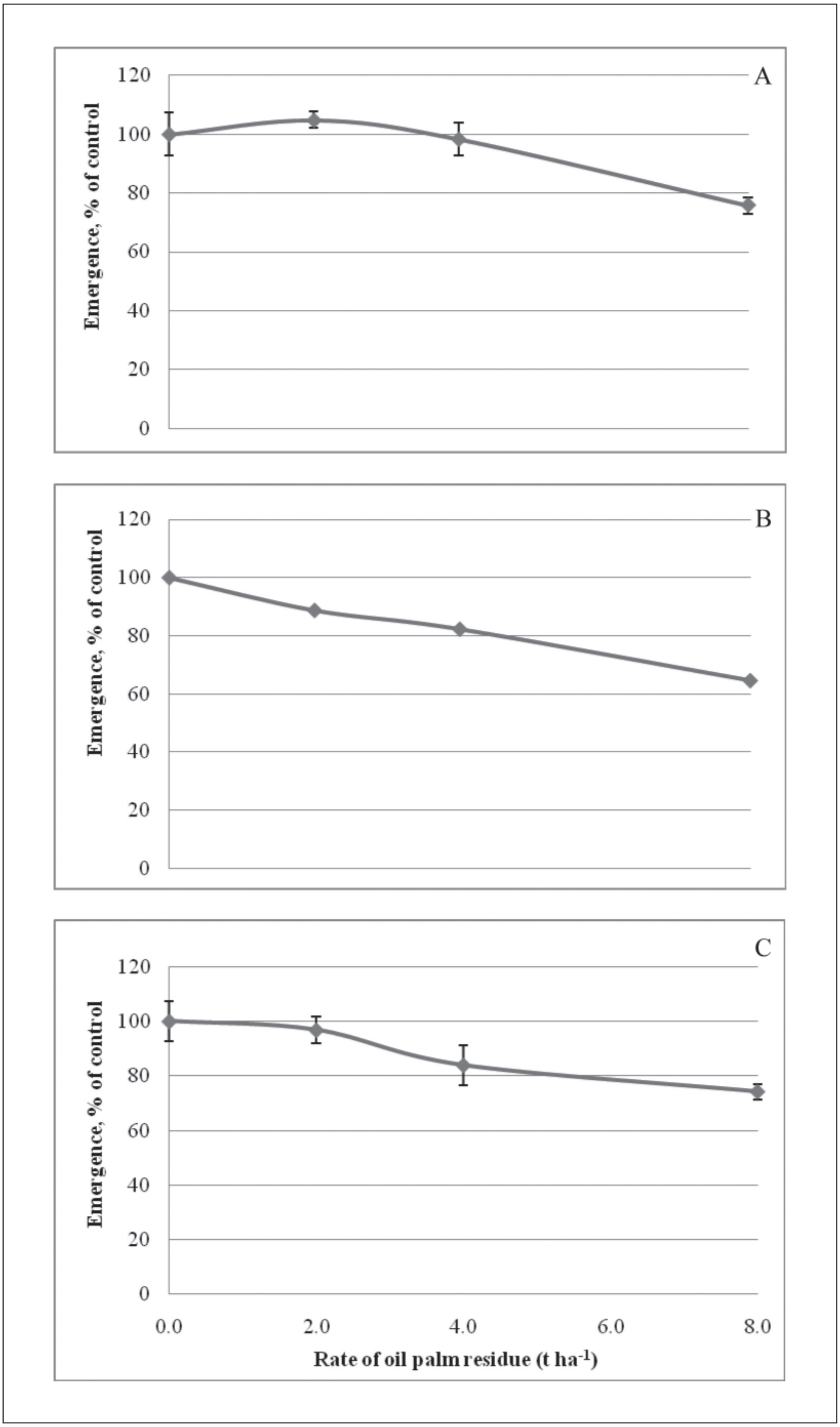

Fig. 4. Effects of oil palm leaflet (A), rachis (B), or frond (C) powder on the emergence of goosegrass (*Eleusine indica*).

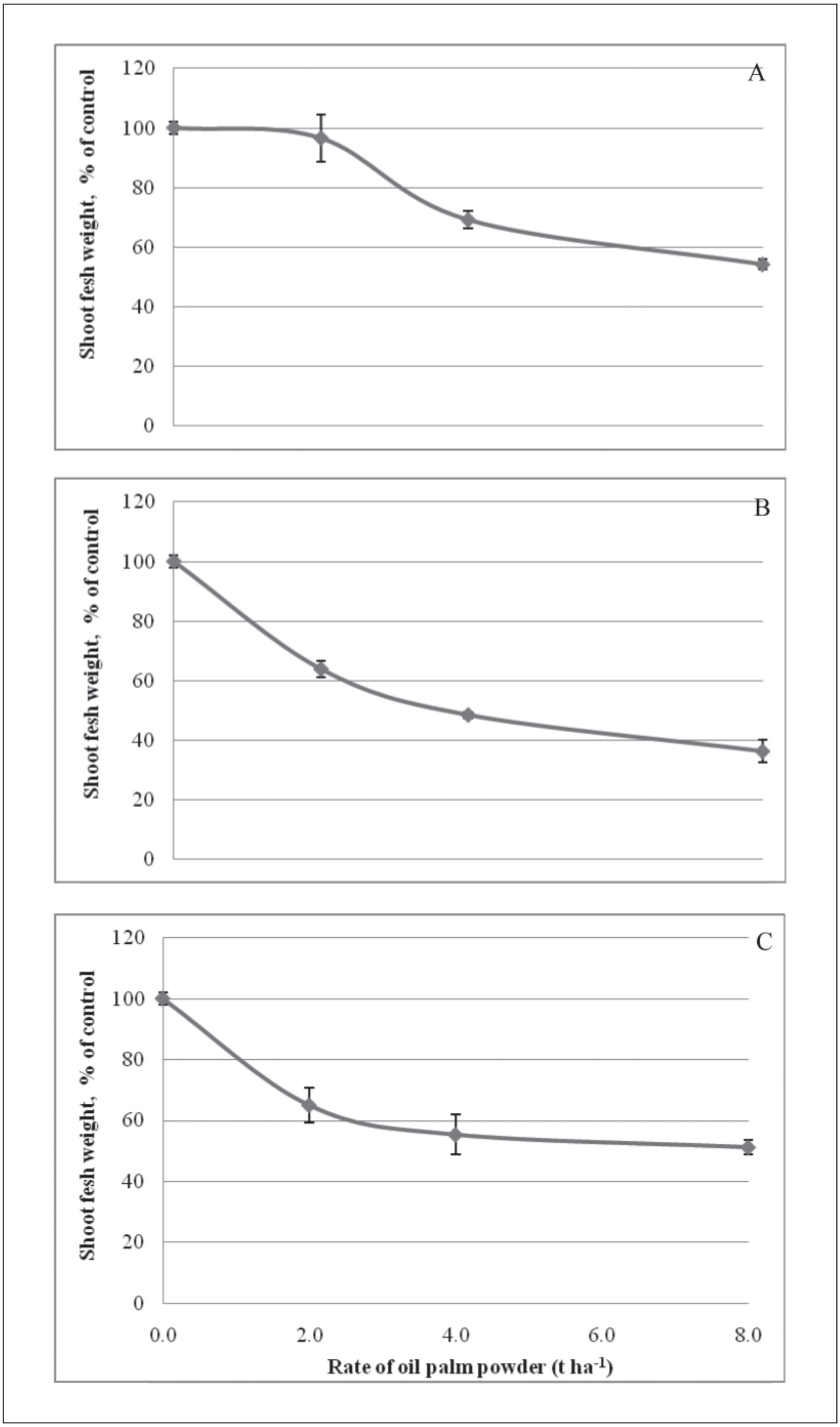

Fig. 5. Effects of oil palm leaflet (A), rachis (B), or frond (C) powder on seedling growth of goosegrass (*Eleusine indica*).

This present preliminary study has revealed that oil palm rachis powder is an alternative to commercial pre-emergence herbicide to control goosegrass. However, glasshouse results cannot be extrapolated to field conditions as the efficacy of oil palm rachis powder as mulching is likely to be influenced by environmental factors such as soil type and soil moisture. Further studies are needed to isolate the phytotoxic compounds of the oil palm rachis powder so that it can be developed as a commercial natural herbicide.

REFERENCES

Batish, D.R., Kaur, M., Singh, H.P. & Kohli, R.K. 2007. Phytotoxicity of a medicinal plant, *Anisomeles indica*, against *Phalaris minor* and its potential use as natural herbicide in wheat fields. *Crop Protection,* **26**: 948-952.

Berger, K. 2003. Palm oil. Wiley Encyclopedia of Food Sciences and Nutrition. 2nd Ed. Palm Oil Research Institute of Malaysia, Malaysia. 4325-4331 pp.

Chalker-Scott, L. 2007. Impact of mulches on landscape plants and the environment. *Journal of Environmental Horticulture,* **25(4)**: 239-249.

Chauhan, B.S. & Johnson, D.E. 2008. Germination ecology of goosegrass (*Eleusine indica*): An important grass weed of rainfed rice. *Weed Science,* **56**: 699-706.

Chauhan, B.S. & Abugho, S.B. 2013. Effect of crop residue on seedling emergence and growth of selected weed species in a sprinkler-irrigated zero-till dry-seeded rice system. *Weed Science,* **61**: 403-409.

Cheema, Z. & Khaliq, A. 2000. Use of sorghum allelopathic properties to control weeds in irrigated wheat in a semi arid region of punjab. *Agriculture, Ecosystems & Environment*, **79(2)**: 105-112.

Chuah, T.S., Nor Asmah, B.J., Cha, T.S., Sayed, M.Z. & Ismail, B.S. 2008a. The use of reduced rates of combinations in tank mixes for goosegrass (*Eleusine indica* L. Gaertn.) control. *World Applied Sciences Journal,* **5(3)**: 358-362.

Chuah, T.S. & Ismail, B.S. 2010. The status of weed resistance in plantation crops in Malaysia. *The Planter*, **86**: 615-620.

Chuah, T.S., Teh, H.H., Cha, T.S. & Ismail, B.S. 2008b. Antagonism of glufosinate ammonium activity caused by glyphosate in tank mixtures used for control of goosegrass (*Eleusine indica* L. Gaertn.). *Plant Protection Quarterly,* **23(3)**: 116-119.

Chuah, T.S., Salmijah, S. & Ismail, B.S. 2004a. Changes in seed bank size and dormancy characteristics of the glyphosate- resistant biotype of goosegrass (*Eleusine indica* (L.) Gaertn.). *Weed Biological and Management,* **4**: 114-121.

Chuah, T.S., Tiun, S.M. & Ismail, B.S. 2011. Allelopathic potential of crops on germination and growth of goosegrass (*Eleusine indica* L. Gaertn) weed. *Allelopathic Journal,* **27(1)**: 33-42.

Chuah, T.S., Salmijah, S. & Ismail, B.S. 2004b. Efficacy of tank-mix combinations of glyphosate and gramicides on the control of glyphosate-resistant and susceptible biotypes of goosegrass (*Eleusine indica* L. Gaertn.). *Plant Protection Quarterly,* **19(4)**: 130-134.

Chuah, T.S., Low, V.L., Cha, T.S. & Ismail, B.S. 2010. Initial report of glufosinate and paraquat multiple resistance evolved in a biotype of goosegrass (*Eleusine indica* (L.) Gaertn.) in Malaysia. *Weed Biological and Management*, **10**: 229-233.

Chung, I.M., Ahn, J.K. & Yun, S.J. 2001. Identification of allelopathic compounds from rice (*Oriza sativa* L.) straw and their biological activity. *Canadian Journal of Political Science*, **81**: 815-9.

Heap, I.M. 2013. International Survey of Herbicide-Resistant Weeds [online]. Available at: http://www.weedscience.org/Summary/Species.aspx?WeedID=81

Herms, D., Gleason, M., Iles, J., Lewis, D., Hoitink, H. & Hartman, J. 2001. Using mulches in managed landscapes. Available at: http://ohioline.osu.edu/b894/pdf/b894.pdf (Accessed: 30 April 2013)

Ismail, B.S., Chuah, T.S., Salmijah, S. & Teng, Y.T. 2003. Effect of shade and watering frequency on growth and development of glyphosate- resistant and susceptible biotypes of goosegrass (*Eleusine indica* (L.) Gaertn.). *Plant Protection Quarterly,* **19(4)**: 130-134.

Ismail, B.S., Chuah, T.S., Salmijah, S., Teng, Y.T., & Schumacher, R.W. 2002. Germination and seedling emergence of glyphosate-resistant and susceptible biotypes of goosegrass (*Eleusine indica* (L.) Gaertn.). *Weed Biological and Management,* **2**: 177-185.

Itoh, K., Azmi, M. & Ahmad, A. 1990. Paraquat resistance in *Amaranthus lividus* and *Conyzasum atrensis* in Malaysia. In: Proceedingsof the 3rd tropical weed science conference (Kuala Lumpur, 4–6 Dec 1990). Malaysian Plant Protection Society, Kuala Lumpur, Malaysia. 489-493 pp.

Kato-Noguchi, H. 2001. Effects of lemon balm (*Melissa Officinalis* L.) extract on germination and seedling growth of six plants. *Acta Physica Polonica*, **23(1)**: 49-53.

Lee, L.J. & Ngim, J. 2000. A first report of glyphosate-resistant goosegrass (*Eleusine indica* (L.) Gaertn) in Malaysia. *Pest Management Science*, **56**: 336-339.

Marshall, G., Kirkwood, R.C. & Leach, L.E. 1993. Comparative studies on graminicide-resistant and susceptible biotypes of *Eleusine indica*. *Weed Research,* **36**: 177-185.

Stecker, L. 2010. W116 Goosegrass. The University of Tennessee Agricultural Extension Service, 06-0089. Available at: http://trace.tennessee.edu/utk_agexcrop/109 (Accessed: 2 May 2013)