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Effects of nitrogen fertilizer levels on the allelopathic potential of pangola grasses and weeds*

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Abstract. The allelopathic potential of pangola grasses, namely *Digitaria decumbens* A24, and A254, and weeds, such as *Panicum repens* and *Imperata cylindrica* were evaluated by both field and laboratory experiments. The field experiments indicated that the biomass production on dry weight basis of both cultivars of *D. decumbens* was generally higher than that of weeds grown in furrowed plots. The production of each grass grown in different levels of nitrogen fertilizer was insignificantly different. The degree of grass dominance was also expressed by the percent coverage of grasses per plot and the results showed that *D. decumbens* A254 generally revealed higher dominance than the other species. However, at the earlier harvesting (6 months after planting) *P. repens* was the predominat species, but at the later harvesting (10 months) *D. decumbens* A254 became the dominant one and *I. cylindrica* always the inferior one. In the laboratory studies, the allelopathic potential was expressed by phytotoxicity of the aqueous extract of each grass on the radicle growth of lettuce and rice seeds. Among the four grasses, *P. repens* exhibited the highest phytotoxicity, *D. decumbens* A24 the second, and *I. cylindrica* the least. Although the increasing amount of nitrogen fertilizer could not significantly increase the biomass of each grasses, it did enhance the phytotoxicity of the dominant grasses. The quantitative comparison of phytotoxic phenolics was also determined by a high peformance liquid chromatograph, thus nine phytotoxins were identified. These compounds were variously distributed in the grasses and varied with treatments. Among these compounds, caffeic, *p*-coumaric, *o*-hydroxyphenylacetic and ferulic acids were abundant in grasses regardless of species and culture treatments. Particularly, ferulic acid was present in significant amount in *P. repens*; while caffeic acid was noticeably high in *I. cylindrica*. More the nitrogen fertilizer applied on the grass soil, higher the quantity of phytotoxins produced, indicating that the high growth rate of *D. decumbens* cultivars may take their advantage to produce more amount of phytotoxins, which may be able to suppress the growth of its inferior competitor, such as *P. repens* and *I. cylindrica*. Thus, allelopathy interaction may play a significant role in the pasture management.

Key words: Allelopathy; *Digitaria decumbens*; Pangola grass; Phytotoxic phenolics; Urea level; Weed control.

Intorduction

The aggressive nature of a grass is often ascribable to competition for physical factors, such as light, soil moisture, and nutrients, and has increasingly been recognized due to an allelopathic interaction, which received a great attention by scientists of the world (Chou and Chung, 1974; Chou and Young, 1975; Friedman, 1983; Liang *et al.*, 1983; Neuman *et al.*, 1977; Rice, 1984; Ueki,

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1979). Some plants grown in unfavorable environmental conditions, such as drought, nutrient deficiency or other environmental stress, may reveal stronger allelopathic potential than those under normal conditions. Koeppe *et al.* (1976) demonstrated that a higher concentration of chlorogenic acids and its isomers was found in the extract of sunflower plants under phosphate deficient condition as compared with phosphate sufficient plants. Chou (1983) also proposed that shikimic acid could lead to form a growth inhibitor instead of stimulators when the paddy soil is under poor water drainage and unfavorable temperature conditions. In addition, Zn deficient paddy soil may be associated with phytotoxins produced during the decomposition of rice residues in soil. The allelopathic interaction between plants is evidently impossible to be singled out from the environmental complex and is indeed often interacted by environmental stress. In the course of pasture management, we often apply enough nitrogen fertilizer in fields and find a pure pangola stands. The dominance mechanism of pangola grass is yet little known, and the allelopathic interaction with environmental stresses, such as levels of nitrogen fertilizer and field treatments could be involved. Thus, in the present study, two dominant *D. decumbens* cultivars, namely A24, A254, *Imperata cylindrica*, and *Panicum repens* were used for the evaluation of their allelopathic potential interacted with different levels of nitrogen fertilizer.

Materials and Methods

Experimental Design

Stolons or cuttings of four subtropical grasses, namely *D. decumbens* A24, and A254, *P. repens* and *I. cylindrica*, were planted in each plot, 2×22 m, with planting density of 50×25 cm in the farms of Taiwan Livestock Research Institute at Hsinhua. In the field, two split block designs with 4 replications were laid out, one with clean furrows between plots the other without furrow between plots. The compound fertilizer, a mixture of urea-$CaHPO_3$-KCl (x:72:60, kg/ha), in which x is varied as 200, 400, and 800, was then applied on the grass soil. One half of the mixture was used as basal dressing before grasses were planted, the other half was divided into three aliquots and used as top dressing after each cutting. The grasses were planted in December 1982, and harvested on May 18, August 16, and October 28, 1983. Prior to each harvesting, ground coverage of grasses was measured and fresh weight as well as dry weight of each grass cut were measured properly. The dry grass was then milled into powder for laboratory assays.

Bioassay Techniques

The potential of phytotoxicity revealed by each grass was evaluated by two bioassay techniques described by Chou and Young (1975) and Chou and Lin (1976). The aqueous extracts of each grass leaves were bioassayed by using lettuce and rice seeds as test material. The phytotoxicity was expressed by the percent of inhibition of radicle growth of extract as compared with that of distilled water control.

Determination of Phytotoxic Phenolics in Grasses

The aqueous extracts of grasses were subjected to further fractionation by ethyl ether, as described by Chou and Young (1975). The ether fraction of aqueous extract of each grass was chromatographed by paper chromatography and a high performance liquid chromatograph (HPLC) (CDC UV monitor III model 1203), in addition, each standard curve of authentic phenolic compounds were also chromatographed prior to the sample. The contents of each phenolics in the grass were thus obtained from the means of four determinations of each treatment.

Determination of Protein Contents in Grasses

The dry leaf of each grass was also determined for its total protein content by using the Kjeldahl method as described by Bremner (1965).

Results and Discussion

Comparison of Grass Production under Various Culture Treatments

Four grasses as mentioned before were grown in field under various culture treatments and the grasses were harvested to measure their fresh weight and dry weight. The results of grass production on dry weight basis are given in Table 1. The production of both cultivars of *D. decumbens* was generally higher than that of the other two grasses in the last harvest, although the production of dry matter of *P. repens* was slightly higher than that of *D. decumbens* at the first harvest. In most cases, the biomass in term of dry weight of grass was significantly higher in those grown in the unfurrowed plots than in the furrowed plots at the first harvesting, but that was reversed at the third harvesting, indicating that in the third harvesting time the grasses grown in unfurrowed plots already interfered each other resulting in biomass decrease. Furthermore, the biomass of the grasses grown under three levels of nitrogen fertilizer treatments seems to be insignificantly different, suggesting that the present design for nitrogen levels made no significant effects on grass growth.

The degree of grass dominance is also expressed by the percent ground coverage of grasses per designated plot, and the comparison of the grass coverage is shown in Table 2. The results indicated that *D. decumbens* A254 generally revealed higher dominance than the rest of species

Table 1. *The comparison of grass production in furrowed (F) and unfurrowed (UF) plots dressed with three levels of urea and harvested on three dates*

Level of urea (kg/ha)	Grass	Dry weight (kg/m^2)								
		May 18, 1983			August 16, 1983			October 28, 1983		
		F	UF	Index	F	UF	Index	F	UF	Index
200	*Digitaria decumbens* A24	0.85^{a}	1.05^{a}	24	2.56	2.81^{a}	10	3.00^{a}	2.55^{a}	−15
	D. decumbens A254	0.71^{a}	1.13^{a}	59	1.98^{a}	1.13^{a}	−43	3.37^{b}	3.02^{a}	11
	Imperata cylindrica	0.12^{c}	0.06^{b}	−50	0.46^{c}	0.21^{c}	−54	0.93^{c}	0.51^{c}	−45
	Panicum repens	1.18^{b}	1.28^{a}	8	1.55^{b}	1.77^{b}	14	2.40^{a}	1.53^{b}	−36
	Mean	0.91^{A}	0.88^{A}	− 4	1.64^{A}	1.98^{A}	21	2.43^{A}	1.90^{A}	−22
400	*D. decumbens* A24	1.00^{a}	1.31^{a}	31	3.02^{a}	3.00^{a}	− 1	2.21^{a}	2.06^{a}	−17
	D. decumbens A254	1.31^{a}	1.54^{a}	18	3.26^{a}	3.54^{a}	9	3.06^{b}	3.15^{a}	3
	I. cylindrica	1.30^{c}	0.56^{b}	−57	0.48^{c}	0.29^{c}	−40	1.20^{c}	0.31^{c}	−75
	P. repens	1.54^{b}	1.58^{a}	3	2.03^{b}	2.24^{b}	10	2.03^{a}	1.33^{b}	−34
	Mean	1.28^{A}	1.12^{B}	−12	2.20^{A}	2.27^{A}	3	1.62^{A}	1.71^{A}	5
800	*D. decumbens* A24	1.10^{a}	1.55^{a}	41	4.04^{a}	3.54^{a}	−12	2.73^{a}	1.89^{a}	−31
	D. decumbens A254	1.39^{a}	1.69^{a}	22	3.68^{a}	3.33^{a}	10	4.04^{a}	3.14^{a}	−23
	I. cylindrica	0.15^{c}	0.08^{b}	−47	0.79^{c}	0.23^{c}	−71	1.47^{c}	1.00^{c}	−32
	P. repens	1.64^{b}	1.68^{a}	2	3.08^{b}	2.64^{b}	−14	2.43^{a}	1.68^{b}	−31
	Mean	1.38^{A}	1.25^{B}	−10	2.90^{A}	2.44^{A}	−16	2.67^{A}	1.70^{A}	−36

^{a,b,c} Different characters indicate the statistical significance between grasses by Duncan's multiple range test.

^{A,B} Different characters indicate the statistical significance between treatments of furrowed (F) and unfurrowed (UF) by Duncan's multiple range test.

Index = [(UF/F) − 1] × 100%

Table 2. *The comparison of grass coverage in furrowed (F) and unfurrowed (UF) plots dressed with three levels of urea and harvested on three dates*

Level of urea (kg/ha)	Grass	% Coverage								
		May 18, 1983			August 16, 1983			October 28, 1983		
		F	UF	Index	F	UF	Index	F	UF	Index
200	*Digitaria decumbens* A24	60.3[a]	79.4[a]	32	74.9[a]	80.3[b]	7	84.1[a]	82.5[a]	− 2
	D. decumbens A254	76.0[b]	78.9[a]	4	75.7[a]	85.3[a]	13	85.0[b]	84.9[a]	− 5
	Imperata cylindrica	13.0[c]	24.0[b]	85	18.1[b]	20.6[d]	14	51.9[c]	40.9[c]	−21
	Panicum repens	66.0[b]	78.6[a]	19	72.7[a]	78.7[c]	8	81.4[ab]	76.0[b]	− 7
	Mean	53.8[A]	65.1[A]		60.3[A]	66.2[A]		75.6[A]	71.1[A]	
400	*D. decumbens* A24	70.2[a]	74.2[a]	6	72.2[a]	86.0[b]	19	76.4[a]	83.5[a]	3
	D. decumbens A254	67.5[b]	79.2[a]	21	76.2[a]	89.4[a]	17	86.6[b]	82.5[a]	− 5
	I. cylindrica	13.1[c]	20.3[b]	55	19.1[b]	21.3[d]	10	55.4[c]	42.4[c]	−24
	P. repens	70.9[b]	75.9[a]	7	74.4[a]	75.5[c]	4	84.9[ab]	78.7[b]	− 7
	Mean	55.4[A]	62.4[B]		60.5[A]	68.5[A]		75.8[A]	71.7[A]	
800	*D. decumbens* A24	69.9[a]	77.1[a]	10	78.2[a]	79.9[b]	2	82.0[a]	83.4[a]	2
	D. decumbens A254	69.1[b]	78.5[a]	14	78.2[a]	88.1[a]	13	84.9[b]	92.5[a]	9
	I. cylindrica	13.9[c]	22.2[b]	60	22.5[b]	20.9[d]	−7	64.8[c]	47.5[c]	−27
	P. repens	71.3[b]	78.8[a]	11	80.4[a]	78.4[c]	−3	85.5[ab]	81.4[b]	− 5
	Mean	56.2[A]	59.2[C]		64.8[A]	66.8[A]		79.3[A]	76.2[A]	

[a,b,c] Different characters indicate the statistical significance between grasses by Duncan's multiple range test.
[A,B] Different characters indicate the statistical significance between treatments of furrowed (F) and unfurrowed (UF) by Duncan's multiple range test.
Index=[(UF/F)−1]×100%

although *P. repens* did show a high dominance in some treatments. At the first cutting the grass dominance was generally higher in the unfurrowed plots than in the furrowed plots; however, the results were entirely reversed at the third cutting. These findings agree well with those of Table 1.

Competitive Exclusion of Grasses under Different Culture Treatments

The degree of competitive exclusion between grasses was determined by the percent coverage of one grass invading to the other grass. The comparison of the four grasses invading ability is shown in Table 3, where the first column gives the percent coverage of grass *in situ*, the second to the fifth columns indicate the grasses invading to its neighbor plots, and the last column shows the total percent coverage of each grass invading to other plots. Evidently, at the time of first cutting *P. repens* was the most aggressive one, while at the second cutting *D. decumbens* A254 became the most aggressive and *I. cylindrica* was the poor competitor. The competitive exclusion of grass was not significantly affected by nitrogen fertilizer levels of the present study. However, it was postulated that at the nitrogen (urea) level below 200 kg/ha the allelopathic effects among grasses would be more pronounced; however, this observation needs to be further vertified in field experiments.

Comparison of Protein Contents in Grasses under Various Culture Treatments

The grasses after cutting were dried and measured for their total protein contents. The results given in Table 4 showed that the protein

Table 3. *Quantitative comparison of grasses invading each designated plots under three culture treatments*

Level of urea (kg/ha)	Grass	% Coverage of grass per plot									
		May 18, 1983					August 28, 1983				
		In situ	Plots received invader				In situ	Plots received invader			
			A24	A254	Ic	Pr		A24	A254	Ic	Pr
200	*D. decumbens* A24	79.35	—	0	0	0	82.53	—	1.38	0	0.45
	D. Decumbens A254	78.90	0.25	—	0	1.5	84.88	0.75	—	0	2.40
	I. cylindrica	23.95	1.05	0.33	0	0.9	40.88	6.40	11.48	0	4.90
	P. repens	78.30	0.25	0.33	0	0	75.98	3.90	7.56	0	—
	Total	—	1.55	0.66	0	2.40	—	11.05	20.42	0	7.75
400	*D. decumbens* A24	74.23	—	0.20	0	0.35	83.45	—	3.30	1.10	2.58
	D. decumbens A254	79.23	0	—	0	1.80	82.45	0.38	—	0.35	5.40
	I. cylindrica	20.25	1.28	1.15	0	2.03	42.40	4.08	16.13	0	2.90
	P. repens	75.90	0.025	0.75	0	—	78.65	0.38	5.05	0	—
	Total	—	1.305	2.10	0	4.18	—	4.84	24.48	1.46	10.88
800	*D. decumbens* A24	77.08	—	0.30	0	0.70	84.43	—	4.80	0	1.40
	D. decumbens A254	78.50	0	—	0	—	92.48	0	—	0	1.73
	I. cylindrica	22.30	2.0	2.13	—	0.93	47.45	0.43	23.53	—	1.78
	P. repens	78.80	0	0.83	0	3.40	81.40	0	7.75	0	—
	Total	—	2.0	3.26	0	5.03	—	0.43	36.08	0	4.91

Table 4. *Quantitative comparison of total protein contents in grass leaves grown under different culture treatments*

Level of urea (kg/ha)	Grass	Total protein content (%)	
		Furrow	Unfurrow
200	*Digitaria decumbens* A24	6.57	5.64
	D. decumbens A254	6.41	6.52
	Imperata cylindrica	8.21	6.17
	Panicum repens	9.58	7.39
400	*D. decumbens* A24	7.45	5.75
	D. decumbens A254	7.61	6.52
	I. cylindrica	8.61	5.03
	P. repens	9.81	7.39
800	*D. decumbens* A24	7.50	5.38
	D. decumbens A254	7.18	5.39
	I. cylindrica	7.93	7.66
	P. repens	8.04	8.31

The values are statistically insignificant at 5% level.

contents were generally higher in *P. repens*, being from 9.3% to 9.8%, and were lower in *D. decumbens* grown in unfurrowed plots. However, the data of protein contents were statistically insignificant between grasses and even were not affected by the treatment of nitrogen levels.

Comparison of Phytotoxicity of Grasses under Various Culture Treatments

The phytotoxicity of each grass extracts was evaluated by the bioassay of lettuce and rice seeds as described before. The four grasses studied generally exhibited inhibition of radicle growth of lettuce and rice seedlings (Table 5). It was noticeable that the grasses grown in the furrowed plots revealed significantly higher inhibition than those in the unfurrowed plots, suggesting that the poorer the growth of grasses under interference, the lesser the phytotoxicity revealed. In the lettuce bioassay, it was observed that the phytotoxicity of grass extracts increased with increased level of nitrogen fertilizer, suggesting that the better the grass grew the more phytotoxic substances could be produced. Comparing the phytotoxicities of the four grasses, *P. repens* exhibited the highest phytotoxicity, *D. decumbens* A24 the second, and *I. cylindrica* the least. Although the increasing amount of nitrogen fertilizer may not significantly enhance the production of grass biomass (Tables 1 and 2), it did enhance the phytotoxicity of the dominant grasses mentioned.

Quantitative Comparison of Phytotoxic Phenolics in Grasses

By means of HPLC, the quantitative comparison of phytotoxic phenolics present in grasses were done. The results are shown in Tables 6a and 6b, which were obtained from two different dates of harvesting. Nine phytotoxic phenolics were identified as vanillic, caffeic, syringic, gallic, protocatechuic, *p*-hydroxybenzoic, *o*-hydroxyphenylacetic, *p*-coumaric, and ferulic acids. Comparing two different harvesting dates, the quantity of phytotoxins produced by grasses was generally higher

Table 5. *The phytotoxic effects of aqueous extracts of grass leaves on the radicle growth of lettuce and pregerminated rice seeds. The grasses were grown under various culture conditions*

Grasses	Phytotoxicity (% inhibition of radicle growth of distilled water control)							
	200[1]		400		800		Mean	
	Furrow	Unfurrow	Furrow	Unfurrow	Furrow	Unfurrow	Furrow	Unfurrow
				Lettuce Bioassay				
Digitaria decumbens A24	49.4	44.8	68.2	40.7	59.3	47.3	58.9	44.3
D. decumbens A254	56.3	47.4	56.9	38.1	57.6	45.9	56.9	43.8
Imperata cylindrica	51.1	45.6	55.5	52.9	58.4	50.2	55.0	49.6
Panicum repens	56.2	41.8	63.9	47.3	63.6	47.9	61.2	45.6
Mean	53.3	44.9	61.1	44.7	59.7	47.8	58.0	45.8
				Rice Bioassay				
Digitatia decumbens A24	50.3	20.5	25.6	11.2	46.9	− 3.4	40.9	9.4
D. decumbens A254	61.9	37.7	6.3	15.4	39.0	− 5.4	35.7	15.9
Imperata cylindrica	50.8	−11.4[2]	20.9	24.5	46.3	−25.5	39.3	4.1
Panicum repens	41.1	43.9	42.6	36.3	59.1	8.2	47.6	29.5
Mean	51.0	22.7	23.9	21.9	47.7	− 6.53	40.9	14.7

[1] The numbers indicate the levels of urea fertilizer dressing in kg/ha.
[2] The negative values indicate percent stimulation.

Table 6a. *Quantitative comparison ofphytotoxic phenolics produced by grasses grown under three levels of nitrogen fertilizer dressing in furrow (F) and unfurrow plots (UF)*

The samples were harvested on May 18, 1983.

Level of urea (kg/ha)	Grass	Treatment	Content of phenolics ($\times^{-8}$ mole/g dry weight)									
			GA	PA	pHBA	oHPAA	VA	CA	SA	pGA	FA	Total
200	*Digitaria decumbens* A24	F	1.95	5.80	11.63	16.25	3.25	23.80	3.69	11.60	11.70	89.67
		UF	10.00	10.10	13.80	65.50	10.70	54.40	32.50	36.60	17.60	212.30
	D. decumbens A254	F	2.10	7.96	17.20	12.50	11.90	41.40	7.99	8.11	11.50	120.66
		UF	7.16	8.59	12.40	4.30	6.36	61.20	4.89	35.10	21.50	176.83
	Imperata cylindrica	F	2.81	8.38	14.70	19.40	9.68	29.30	5.28	6.57	4.37	100.49
		UF	1.70	9.20	9.38	51.90	5.74	48.40	3.28	40.30	16.80	186.17
	Panicum repens	F	2.75	9.55	13.10	6.33	4.19	13.10	4.58	8.61	43.00	105.19
		UF	1.81	6.66	8.25	39.60	7.91	23.00	7.00	36.10	46.50	176.83
400	*D. decumbens* A24	F	0.93	4.16	15.60	17.50	14.30	71.90	4.29	40.30	23.90	192.88
		UF	11.80	10.40	15.10	32.40	5.65	42.80	4.94	33.40	36.80	193.29
	D. decumbens A254	F	0.68	4.34	13.30	14.90	15.80	21.00	7.07	35.20	16.70	128.99
		UF	0.07	10.20	17.70	32.60	6.26	43.10	3.59	31.20	19.80	164.50
	I. cylindrica	F	0.83	4.48	13.00	10.20	20.90	53.60	5.85	45.00	17.00	170.86
		UF	9.18	9.28	9.11	54.70	5.34	55.10	3.00	27.50	16.10	189.31
	P. repens	F	4.04	3.65	10.00	16.20	15.50	5.70	3.76	61.10	43.00	162.95
		UF	1.81	6.66	8.25	39.60	7.91	23.00	7.00	36.10	46.50	176.83
800	*D. decumbens* A24	F	+[1]	5.43	14.70	41.70	11.70	40.50	3.08	40.50	16.50	174.11
		UF	14.80	7.31	10.70	20.30	3.01	38.60	2.16	22.20	13.40	132.48
	D. decumbens A254	F	+	5.23	12.90	39.90	13.60	122.00	5.37	42.60	21.80	263.40
		UF	7.83	8.12	9.24	44.90	10.50	27.60	4.08	18.20	11.50	101.97
	I. cylindrica	F	+	5.36	8.13	31.40	11.00	24.30	2.30	35.40	13.60	131.49
		UF	7.13	9.18	9.07	32.20	4.50	36.70	2.89	54.50	38.00	194.17
	P. repens	F	5.77	5.12	9.23	28.10	8.23	34.90	+	42.50	33.30	167.15
		UF	6.33	6.89	11.20	23.00	6.05	23.40	2.48	32.20	43.00	154.55

[1] Trace amount of the compound was detected. The abbreviations of compounds: GA=gallic acid, PA=protocatechuic acid, pHBA=*p*-hydroxybenzoic acid, oHPAA=*o*-hydroxyphenylacetic acid, VA=vanillic acid, CA=caffeic acid, SA=syringic acid, pCA=*p*-coumaric acid, FA=ferulic acid.

in the later harvesting sample (October 28) than the early harvesting sample (May 18), suggesting that the quantity of toxic phenolics could increase with age. Among the nine compounds, caffeic, *p*-coumaric, *o*-hydroxyphenylacetic, and ferulic acids were evidently abundant in grasses regardless of species and culture treatments. Particularly, the content of ferulic acid was revealed to be the highest in *P. repens*; while that of caffeic acid was noticeably high in *I. cylindrica*. As far as the culture treatments are concerned, the contents of phenolics were generally higher in the grasses grown in the furrowed plots than that in the unfurrowed plots. These findings were particularly significant in the grasses grown in plot receiving heavy nitrogen fertilizer dressing and harvested on October 28. It can be interpreted that under a heavy nitrogen dressing, the aggressive grasses may produce more phytotoxic phenolics in order to suppress the growth of its

Table 6b. *Quantitative comparison of phytotoxic phenolics produced by grasses grown under three levels of nitrogen fertilizer dressing in furrow (F) and unfurrow plots (UF)*

The samples were harvested on October 28, 1983.

Level of urea (kg/ha)	Grass	Treatment	Content of phenolics ($\times 10^{-8}$ mole/g dry weight)									
			GA	PA	pHBA	oHPAA	VA	CA	SA	pCA	FA	Total
200	*Digitaria decumbens* A24	F	+[1]	3.87	3.55	38.43	16.92	36.92	3.00	43.05	15.93	161.67
		UF	+	+	17.37	112.18	18.36	64.84	1.41	62.71	15.71	292.58
	*D. decumbens*A254	F	+	4.96	7.68	27.89	28.77	40.94	4.18	47.87	21.17	183.46
		UF	+	+	6.69	5.28	9.09	20.76	1.07	32.26	9.98	85.13
	Imperata cylindrica	F	+	5.86	8.13	43.03	36.42	77.82	3.82	59.40	23.92	258.39
		UF	+	+	10.08	19.36	45.37	89.88	2.04	58.25	17.91	242.79
	Panicum repens	F	+	3.75	7.03	52.58	43.53	33.91	3.40	89.24	63.71	297.15
		UF	+	+	24.80	24.77	25.78	53.14	2.39	101.81	40.56	273.25
400	*D. decumbens* A24	F	+	4.14	5.44	42.38	32.56	64.72	3.16	45.75	26.53	224.68
		UF	+	+	29.51	15.34	15.17	51.60	2.12	53.88	18.22	185.84
	D. decumbens A254	F	+	0.55	5.28	44.35	2.57	9.59	2.66	24.41	4.19	93.60
		UF	+	+	25.00	41.12	21.84	38.15	2.24	45.61	14.14	188.10
	I. cylindrica	F	+	1.27	8.36	13.73	12.54	45.41	2.98	46.97	14.63	145.89
		UF	+	+	30.67	62.50	42.98	108.32	3.09	83.25	27.39	358.20
	P. repens	F	+	0.79	5.15	8.80	5.96	5.57	2.97	87.33	53.52	170.09
		UF	+	+	19.22	44.68	26.02	59.44	2.68	99.21	56.33	307.59
800	*D. decumbens* A24	F	+	0.90	8.23	21.96	1.63	25.06	2.54	36.42	14.80	111.54
		UF	+	+	32.64	41.75	22.45	59.38	2.02	79.17	24.54	234.52
	D. decumbens A254	F	+	0.70	9.27	35.27	4.47	9.59	2.74	28.58	8.67	99.29
		UF	+	+	36.10	45.84	30.33	14.50	3.60	57.82	17.49	205.68
	I. cylindrica	F	+	1.32	9.04	68.19	29.15	40.87	3.03	56.54	14.01	222.15
		UF	+	+	28.13	49.61	46.14	152.00	3.58	85.56	31.39	396.42
	P. repens	F	+	1.05	6.55	3.15	7.39	11.20	2.62	77.96	55.32	165.24
		UF	+	+	27.52	54.33	39.02	27.09	2.68	97.55	71.62	321.79

[1] Trace amount of the compound was detected. The abbreviations of compounds see Table 6a.

competitor sharing the same nitrogen fertilizer. In this study, although *I. cylindrica* does possess a significant amount of phytotoxic phenolics, it still fails to compete with *P. repens* or *D. decumbens* cultivars when a heavy nitrogen fertilizer is applied. This is simply due to the growth performance of different grasses *per se*. The growth rate of *P. repens* and *D. decumbens* was much higher than that of *I. cylindrica*. In other words, the more biomass produced by the former two species the higher contents of phytotoxic phenolics would be released, resulting in the suppression of the later one. More research should be conducted to test the allelopathic interaction between pasture and weeds in order to clarify whether allelopathy or simple competition for physical factors is the main mechanism for the dominance.

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不同氮肥施量對盤固草及雜草之植物相剋潛能的影響

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以三種施量之尿素及混以鉀肥及磷肥於四種禾草即盤固草 A24，A254，舖地黍及白茅之田中，經三次收割。在收割前調查其覆蓋面積及產草量，收割後分別做生物分析以比較其水溶萃取液中之植物毒性及植物毒物質的含量。田間之結果顯示盤固草 A254 之優勢性顯然較其他三者高，其中白茅之優勢性差。尤其在重氮肥（800 kg/ha 尿素）情形下，盤固草之優勢性更爲顯著且植物毒性亦相對提高。經高效能液態色層分析儀之鑑定得九種酚類植物毒物質分布於四種禾草中，其中以 caffeic acid, *p*-coumaric acid, *o*-hydroxyphenylacetic 及 ferulic acid 之含量最高。在上述重氮肥之施量中盤固草之品系所含上述酚酸量亦顯著高於其他處理者，此結果引申在不同氮肥施量中對盤固草之植物相剋潛能有影響，此扮演盤固草在田間成爲優勢性機制之一。