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Table: -, Figs : 4

Allelopathic potential of Chinese rice flower (*Aglaia odorata* Lour.) as organic herbicide

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ABSTRACT

The aqueous extracts of leaf and branches of *Aglaia odorata* inhibited the germination and seedling growth of barnyardgrass (*Echinochloa crus-galli* (L.) Beauv.) and wild pea (*Phaseolus lathyroides* L.) over the control. Besides its dry leaf powder (31.25, 62.5, 125 and 250 mg/plate) was more inhibitory to these parameters than aqueous extract. Furthermore, the inhibitory effects of dried leaf pellets of Chinese rice flower were more stronger than dried leaf powders at equal rates. The pellets applied at 0.5 ton ha^{-1} dose as soil surface mulch inhibited the seedlings emrgence of banyardgrass and wild pea by 67% and 2%, respectively. Thus the Chinese rice flower pellets has the potential to act as organic herbicide for control of barnyardgrass weed.

Key Words: *Aglaia odorata,* allelopathy, aqueous extracts, barnyardgrass, Chinese rice flower, *Echinochloa crus-galli*, inhibition, leaf powder, organic herbicide, pellet, *Phaseolus lathyroides*, weed control, wild pea

INTRODUCTION

Weeds compete with cultivated crop plants for growth factors (water, light, nutrients, and space) and reduce the crop yields. The increasing and continuous use of herbicides has resulted in increased resistance to herbicides in weeds, environmental pollution, unsafe agricultural products and human health concerns (15,26). This had led us to search for new technologies and cultural practices to manage weeds for sustainable crop production. Allelopathy is defined as a beneficial or detrimental effect from donor plant to the recipient by chemical pathway. The inhibitory effects of allelopathy can be exploited as a tool for weed control. The use of allelopathic plants for weed management to minimize our dependence on synthetic herbicides may be feasible. The use of allelopathic plants as mulch or soil incorporated has been suggested for alternative weed management in sustainable agriculture (1,7,10,15,23,24). For example, hairy vetch (*Vicia vilosa* L.) is promising cover crop for weed control in fields, grasslands and orchards in Japan (7). Buckwheat (*Fagopyrum esculentum* Moench) pellets significantly reduces the paddy weeds at 2 ton ha^{-1} and kava root (*Piper methysticum* L) provides weed control in paddy at 1 ton ha^{-1} applied at 6 and 10 days after the soil was saturated with water (25). Dried

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Saururaceae (*Houttuynia cordata* Thunb.) powder significantly reduces the *Echinochloa* and *Monochoria* paddy weeds at 150 g m^{-2} and increases the grain yield of rice than control (18). The *Aglaia* genus consists of about 130 spp., mainly distributed in Indo-Malayan region, southern mainland China and the Pacific Islands (21). Chinese rice flower (*Aglaia odorata* Lour.) has been used as medicinal plant in Thai traditions. Its compounds possess antiviral (13,20), anticancer (4,9,16), antifungal (6), anti-inflammatory (2,19) and insecticidal activities (8,22). However, its allelopathic and herbicidal activity for weed control has not been investigated. This study aimed to determine (i). the allelopathic effects of aqueous extracts and dried powder of Chinese rice flower on the germination and initial seedling growth of barnyardgrass (*Echinochloa crus-galli*) and wild pea (*Phaseolus lathyroides*) and (ii). to find the herbicidal effects of its pellets on test weed species.

MATERIALS AND METHODS

Plant materials (leaves and branches) of Chinese rice flower plants, growing in our Institutes fields were collected before flowering and were separated into the leaves and branches. They were washed several times with tap water and dried in hot-air oven at 45 °C for 72 h. Then cut into 1 cm pieces, powdered in a blender and sieved through 40 mesh (420 μm) sieve.

The study consisted of three separate experiments (I). Petriplate bioassay with aqueous extract, (II). Petriplate bioassay with powdered material and (III). Pot culture with pellets of Chinese rice flower.

I. Aqueous extract bioassay

The experiment consisted of three factors : (i). Test weeds : 2 (Barnyard grass, wild pea), (ii). Chinese rice flower parts : 2 (Leaf, branches) and (iii). Aqueous extracts concentrations : 5 (0,6.25,12,5,25,50 mg/ml). The treatments were replicated 4 times in completely Randomised design.

To prepare aqueous extracts, the powdered leaves and branches of Chinese rice flower were dissolved each at 10 g in 100 mL distilled water for 72 h at 10 °C, followed by filtration through three layers of cheesecloth to remove any debris. The supernatant was then filtered through Whatman No. 1 filter paper, its concentration was 100 gL^{-1} and this stock extract was kept at 5 °C until used. The Chinese rice flower extract was further diluted with distilled water to get 6.25, 12.5, 25, and 50 g L^{-1} concentrations. Seeds of barnyardgrass (*Echinochloa crus-galli* L. Beauv.) were collected from paddy fields in Ladkrabang district, dried in shade at room temperature for three months and then incubated in a hot-air oven at 45 °C for 48 h to break dormancy. Seeds of wild pea (*Phaseolus lathyroides* L.) were collected from an upland field. Twenty healthy seeds (imbibed for 24 h in distilled water) of both bioassay plants were placed in separate Petri dishes (9 cm dia) lined with two sheets of germination paper, moistened with 5 mL of 6.25, 12.5, 25, or 50 g L^{-1} of leaf or branches extract as per treatments. The Petri dishes were kept in growth chamber (25–32 °C, a 12/12 h dark/light photoperiod, and relative humidity of around 80%). The distilled water served as control. Germination was

considered only after the radicle had protruded 1 cm beyond the seed coat. Seedlings growth root and shoot lengths was measured at seven days after sowing. Inhibition (%) over control was calculated as under:

$$\text{Inhibition (\%) over control} = 100 - (\text{sample extracts/control}) \times 100$$

II. Dried leaf powder bioassay

The experiment consisted of two factors : (i) Test weeds : 2 (Barnyardgrass, wild pea) and (ii). Chinese rice flower leaf powder concentrations :5 (0,31.25,62.50,125,250 mg/plate). The treatments were replicated 4 times in completely Randomised design. In lab Petriplate bioassay, the effects of Chinese rice flower dried leaf powder were determined on the germination and seedling growth of barnyardgrass and wild pea seeds were studied in a Petri dish (9 cm dia) bioassay. The dried powder of Chinese rice flower was added to Petri dishes (lined with two sheets of germination paper) at 31.25, 62.5, 125, or 250 mg/Petri dish (equivalent to 6.25, 12.5, 25, and 50 g L^{-1} concentrations) and 5 mL of distilled water was added to each Petri dish. The bioassay was done as per the previous bioassay.

III. Pellets Pot culture

Two pot experiments were conducted. In both experiments there were two factors viz. (i) Test Weeds : 2 (Barnyard grass and wild pea) and (ii). Pellet doses : 5 (0,62.50,125,250,500 mg/plate). While in second experiment Pellet Doses were 4 (0,0.5,1.0,2.0 t/la). The treatments were replicated 4 times in completely Randomised design in both Experiments. This experiment determines the effects of Pellets of Chinese rice flower on test weed spp. The pellets were prepared by mixing 50% *Aglaia odorata* dried leaf powder, 25% cassava glue and 25% $CaCO_3$ powder were dried in hot-air oven at 45°C for 3 days. The influence of these pellets was examined in Petri dishes (9 cm dia.) on the germination and seedling growth of barnyardgrass and wild pea, as in previous experiment. The pellets were applied at 62.5, 125, 250, and 500 mg per Petri dish (equivalent to 31.25, 62.5, 125, and 250 mg dried leaf concentrations per Petri dish) and 5 mL distilled water was added per Petri dish. These were placed in growth chamber (25-32 °C, a 12/12 h dark/light photoperiod, and relative humidity of around 80%). The distilled water served as control. The germination (%) and the initial seedling growth were evaluated as in the previous experiment.

IV. Soil application bioassay

The influence of Chinese rice flower pellets was explored in pot studies done in experimental house, on the seedlings emergence and growth of barnyardgrass and wild pea. The experimental soil used was sandy loam with pH 6.5. Ten kgs of soil mixed with farmyard manure (2:1 ratio), were filled in each plastic pot (15 cm dia, 15 cm depth). Twenty seeds of barnyardgrass or wild pea weeds were sown per pot at 0.5 cm depth. Thereafter pellets of Chinese rice flower were placed on surface of soil as mulch at 0.5, 1.0

and 2.0 ton ai/ha and no mulch was used in control. There were 6-pots per treatment arranged in completely randomized design and watered daily. Number of emerged weeds plants was counted at 14 days after sowing, while plant height and their biomass were determined at 28 days. Inhibition (%) over control was calculated as under:

$$\text{Inhibition (\%) over control} = 100 - (\text{sample extracts/control}) \times 100$$

Statistical analysis

Analysis of variance was calculated for all data and comparisons between treatments were made at the 0.05 probability level using Tukey's honestly significant difference test.

RESULTS AND DISCUSSION

I. Aqueous Extracts bioassay

The aqueous extracts of Chinese rice flower at all test concentrations markedly reduced the seed germination (%) of both test species compared to control (Figure 1). The leaf extract was slightly more inhibitory than the branches extract, but they were similar at the same concentration. The degree of inhibition increased with increase in concentration increased and the germination of barnyardgrass was completely inhibited (100% inhibition) at 50 g L^{-1} concentration of both leaf and branch extracts. The degree of inhibition increases with increasing extract concentrations (3,17). Interestingly, the aqueous extracts were more inhibitory to barnyardgrass than to wild pea. These results indicate that the inhibitory effects of extract varied with the weed species and are in agreement with Lin *et al*. (18), who reported that the inhibitory effects of Saururaceae (*Houttuynia cordata* Thunb.) varied with the weed species. Thus Barnyardgrass was more sensitive to Chinese rice flower extract than wild pea because of its smaller seeds than wild pea. All extracts concentrations (except 6.25 g L^{-1}) significantly reduced the initial seedling growth of barnyardgrass and wild pea. The higher concentrations (12.5-50 g L^{-1}), markedly reduced the shoot and root lengths of both barnyardgrass and wild pea but the reduction was more drastic in root length than in shoot length. The highest concentration (50 g L^{-1}) completely inhibited the seedling growth of barnyardgrass, thus Chinese rice flower plants contained certain allelochemicals inhibitory to weed germination and growth.

II. Dried leaf powder bioassay

These results confirmed that allelochemicals from powdered Chinese rice flower leaves adversely affected the germination and seedling growth of test species (Fig 2). The application of 31.25, 62.5, 125, and 250 mg leaf powder/Petri dish (equivalent to 6.25, 12.5, 25, and 50 g L^{-1}) significantly reduced the germination of barnyardgrass to 75, 50, 22, and 0 %, respectively, and of wild pea to 100, 80, 45, and 0 %, respectively over the

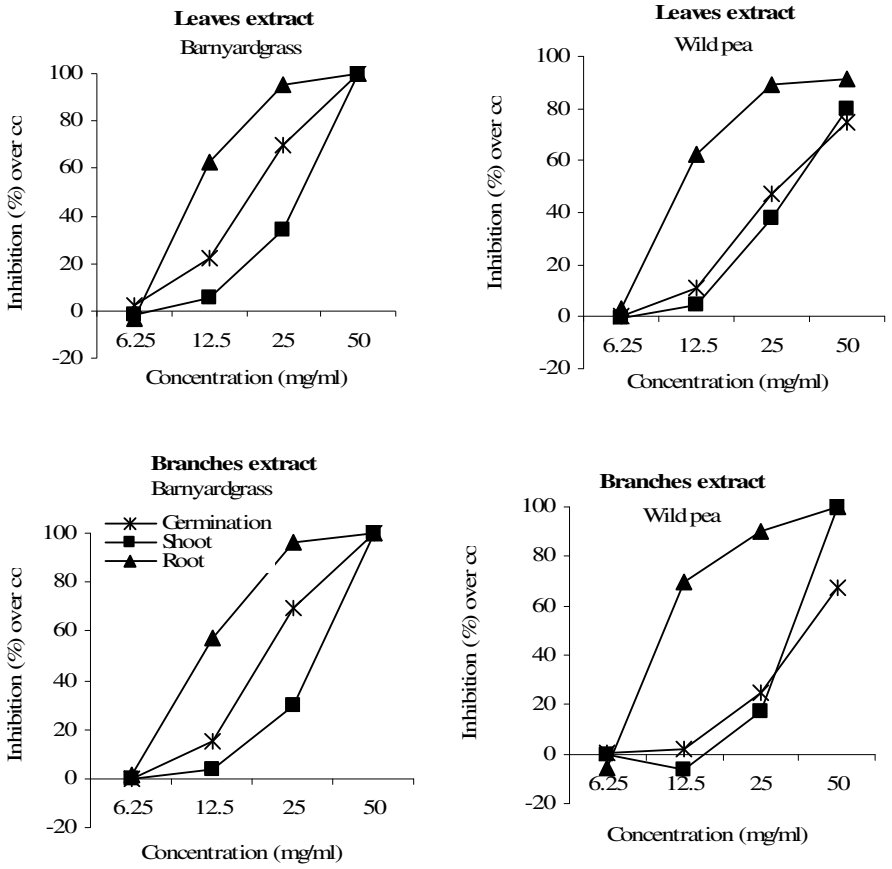

Figure 1. Effects of aqueous extracts of leaves and branches of Chinese rice flower on germination and initial growth of barnyardgrass and wild pea in petriplate bioassay.

control. The germination (%) of both bioassay species declined significantly at all applied rates (except 62.5 mg/Petri dish for wild pea). The leaf powder most strongly reduced the root length and caused complete inhibition at 250 mg/Petri dish. Thus Chinese rice flower leaf powder placed directly into the Petri dish and with subsequent addition of water was most inhibitory to both bioassay species than the aqueous extracts at the same concentration. Because in aqueous extract, the allelochemicals were extracted partially from the leaf powder in water, during the soaking at 10 °C for 72 h. However, when the leaf powder was placed directly into the Petri dish and water was added, the allelochemicals might have released continuously during the experimental period. Past studies have reported the inhibitory effects of plant biomass mulch against the weeds

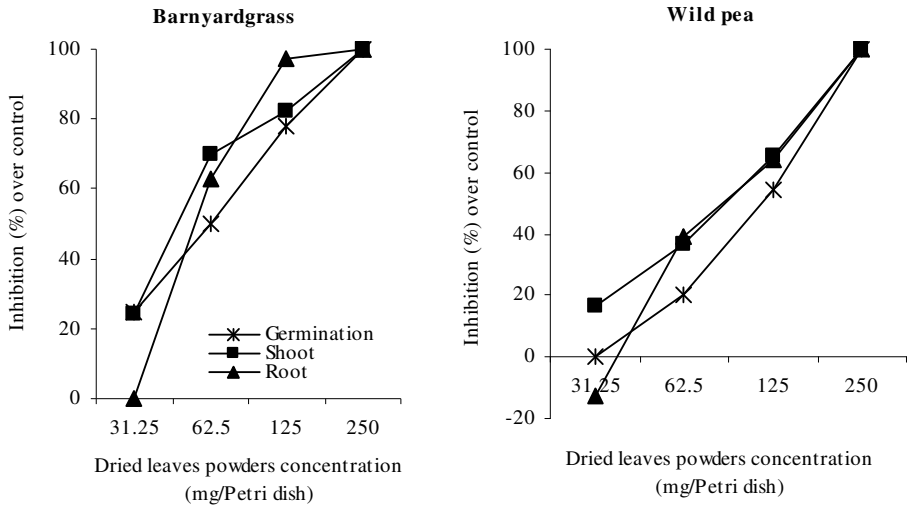

Figure 2. Effects of application of the Chinese rice flower dried leaves powders on germination and seedling growth of barnyardgrass and wild pea in petriplate bioassay.

(3,18,23). Although, there are certain limitations in using the allelopathic plants and allelochemicals for weed control in the fields, but many plants residues as mulch or soil incorporation provides weed management (11,25,26). Yet use of plant residue as mulch or incorporation rate (1-2 ton ha^{-1}) for weed control involves heavy fieldwork. The preparation of pellets from the plant materials allows their easier application, hence, studies were further extended to explore the impact of pellets on germination and growth of test weeds.

III. Pellets bioassay

The application of pellets to petridishes reduced the seed germination of both test weed spp. (Fig 3). However at the lowest dose (62.5 mg pellets per petridish) the germination of wild pea was similar to control but was significantly reduced in barnyardgrass. The 125 mg pellets dose drastically reduced the germination of both barnyardgrass and wild pea. The magnitude of reduction in germination increased with increase in Pellets dose and the 500 mg/petridish dose, completely inhibited the germination of both bioassay species. The shoot and root lengths of both bioassay species were significantly inhibited at the lowest dose (62.5 mg pellets) and the inhibitory effects increased with increasing rates, until complete inhibition at 500 mg pellets per Petri dish. Interestingly, the inhibitory effects of pellets prepared from the dried leaves were stronger than equal amount of leaf powder. This phenomenon might be attributed to the moisture of cassava glue acting as a compatibile medium during the pellets preparation. To use

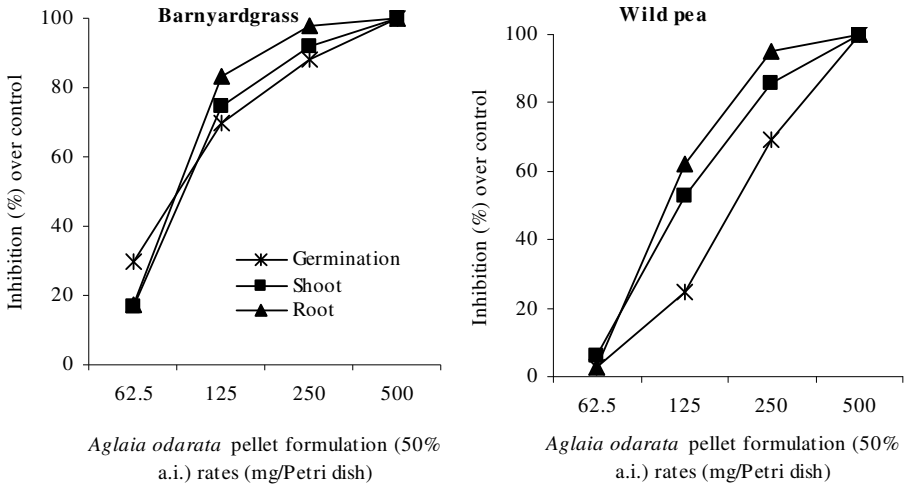

Figure 3. Effects of application of the Chinese rice flower pellet formulation on germination and seedling growth of barnyardgrass and wild pea in petriplate bioassay

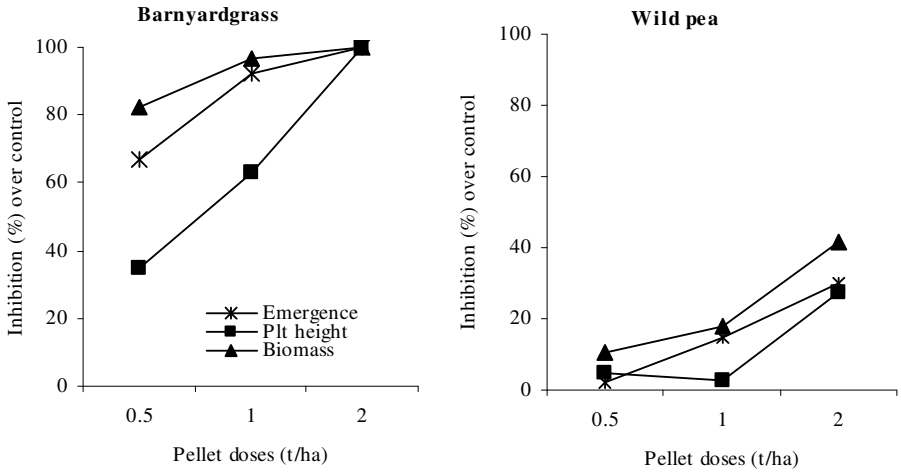

Figure 4. Emergence (14 DAT) and growth (28 DAT) of barnyardgrass (*Echinochloa crus-galli*) and wild pea (*Phaseolus lathyroides*) in response to the use of Chinese rice flower pellet formulation as soil surface mulch in the pot experiment

allelopathic plant materials in the field, water is necessary for the biomass decomposition and release of allelochemicals. Therefore if water is not available, the weeds control in upland areas is more difficult. Our research results offer a solution to some of these limitations. The Chinese rice flower pellet under field conditions also suppress the growth and yield of barnyardgrass. We should further investigate the practical uses of pellets of Chinese rice flower and their influence on crops.

IV. Pot culture

The soil surface mulching of Chinese rice flower pellet reduced the seedlings emergence, plant height and dry biomass of both test weeds: barnyardgrass and wild pea (Figure 4.). The pellets were more inhibitory to barnyardgrass than to wild pea. The reduction in emergence of barnyardgrass at the lowest dose (0.5 t ha^{-1}) was 67% and was only 2% in wild pea. With increasing doses of application, the weed emergence as well as the plant height and dry biomass were decreased further. At 2.0 t ha^{-1} dose, the emergence of barnyardgrass was reduced by 92% and that of wild pea only by 30%. Thus Chinese rice flower pellets significantly reduced the emergence and growth of barnyardgrass and had moderate effects on wild pea. Further studies are required to determine the nature of active compounds present in the pellets and their effects in fields condition on nutrients status of soil, before it is recommended for use in field conditions.

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