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UNIVERSITY OF COLOMBO, SRI LANKA

DEPARTMENTS OF BOTANY & CHEMISTRY
FACULTY OF SCIENCE

UNITED STATES AGENCY FOR INTERNATIONAL
DEVELOPMENT RESEARCH GRANT
No. 8.254

NATURAL RESOURCES, ENERGY & SCIENCE AUTHORITY (NARESA)
OF SRI LANKA, RESEARCH GRANT RG/AID/11

"STUDIES ON THE ALLELOPATHIC POTENTIAL OF SELECTED PLANT SPECIES AND CHARACTERIZATION OF ALLELOCHEMICALS"

PROGRESS REPORT

AUGUST, 1988 - FEBRUARY, 1989

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PROGRESS REPORT 1 - AUGUST, 1988 to FEBRUARY, 1989

1. **RESEARCH GRANT NUMBER:**

   USAID 8.254

   Administered by the Natural Resources, Energy and Science Authority (NARESA) of Sri Lanka (RG/AID/11)

2. **TITLE OF PROJECT:**

   "Studies on the Allelopathic Potential of selected plant species and characterization of Allelochemicals"

3. **INSTITUTE WHERE RESEARCH IS BEING DONE:**

   Departments of Botany and Chemistry, Faculty of Science, University of Colombo, P.O.Box 1490, Colombo-3, Sri Lanka

4. **TIME PERIOD COVERED:**

   Six months, from Date of Award (1 August, 1988 to 28 February, 1989)

5. **OBJECTIVES OF THE STUDY:**

   (a) To investigate and identify from among selected plant species, those that have a high potential for allelopathic interactions

   (b) To explore the possibility of manipulating or utilizing allelopathic species (or their residues) in biological weed suppression in field crop production

   (c) To extract and characterize the inhibitory (or stimulatory) allelochemicals from species having high activity with a view to obtaining biological pesticides and/or plant growth regulators

   (d) To set up a research facility within the Faculty of Science to pioneer and lead research activities aimed at achieving the above

PROJECT PERSONNEL

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SECTION 1

DESCRIPTION OF RESEARCH CARRIED OUT

1. ALLELOPATHIC INFLUENCES OF LEGUMINOUS COVER CROPS:

As proposed in the Technical Work Plan, three leguminous cover-crops which had exhibited allelopathic potential in preliminary studies, were selected for further investigations. The species examined were:

Gliricidia maculata H.B.K.

Leucaena leucocephala (Lam.)de Wit

Pueraria phaseoloides R.Br.

Gliricidia maculata and *Leucaena leucocephala* are two of the most heavily used leguminous cover-crop/shade trees in the island. Both are widely grown as the hedge-row species in 'alley-cropping' and as shade trees or wind belts at mid and high-elevations. Both trees provide large amounts of leaf matter extensively used as 'green manure' in upland cropping, and which are placed on soil surface as 'mulch'. *Pueraria phaseoloides* is the most extensively used creeping 'cover crop' in Rubber and Coconut plantations of the island. In addition to contributing heavily towards stabilization and conservation of soil, and replenishment of soil nutrients, *Pueraria* 'living mulch' is known to suppress weed growth as well.

The specific objectives of the present studies were to (a) identify weed or crop species which are sensitive to aqueous extracts or residues of the three legume species, (b) identify possible adverse effects on sensitive species, particularly on field crops, (c) explore the possibility of utilizing the allelopathic potential in the field to suppress weeds, (d) isolate and chemically characterize the allelochemicals responsible.

2. OTHER POTENTIALLY ALLELOPATHIC WEEDS

As stated in the Project Proposal, several other weed species which have displayed allelopathic activity in preliminary screening trials, are also being studied for the same objectives as above. Currently, work has begun with fresh leaf materials and residues of four common weed species of the *ASTERACEAE*, namely:

Tagetes erecta

Tithonia diversifolia

Eupatorium odoratum

Mikania cordata

1.1 Laboratory Trials with Water Extracts of Leaf Materials

Preparation of Extracts

Studies were carried out with aqueous extracts of both (a) fresh leaf materials and (b) dried leaf 'litter'. The latter was prepared by sun-drying freshly collected leaf materials.

Aqueous extracts were made by taking a known weight of fresh or dried leaf and (a) blending the leaf with the appropriate volume of water in a Food processor (blended extract), or (b) soaking fresh/dry leaf in water with continuous shaking for 24 hrs. (leached extract). Extracts were filtered first through cheese-cloth, and later under suction through Whatman No.2 filter paper. Extracts were then diluted as appropriate to produce a dilution series in the range of 2.5 to 250 mg/ml.

Petri-dish Studies

The effects of the fresh leaf or dried leaf extracts prepared by blending or leaching, on seed germination and seedling growth of a variety of common weed and crop species were examined using standard petri-dish assays. Seeds of the test species were either collected from the field (weed species) or purchased from seed outlets of the Department of Agriculture (crop species). Seeds were stored in glass bottles until needed and all were surface sterilized by dipping in 1% Mercuric chloride for 1 minute just before use.

Twenty-five seeds of each test species were placed in each petri-dish (9 cm diam) lined with Whatman No.1 filter paper. Six ml of each extract was added to each of the dishes. The petri dishes were kept on the laboratory bench under continuous light at 29 + 1 ^{0}C and 70 + 5% relative humidity. Three replicate dishes were used for each treatment and the dishes arranged on the bench in a completely randomized design.

Percent germination was taken at 7 or 10 days. At 21 to 28 days after the initiation of each experiment, the seedlings were measured for their shoot length, radicle length or weighed for fresh weight. These values were compared with the results of the untreated controls.

1.2 Greenhouse Studies with Leaf Residues

Greenhouse Conditions

Experiments with residues were carried out in a greenhouse, under natural daylight only, which was received generally between 8.00 and 17.00 hrs. The day temperature within the greenhouse ranged between 29 and 31^{0}C. while at night it was between 27 and 29^{0}C. The relative humidity was 75% or above.

General

Each of the following experiments was carried out separately for each legume species. There were a minimum of three replicate pots per treatment and all pots were completely randomized, or arranged in randomized complete block designs on the glasshouse bench. Each experiment was repeated at least once more.

Preparation of Residues

Residues of the three leguminous species were prepared by harvesting fresh foliage and sun-drying the leaves for 48 hrs. Once dried the leaf material was ground to a uniform size in a toothed-disk mill, and stored in large glass bottles until required for experiments.

Soil

A sandy-loam soil was used in the studies, which contained 40-45% sand, 24-25% each of silt and clay, and 1-2.5% organic matter.

Soil-Incorporated Residues

The main purpose of this study was to determine whether incorporated residues of the three legume species produced any inhibitory (or stimulatory) effect on the indicator species.

Residues of each legume species were incorporated into soil at concentrations of 0, 1, 2 and 4% (w/w). The plant material was uniformly mixed with separate batches of 25 kgs of soil, and the incorporated soil taken up in an appropriate number of 20 cm diam clay pots (ml). Ten seeds of each of the test species (Crop- Tomato, brinjal; Weed- *Tridax procumbens*, *Hyptis capitata*, *Achyranthes aspera*) were planted one cm deep in each pot. No extra fertilizer was provided. Water was added daily in equal volumes across the pots, to keep the soil just under field capacity. Percent seed germination was obtained at 14 days, after which plants were allowed to grow until a final harvest at 28 days.

Surface Mulch

This study investigated the effect of the three legume residues applied as 'surface mulch' only, on the germination and growth of indicator species.

As in the case of incorporated residues, the concentrations of residues used were 0, 1, 2 and 4% (w/w). The appropriate amount of residue material per pot, was placed on the soil surface as a 'Surface mulch'. Seeds of crop and weed indicator species were planted one cm deep in the soil, and the pots watered daily to a level just under field capacity. Growing conditions were the same as in the previous experiment.

Soil-incorporated and Decomposing Residues

To examine the effect of decomposing legume residues on the germination and seedling growth of crop and weed species, dried leaf residues were incorporated into batches of soil to give concentrations of 1, 2 and 4%. Control soils were free of any residues. Batches of soil (8 or 10 kg each) incorporated with residues were placed in double-layered poly-ethylene bags and kept in the glasshouse for decomposition of residues to occur. One hundred ml of water was provided per bag per week to replace the water that may have been lost through evaporation. Control soil was free of any residues. After allowing for decomposition of residues to take place for 1, 2, 4 and 6 weeks, samples of soil were taken out from each treated batch into small plastic pots (4" diam). Ten seeds each of several indicator species were planted in different pots and allowed to grow for 28-30 days after which plants were harvested. Percent seed germination was recorded at 14 days. At final harvest, the mean dry weight of test species was measured per pot.

1.3Statistical Analyses

All data were subjected to analyses of variance to determine the significance of treatments. Percent germination results were transformed to ARCSINE values before analyses. Where treatment effects were significant, separation of significant Means was done by the Duncan's Multiple range test.

SECTION 2

RESULTS AND DISCUSSION

2.1 Laboratory Studies with Aqueous Extracts

Activity of Extracts of Fresh and Dried Leaf Materials:

(a) Gliricidia: (Tables 1, 2, 3 & 4)

Both the blended and leached extracts of fresh leaf materials caused significant inhibition of germination of tomato, brinjal, chilli, Tridax, Hyptis and Achyranthes, at the highest extract concentration of 250 mg/ml. The blended extract was more active and inhibitory than the leached extract possibly due greater extraction of phytotoxic compounds during blending (Table 1).

The aqueous fresh leaf extract of Gliricidia at 250 mg/ml was also inhibitory to the seedling growth of the four test species as indicated by the reduction in seedling height (Table 2).

Similarly, blended and leached extracts of Gliricidia dried leaf material were inhibitory to the seed germination of tomato, chilli, Tridax and Achyranthes, at the extract concentration of 250 mg/ml. Chilli seeds were noticeably less sensitive to the leached extract, compared with the blended extract (Table 3).

Extracts of Gliricidia dried leaves were both stimulatory and inhibitory to seedling growth, depending on species and concentration (Table 4).

(b) Leucaena: (Tables 5, 6, 7 & 8)

Both the blended and leached extracts of fresh leaves of Leucaena caused significant inhibition of germination of several test species at the highest extract concentration of 250 mg/ml. The amount of inhibition achieved was generally less than that with Gliricia extracts, suggesting that the latter extract contained more phytotoxins. The blended extract was more active and inhibitory than the leached extract. Again the degree of inhibition of seed germination was comparatively less with Leucaena extract (Table 5).

The aqueous fresh leaf extracts of Leucaena were generally less inhibitory to the seedling growth of the four test species, compared with the Gliricidia extract (Table 6). The extract did not significantly inhibit the seedling growth of brinjal, chilli or Eupatorium, but affected Tridax only (Table 6), as evidenced by mean

Table 1. The Effect of Aqueous Extract of Fresh Leaves of *Gliricidia* on the % Germination of selected Crop and Weed species (at 10 days).

Extract Type/Species	Extract Concentration (mg/ml) 0	2.5	25	250
(a) Blended Extract				
Tomato	69a	73a	65a	11b
Brinjal	69a	61a	53a	8b
Chilli	41a	36a	26b	8c
Tridax	45a	33a	42a	0b
Hyptis	74a	77a	65a	0b
Achyranthes	53a	52a	45a	0b
(b) Leached Extract				
Tomato	69a	68a	76a	64a
Chilli	41a	39a	44a	19b
Tridax	49a	55a	49a	5b
Achyranthes	68a	68a	59a	32b

In this and all Tables to follow Mean values in each row followed by the same letter are not significantly different at 5% level of probability according to the Duncan's Multiple range test.

Table 2. The effect of Aqueous Fresh Leaf Extract of *Gliricidia* on the Mean Seedling Length (cm) of selected Crop and Weed Species (at 28 days).

Species	Extract Concentration (mg/ml) 0	2.5	25	250
Brinjal	7.9b	8.9a	8.1b	7.2c
Chilli	8.0a	7.9a	8.4a	6.0b
Tridax	5.1a	5.4a	5.2a	2.6b
Eupatorium	3.9a	3.5ab	2.9b	1.3c

Table 3. The Effect of Aqueous Extract of Dried Leaves of *Gliricidia* on the % Germination (at 14 days) of selected Crop and Weed species.

Extract Type/Species	Extract Concentration (mg/ml) 0	2.5	25	250
(a) Blended Extract				
Tomato	73a	78a	68a	0b
Chilli	85a	80a	80a	0b
Tridax	70a	84a	74a	0b
Achyranthes	90a	78b	32c	0d
(b) Leached Extract				
Tomato	70a	66a	68a	0b
Chilli	85a	84a	89a	48b
Tridax	76a	73a	73a	0b

Table 4. The Effect of Aqueous Dried Leaf Extract of *Gliricidia* on the Mean Seedling Fresh Weight (mg) of selected Crop and Weed Species (at 14 days).

Species	Extract Concentration (mg/ml) 0	2.5	25	250
(a) Blended Extract				
Tomato	560.0a	351.0b	202.3c	0d
Chilli	117.4c	124.7b	2046.3a	0d
Tridax	182.5b	161.0b	357.3a	0c
Achyranthes	412.6b	618.5a	236.4c	0d
(b) Leached Extract				
Chilli	1225.0b	1227.4b	1816.9a	544.2c
Tridax	217.2b	244.5b	338.1a	0c

Table 5. The Effect of Aqueous Extract of Fresh Leaves of *Leucaena* on the % Germination of selected Crop and Weed species (at 10 days).

Extract Type/Species	Extract Concentration (mg/ml) 0	2.5	25	250
(a) Blended Extract				
Tomato	77a	75a	75a	3b
Brinjal	79a	71a	71a	15b
Chilli	41a	45a	25b	4c
Tridax	83a	79a	64a	0b
Hyptis	91a	69b	72b	8c
Achyranthes	80a	80a	80a	8b
(b) Leached Extract				
Tomato	57a	63a	47ab	36b
Brinjal	80a	83a	89a	71a
Tridax	67a	71a	75a	25b
Hyptis	53a	47a	48a	47a

Table 6. The Effect of Aqueous Fresh Leaf Extract of *Leucaena* on the Mean Seedling Length (cm) of selected Crop and Weed Species (at 28 days).

Species	Extract Concentration (mg/ml) 0	2.5	25	250
Brinjal	7.9b	8.7ab	10.0a	7.2b
Chilli	6.8a	5.4b	7.9a	7.2a
Tridax	5.4b	6.3a	6.6a	3.5c
Eupatorium	3.7a	3.1a	3.8a	2.1a

Table 7. The Effect of Aqueous Extract of Dried Leaves of *Leucaena* on the % Germination (at 14 days) of selected Crop and Weed species.

Extract Type/Species	Extract Concentration (mg/ml) 0	2.5	25	250
(a) Blended Extract				
Tomato	75a	59a	57a	0b
Chilli	60a	72a	79a	72a
Tridax	84a	83a	24b	0b
Achyranthes	65a	73a	59a	0b
(b) Leached Extract				
Chilli	85a	80a	84a	84a
Tridax	76a	69a	61a	0b
Achyranthes	68a	79a	65a	0b

Table 8. The Effect of Aqueous Dried Leaf Extract of *Leucaena* on the Mean Seedling Fresh Weight (mg) of selected Crop and Weed Species (at 14 days).

Species	Extract Concentration (mg/ml) 0	2.5	25	250
(a) Blended Extract				
Chilli	713.8c	1571.1b	2177.0a	1201.2b
Tridax	413.4b	532.3a	230.8c	0d
Achyranthes	625.3b	793.3a	0c	0c
(b) Leached Extract				
Chilli	1228.0a	1153.0a	2400.0a	1968.0a
Tridax	285.3b	304.0b	430.6a	0c
Achyranthes	528.0b	728.0a	753.3a	0b

fresh weight measurements.

As in the case of Gliricidia, blended and leached extracts of Leucaena dried leaf material were severely inhibitory to the seed germination of tomato, Tridax and Achyranthes, at the extract concentration of 250 mg/ml. Tomato seeds were affected by the lower concentrations of 2.5 and 25 mg/ml of the blended extract as well, and Tridax too by the 25 mg/ml blended extract. The leached extract at the highest concentration (250 mg/ml) was inhibitory to the seed germination of both Tridax and Achyranthes. Chilli seeds were unaffected by either of the extracts at the concentrations tested (Table 7).

Extracts of Leucaena dried leaves were both stimulatory and inhibitory to seedling growth of the test species, depending on species and concentration (Table 8). Both extracts were generally stimulatory to the growth of chilli seedlings at the three concentrations tested. In the case of Tridax and Achyranthes, seedling growth was stimulated significantly by extract concentrations of 2.5 mg/ml, but completely prevented by 250 mg/ml concentration.

(c) Pueraria: (Tables 9, 10, 11 and 12)

Both the blended and leached extracts caused significant inhibition of germination of test species at the highest extract concentration of 250 mg/ml (Table 9). The blended extract was more active and inhibitory than the leached extract.

The aqueous fresh leaf extract of Pueraria at 250 mg/ml was inhibitory to the seedling growth of chilli and Tridax, but not to tomato and Hyptis as determined by mean seedling length (Table 10).

Blended and leached extracts of Pueraria dried leaf material were inhibitory to the seed germination of tomato, chilli, Tridax and Achyranthes, at the extract concentration of 250 mg/ml. Seed germination of Tridax was affected by 25 mg/ml of blended extract as well, while Achyranthes seeds were sensitive to both 2.5 and 25 mg/ml concentrations of the blended extract. The leached extract was less phytotoxic, compared with the blended extract and did not affect the germination of tomato and chilli (Table 11).

As in the cases of Gliricidia and Leucaena, extracts of Pueraria dried leaves were both stimulatory and inhibitory to the seedling growth of the test species, with the response dependent on species and extract concentration (Table 12). In general the blended extract was more phytotoxic than the leached extract.

These studies demonstrated that the fresh or dried leaves of all three legume species contained water-extractable phytotoxic compounds. Of particular significance was the presence of phytotoxicity in the extracts of dried leaf residues or 'litter'. In general, the fresh leaf extracts were more inhibitory than the extracts from dried leaves.

Table 9. The Effect of Aqueous Extract of Fresh Leaves of *Pueraria* on the % Germination (at 10 days) of selected Crop and Weed species.

Extract Type/Species	Extract Concentration (mg/ml) 0	2.5	25	250
(a) Blended Extract				
Tomato	69a	73a	65a	11b
Brinjal	69a	61a	53a	8b
Chilli	41a	36a	26b	8c
Tridax	45a	33a	42a	0b
Hyptis	74a	77a	65a	0b
Achyranthes	53a	52a	45a	0b
(b) Leached Extract				
Tomato	69a	68a	76a	64a
Chilli	41a	39a	44a	19b
Tridax	49a	55a	49a	5b
Achyranthes	68a	68a	59a	32b

Table 10. The Effect of Aqueous Fresh Leaf Extract of *Pueraria* on the Mean Seedling Length (cm) of selected Crop and Weed Species (at 28 days).

Species	Extract Concentration (mg/ml) 0	2.5	25	250
Tomato	9.9b	11.3a	10.4ab	9.2b
Chilli	9.3a	8.4a	5.2b	3.2c
Tridax	6.8a	5.4b	2.4c	2.5c
Hyptis	6.3b	8.2a	7.2ab	5.7b

Table 11. The Effect of Aqueous Extract of Dried Leaves of *Pueraria* on the % Germination (at 14 days) of selected Crop and Weed species.

Extract Type/Species	Extract Concentration (mg/ml) 0	2.5	25	250
(a) Blended Extract				
Tomato	96a	89a	84a	0b
Chilli	77a	80a	83a	8b
Tridax	64a	69a	44a	0b
Achyranthes	42a	21b	1c	0c
(b) Leached Extract				
Tomato	96a	92a	84a	86a
Chilli	77a	84a	73a	71a
Tridax	64ab	47bc	77a	31c
Achyranthes	42a	41a	23b	1c

Table 12. The Effect of Aqueous Dried Leaf Extract of *Pueraria* on Mean Seedling Fresh Weight (mg) of selected Crop and Weed Species.

Species	Extract Concentration (mg/ml) 0	2.5	25	250
(a) Blended Extract				
Tomato	2213.8a	1787.8b	2330.0a	0c
Chilli	1428.0b	1516.9a	1224.3c	0d
Tridax	300.5a	324.7a	203.1a	0b
Achyranthes	327.4a	162.2a	190.5a	0b
(b) Leached Extract				
Tomato	2213.7a	1861.7a	2121.8a	2163.8a
Chilli	1428.0a	1401.8a	1817.4a	1021.1a
Tridax	300.5a	190.6a	420.8a	150.0c
Achyranthes	327.4b	570.1a	172.9c	90.8d

Although these laboratory studies demonstrate that the legume residues commonly used as 'green manure' or 'mulch' purposes contain water-soluble substances which depress germination and seedling growth of other plant species, the extent to which crops or weeds are affected by the residues under field conditions would vary greatly depending on environmental factors and residue management.

2.2 Greenhouse Studies with Leaf Residues

Soil-Incorporated Residues (Tables 13, 14)

(a) Gliricidia:

Soil-incorporated residues of Gliricidia did not affect the germination of tomato, brinjal, Tridax and Achyranthes (Table 13). However, the residues significantly reduced the germination of Hyptis at all three rates of incorporation.

The residues significantly promoted the growth of crop species tomato and brinjal at the rate of 4% (w/w), but had no effect on the growth of weed species Tridax, Hyptis and Achyranthes (Table 13).

(b) Pueraria:

Soil-incorporated residues of Pueraria did not affect the germination of any of the test species tomato, brinjal, Tridax, Hyptis and Achyranthes (Table 14).

However, the residues significantly promoted the growth of tomato at the rate of 4% (w/w) and Tridax at all three rates of residue incorporation. Pueraria residues had no effect on the growth of the other species chilli, Hyptis and Achyranthes (Table 14).

The overall result of this study indicated that the legume leaf residues incorporated into soil were not highly inhibitory to the germination and growth of test species.

Surface Mulch (Tables 15, 16 & 17)

(a) Gliricidia:

Gliricidia leaf residues placed on the soil surface as 'mulch' at 4% (w/w) significantly reduced the % germination of Achyranthes and promoted the germination of Tridax and Hyptis (Table 15). Germination of Tridax was promoted even by the 2% (w/w) mulch rate. The mulch did not inhibit the germination of crop species tomato and brinjal at any of the rates, and infact promoted seed germination at the 2% mulch

Table 13. The Effect of Gliricidia Leaf Residues incorporated into soil on the Germination and Growth of indicator Species.

Species	Residue Concentration (% w/w)							
	0	1	2	4	0	1	2	4
	Germination (%)				Fresh Weight (g)			
Tomato	63a	30a	40a	67a	1.0b	1.1b	0.9b	1.9a
Brinjal	73a	40a	37a	30a	0.6b	0.6b	1.1a	1.4a
Tridax	47a	20a	27a	40a	0.8a	1.1a	0.8a	1.3a
Hyptis	67a	31b	30b	23b	0.7a	0.2a	0.5a	0.7a
Achyranthes	37a	27a	20a	27a	0.6a	1.0a	0.5a	0.5a

% Germination after 14 days; Fresh Weight after 28 days.

Table 14. The Effect of Pueraria Leaf Residues incorporated into soil on the Germination and Growth of indicator Species.

Species	Residue Concentration (% w/w)							
	0	1	2	4	0	1	2	4
	Germination (%)				Fresh Weight (g)			
Tomato	90a	53a	60a	73a	2.5b	4.4b	4.1b	7.1a
Chilli	43a	33a	43a	20a	0.7a	0.3a	0.8a	0.3a
Tridax	73a	80a	70a	90a	1.2b	2.9a	3.5a	3.8a
Hyptis	77a	70a	70a	40a	1.1a	1.7a	1.2a	1.5a
Achyranthes	67a	80a	67a	77a	0.8a	1.5a	2.3a	2.0a

% Germination after 14 days; Fresh Weight after 28 days.

Table 15. The Effect of Gliricidia Leaf Residues applied as a Surface Mulch on the Germination and Growth of indicator Species.

Species	Residue Concentration (% w/w)							
	0	1	2	4	0	1	2	4
	Germination (%)				Fresh Weight (g)			
Tomato	53b	90a	67b	50b	0.4c	2.1b	2.7a	3.0a
Brinjal	40bc	87a	80ab	20c	0.3c	1.4a	1.4a	1.1b
Tridax	33a	23a	0b	0b	0.3ab	0.6a	0.1b	0b
Hyptis	63a	17b	10bc	0b	0.6a	0.5a	0.3a	0a
Achyranthes	47a	37a	42a	13b	0.4c	1.0ab	1.4a	0.8bc

% Germination after 14 days; Fresh Weight after 28 days.

Table 16. The Effect of Leucaena Leaf Residues applied as a Surface Mulch on the Germination and Growth of indicator Species.

Species	Residue Concentration (% w/w)							
	0	1	2	4	0	1	2	4
	Germination (%)				Fresh Weight (g)			
Tomato	57a	67a	57a	33a	0.9b	1.4b	2.3a	3.0a
Chilli	13a	27a	10a	7a	0.2b	0.8ab	1.0ab	1.5a
Tridax	37a	7b	3b	0b	0.6b	1.5a	0.4b	0b
Hyptis	20a	3b	3b	0b	1.4a	1.2a	1.0a	0.3b
Achyranthes	43a	50a	27a	0b	0.8b	1.3a	1.6a	1.5a

% Germination after 14 days; Fresh Weight after 28 days.

Table 17. The Effect of *Pueraria* Leaf Residues applied as a Surface Mulch on the Germination and Growth of indicator Species.

Species	Residue Concentration (% w/w)							
	0	1	2	4	0	1	2	4
	Germination (%)				Fresh Weight (g)			
Tomato	93a	83a	80a	47b	1.4b	2.2ab	2.8a	3.2a
Chilli	67ab	53bc	70a	47c	0.2c	0.4bc	0.8ab	1.1a
Tridax	63a	10b	0c	0c	0.7a	0.5a	0b	0b
Hyptis	83a	3b	3b	0c	0.6a	0.2a	0.2a	0.1b
Achyranthes	50a	40a	27a	47a	0.6c	1.2b	1.8a	2.1a

% Germination after 14 days; Fresh Weight after 28 days.

rate. Subsequent growth of tomato and brinjal was very significantly promoted by mulch. The growth of Achyranthes was also increased by mulch at all rates.

(b) Leucaena:

Leucaenaa leaf residues placed on the soil surface as 'mulch' at 4% (w/w) significantly reduced the % germination of Tridax and Hyptis at rates of 1 and 2% and prevented germination completely at 4% (w/w) (Table 16). The seed germination of Achyranthes was unaffected by mulch rates of 1 and 2% but in the presence of 4% (w/w) mulch Achyranthes seeds did not grow. The mulch did not inhibit the germination of crop species tomato and chilli at any of the rates. Subsequent growth of tomato and chilli was very significantly promoted by mulch. The growth of Achyranthes was increased by mulch at all rates. The mulch rate of 1% significantly promoted the growth of Tridax, but higher rates caused significant suppression of this weed.

(c) Pueraria:

Pueraria leaf residues placed on the soil surface as 'mulch' at 1, 2 or 4% (w/w) significantly reduced the % germination of Tridax and Hyptis (Table 17). Germination of Achyranthes was unaffected even by the 4% (w/w) mulch rate. The mulch at 4% significantly inhibited the germination of crop species tomato and chilli. However, at 2 and 4% rates of mulch, subsequent growth of tomato and chilli was significantly increased. The growth of Tridax was completely prevented by the mulch rates 2 and 4%, and the growth of Hyptis significantly affected by the 4% rate. The growth of Achyranthes however, was increased by mulch at all rates.

The results of these greenhouse studies clearly demonstrated that the legume residues when applied to the soil surface as a 'mulch' adversely affected the germination and establishment of several weed species. In general the crop species tested were not inhibited by the mulch and in fact, were promoted in growth in many instances.

Soil-incorporated and Decomposing Residues:

(a) Gliricidia:

Decomposing Gliricidia residues in soil affected the seedling growth of all four test species, particularly at 4% (w/w) (Fig. 1). The growth of tomato, brinjal, and Hyptis was significantly reduced by the 4% residues which had decomposed in soil for up to 2 weeks. After decomposition had taken place for 6 weeks the growth of tomato and brinjal was significantly promoted by the residues. The growth of Achyranthes was stimulated by Gliricidia residues at all three rates and irrespective of decomposition time.

(b) Leucaena:

In general decomposing Leucaena residues were not inhibitory to the growth of the test species. Significant stimulation of the growth of tomato, brinjal, Hyptis and Achyranthes occurred in the presence of 1, 2 or 4% (w/w) residues which had decomposed for 1 to 6 weeks (Fig. 2).

(c) Pueraria:

Decomposing Pueraria residues were also generally less inhibitory to the growth of the test species. Significant stimulation of the growth of tomato, chilli, Hyptis and Achyranthes occurred in the presence of 1, 2 or 4% (w/w) residues which had decomposed for 1 to 6 weeks (Fig. 3).

The overall results of this study confirmed the view that the three legume residues were generally not highly inhibitory to the growth of crop or weed species after soil incorporation. Some species dependent effects were observed, but in general the residues were not phytotoxic even at a relatively high incorporation rate of 4% (w/w).

In general, only the Gliricidia residues at 4% (w/w) which had decomposed for 1 or 2 weeks, brought about significant inhibitory effects to some of the test species. However, even Gliricidia residues were not inhibitory after 4 weeks of decomposition. This would mean that any toxic compounds that may be released during the decay of Gliricidia residues, do not persist in soil for more than 1 or 2 weeks. Decomposing Leucaena and Pueraria residues do not seem to have pronounced inhibitory effects on the growth of other crop or weed species. On the other hand these residues stimulate the growth of other species possibly through the release of readily available nutrients, including nitrogenous compounds.

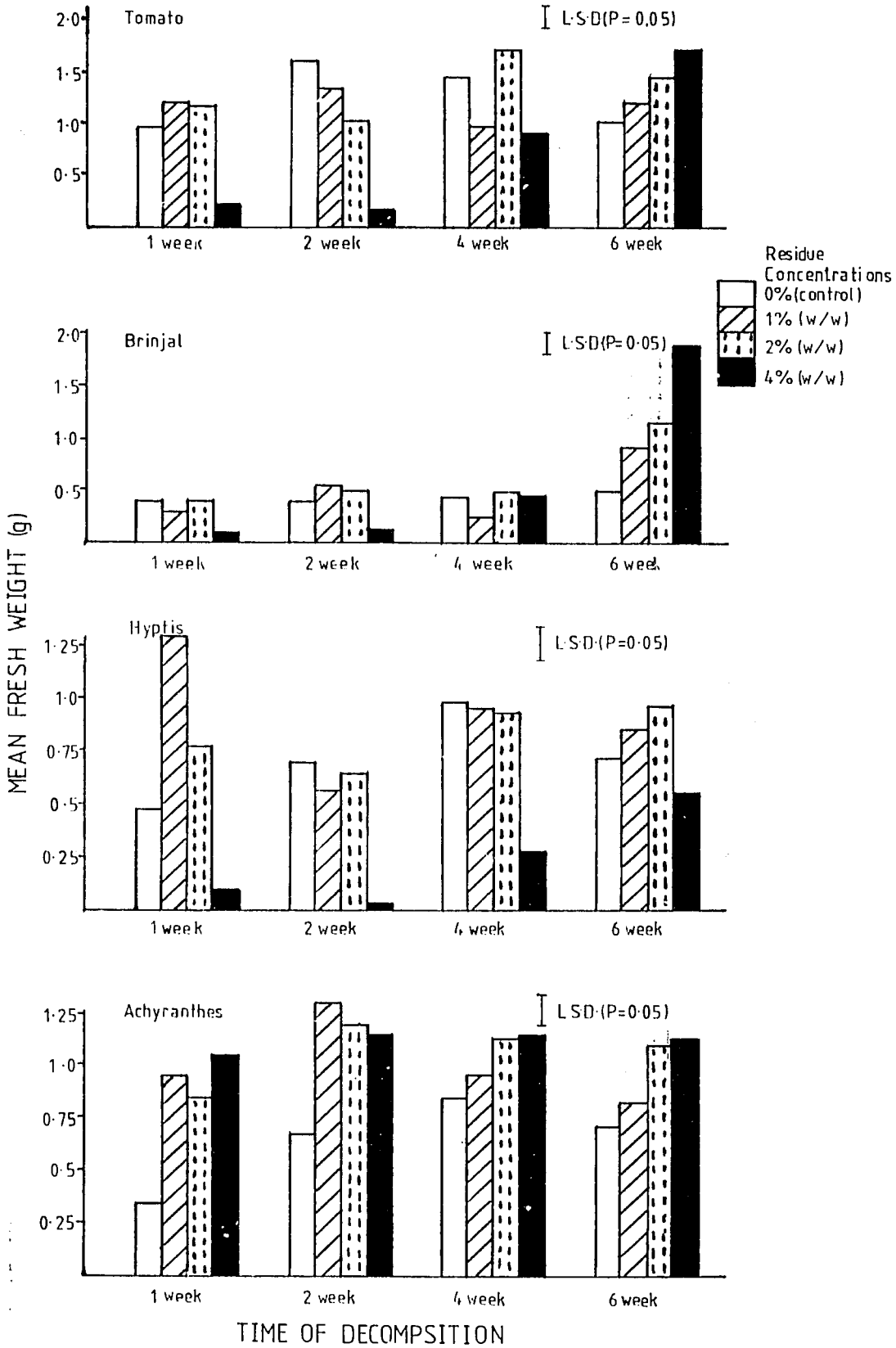
Tomato
L.S.D(P=0.05)
2·0
1·5
1·0
0·5
1 week
2 week
4 week
6 week
Residue Concentrations
0%(control)
1% (w/w)
2% (w/w)
4% (w/w)
Brinjal
L.S.D(P=0·05)
Hyptis
L.S.D.(P=0·05)
1·25
0·75
0·25
Achyranthes
MEAN FRESH WEIGHT (g)
TIME OF DECOMPSITION

FIGURE 1

21

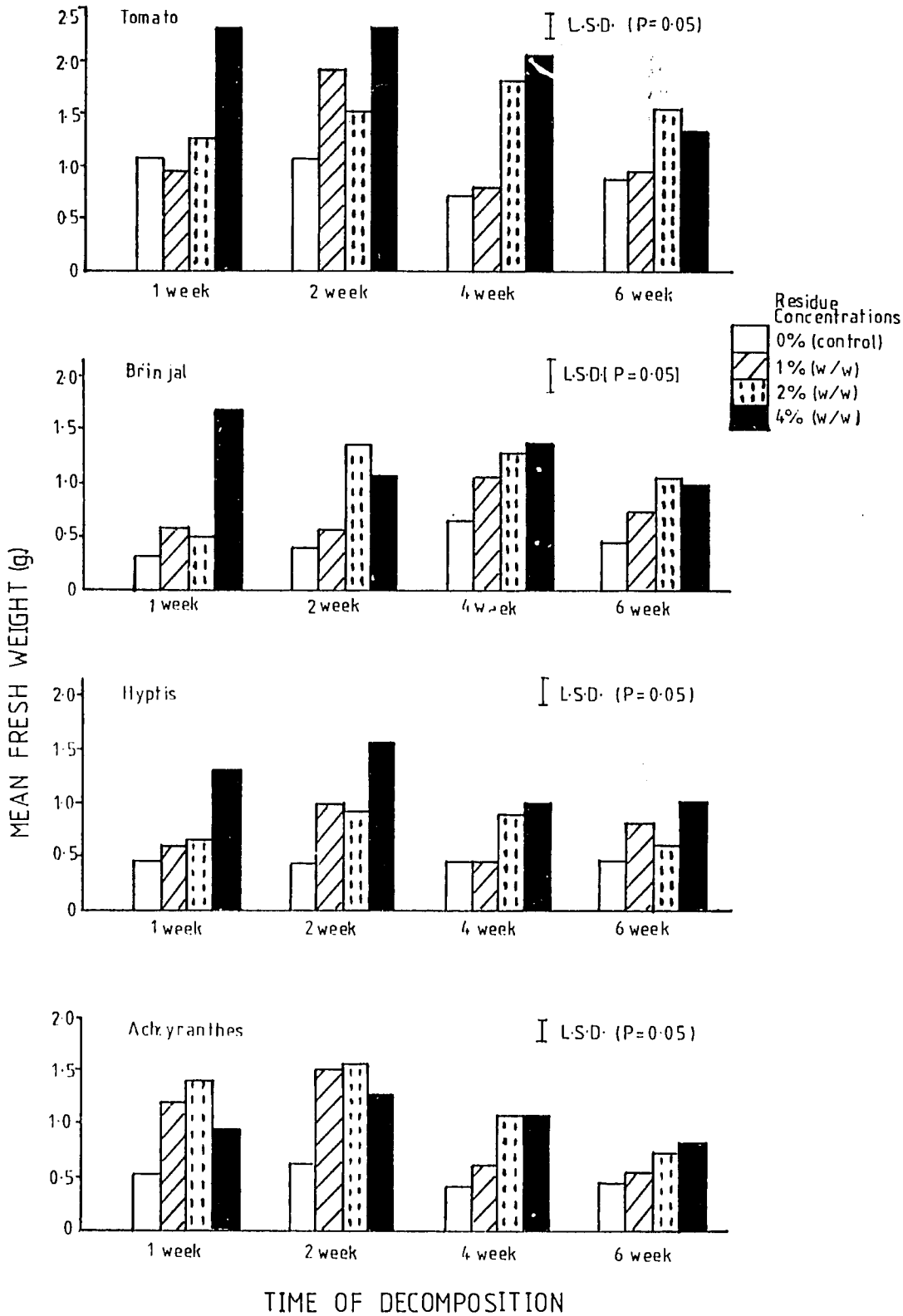
Tomato
L.S.D. (P=0.05)
Brinjal
L.S.D.(P=0.05)
Hyptis
L.S.D. (P=0.05)
Achyranthes
L.S.D. (P=0.05)
1 week
2 week
4 week
6 week
Residue Concentrations
0% (control)
1% (w/w)
2% (w/w)
4% (w/w)
MEAN FRESH WEIGHT (g)
TIME OF DECOMPOSITION

FIGURE 2

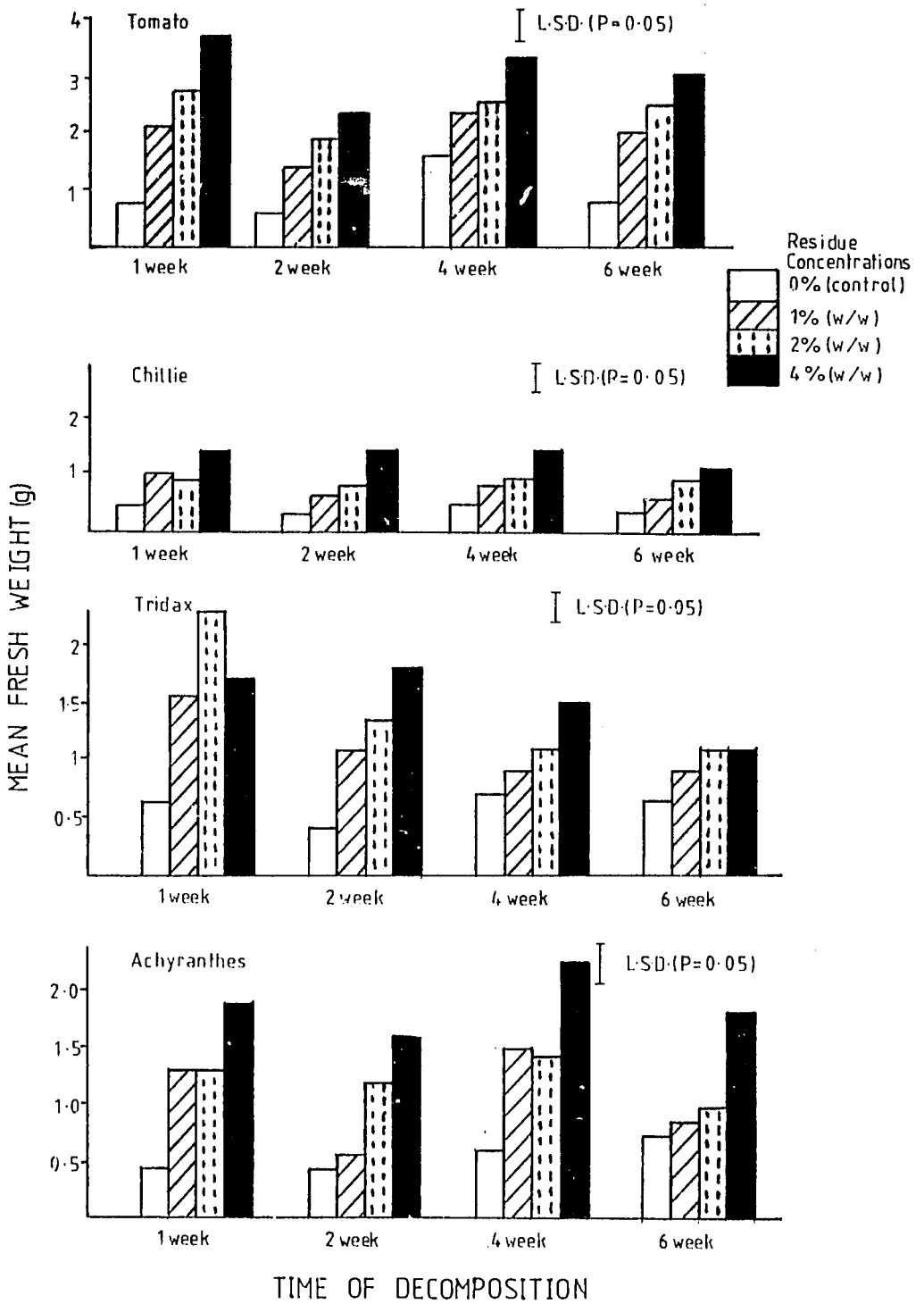
Tomato
L·S·D·(P=0·05)
1 week
2 week
4 week
6 week
Residue Concentrations
0% (control)
1% (w/w)
2% (w/w)
4% (w/w)
Chillie
L·S·D·(P=0·05)
Tridax
L·S·D·(P=0·05)
Achyranthes
L·S·D·(P=0·05)
MEAN FRESH WEIGHT (g)
TIME OF DECOMPOSITION

FIGURE 3

SECTION 3

WORK TO BE DONE IN THE FUTURE

3.1 Field Trials using Legume Residues for Weed Control

Field trials will be conducted using *Gliricidia*, *Leucaena* and *Pueraria* residues either as incorporated (tilled) residues or surface 'mulches' at several rates. Several upland crops i.e. tomato, brinjal, chilli, okra, soybean and corn, will be used in these studies. The overall objective would be to determine the weed suppressing ability of the residues. The effect of the residues on the growth of the crop species will be monitored, as well as the effects on nutrient uptake by the crop plants.

3.2 Chemical Characterization of Allelochemicals in Legume Cover-Crops

Of the three legume species studied thus far, *Gliricidia* residues which show stronger allelopathic potentials than the others, will be initially investigated for its allelochemicals. Plant material will be extracted using suitable solvents, and bioassays carried out to determine the bioactivity of extracts. The bioactive fractions will then fractionated by solvent extraction and different chromatographic techniques used to isolate the active principles. The allelochemicals isolated will be characterized by chemical and spectroscopic methods.

3.3 Laboratory and Greenhouse Screening of the Allelopathic Potential of Selected Weed Species

Procedures described under Section 1 (Laboratory and Greenhouse Studies) will form the basis of the screening of a number of major tropical weeds for their potential allelopathic properties. Species earmarked for screening include:

Tagetes erecta	(Asteraceae)
Eupatorium odoratum	(Asteraceae)
Mikania cordata	(Asteraceae)
Tithonia diversifolia	(Asteraceae)
Antiganon leptopus	(Verbenacea)
Polygonum barbatum	(Polygonaceae)
Ludwigia peruviana	(Onagraceae)
Lantana camara	(Verbenaceae)
Imperata cylindrica	(Poaceae)
Hyptis suaveolens	(Lamiaceae)

The species displaying strong allelopathic potential will be subject to intensive testing of bioactivity both in the laboratory and field, and the allelochemicals identified by chemical extractions followed by characterization.

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