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Screening on allelopathic potential of 12 leguminous plants on germination and growth of barnyardgrass

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A preparatory study of leguminous plants on allelopathic potential was completed from January to June 2015. In laboratory conditions, entire plants of 12 leguminous plants at the blossoming stage were collected and ground into residue powder. The powders were measured by phytotoxicity on germination and development of barnyard grass (*Echinochloa crus-galli* (L.) Beauv.) by direct application in a Petri dish at the rate of 250 and 500 mg/Petri dish. *Centrosema pascuorum* cv. *Cavalcade*, *Clitoria ternatea* and *Stylosanthes guianensis* demonstrated the most phytotoxic impact on germination and seedling development of barnyard grass. The level of hindrance on germination at 500 mg/Petri dish was 86%, 98% and 98% respectfully. *Macroptillium atropurpureum* and *Phaseolus lathyroides* powders demonstrated the slightest phytotoxicity. Another trial was directed to test the powders on weed control in pot scale. Directed wet seeds were sowed in the pot for 10 days. Utilization of powder integrated with a water irrigation was included into the pot at the proportion of 250 and 500 kg./ha. The outcome interestingly demonstrated all powders could smother weed density and weed biomass when compared with the control pot. *Canavalia ensiformis*, *Crotalaria pallida*, *C. pascuorum* cv. *Cavalcade*, *C. ternatea* and *S. guianensis* indicated totally diminishing weed density at the rate of 500 kg./ha, while the rice seedlings had no-harmful impact. Then again, mechanisms on restraining weeds were not understanding. The future works were centered on segregation and the distinguishing proof of dynamic mixes of chosen species, and the possibility of use in the field.

Keywords: Leguminous plant, Weed suppression, Residue integrated with irrigation, paddy weeds

Introduction

Allelopathy is any procedure whereby plants create and discharge phytotoxins into a close environment (Wu *et al.*, 2001). These phytotoxins called by the allelochemicals, allelochemic or allelopathic compounds, which

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influence both stimulation and inhibition of recipient plants (Rice, 1984). To date, the misuse of allelopathy in plants in rural practice as an apparatus of weed control has demonstrated weed lessening, pathogen anticipation and soil enhancement. The use of allelopathic plants as an instrument of weed control was engaged, particularly leguminous plants.

It was to realize that leguminous plants had valuable elements on soil change, soil properties, decreasing on disintegration and supplement filtering by spread products and yield revolution in an agrarian framework. Up to this point, the allelopathic capability of spread yields are especially intrigued to producers (Hill *et al*., 2007). A few spread yields had been accounted for to have allelopathic potential and an endeavor to apply them as an instrument for maintainable and eco-accommodating weed control systems, for example, Vicia as living mulch (Anugroho and Kitou, 2011; Campiglia *et al*., 2010; Isik *et al*., 2009), the spread buildups of cowpea (*Vigna unguiculata* L.), sunnhemp (*Crotalaria juncea* L.) and velvetbean (*Mucuna deeringiana* Bort.) (Adler and Chase, 2007).

A lab bioassay is the initial step to screen allelopathic potential. A water extraction of plant residues to influence product and weed development is constantly utilized for screening (Fujii *et al*., 2003; Hong *et al*., 2003; Hill *et al*., 2006; Hill *et al*., 2007). Moreover, sandwich and dish-pack techniques were accounted for (Morita *et al*. 2005). In any case, allelochemicals discharged by plant residues when connected into soil by any means, are constantly adsorbed on soil solids, and metabolized by substance and organic responses amid the development in soil (Kobayashi, 2004). Laosinwattana et al. (2010) had reported that dried leaf powder of Suregada when coordinated into a petri-dish had a higher inhibitory impact than fluid concentrates at equivalent focuses. They uncovered that it produced a consistent arrival of allelochemicals accomplished amid the time of the bioassay.

The target of this study was to screen allopathic potential of 12 leguminous plants including; *Stylosanthes guianensis* CIAT 184, *Senna hirsute (L.) H.S.Irwin & Barneby*, *Crotalaria pallida* Ait., *Calopogonium mucunoides* Desv., *Calopogonium caeruleum* Benth., *Mucuna pruriens* (L.) DC., *Lablab purpureus* (L.) Sweet, *Clitoria ternatea* L., *Centrosema pascuorum* cv. *Cavalcade*, *Phaseolus lathyroides* L., *Macroptillium atropurpureum* L., *Canavalia ensiformis* (L.) DC. In a laboratory assay, the dried plant powder was placed into a Petri dish against barnyard grass was utilized for this examination. Another study inspected the utilization of the powders integrated with the watering system on paddy weed control in a glasshouse.

Materials and methods

Plant materials

Seeds of 12 leguminous plants were sowed in plastic pots (30 cm diameter) and growed in a glasshouse at Naresuan University, Phitsanulok, Thailand. Whole plants at flowering stage was harvested and dried under shading light. The plants were grinded by electronic grinder giving the whole plant powder of each species, and kept in laboratory room.

Bioassay seeds

Barnyardgrass, a major annual grass weed in paddy, was used as a bioassay specie. Seeds were collected under rice field of farmers. Then, they were dried under sunlight for 3 days. The seeds were kept in laboratory room for 3 months for break dormancy.

Dried powder bioassay

The powder of each species was added into 9-cm Petri dish lined with germination paper at 250 and 500 mg per Petri dish, and then 5 mL of distilled water was added to each Petri dish. Twenty seeds of barnyardgrass were placed into the Petri dish. The dish that had only distilled water was used as control. The experiment was repeated four times in a completely randomized design. The dishes was placed in laboratory room that had the temperature around 25 – 30 ^{o}C. After 7 days, the germination, hypocotyls length, and roots length was measured by a ruler.

Application of the powders integrated with irrigation on paddy weed control

This method was observed by farmers that always irrigate at 10 – 15 days after directed germinated rice seeds. This stage, weeds are always smaller rice seedling. The water level is about 5 – 10 cm above a soil level. Our preliminary study was showed that the directing application of plant material integrated with water irrigation could reduce or kill paddy weeds while rice seedling was not toxicity. This reason was the background of this experiment.

A glasshouse condition was conducted in this experiment. The natural paddy soil was collected by 30-cm depth. The soil was dried under sunlight. After that, it was saturated in water for several days. The soil was added to 30-cm plastic pots by 75% of pot volume. 3-germinating seeds of rice cultivar

Phitsanulok2 were planted into the soil. At 10 days after sowing, water was supplied into at the level of 5 cm, meanwhile the each powder was also added into the water at the rates of 250 and 500 kg./ha. The controls were untreated and hand-weeded pot. Experiments were carried out in four replications for each pot in completely randomized design manner. Total weed density was counted at 14 days after applications. Shoot biomass of total weed was collected at 14 days after application. The height of rice was measured at 14 days after sowing. Rice shoot biomass was collected at 28 days after sowing.

Data analysis

All the data were analyzed by one-way ANOVA and the means were separated by Least Significant Difference (LSD) at P = 0.05.

Results

Dried powders of leguminous plants on germination, shoot and root growth of barnyardgrass

Table 1 showed the effect of dried powders of 12 leguminous plants on germination, shoot and root growth of barnyardgrass. The degree of inhibition of all species at 500 mg/Petri dish was greater than 250 mg/Petri dish. *C. ternatea S. guianensis* and *C. pascuorum* cv. *Cavalcade* at all rates showed the high inhibitory effect on germination of barnyardgrass over 50%. The degree of inhibition of *C. ternatea* and *S. guianensis* were 78.48%, 98.73% at 250 and 500 mg/Petri dish respectively, while *C. pascuorum* cv. *Cavalcade* was 67.08% and 86.07% respectively. *M.atropurpureum* and *P.lathyroides* at 250 mg/Petri dish showed the least degree inhibition by 3.79%.

The effects of dried powder of 12 leguminous plants on shoot and root growth of barnyardgrass seedling were similar to the result of germination. *C. ternatea* and *S. guianensis* showed the greatest inhibitory effect. *M.atropurpureum*
And *M. pruriens* at 250 mg/Petri dish showed the minus degree of inhibition.

Application of dried powders of 12 leguminous plants integrated with irrigation on paddy weed control

Table 2 exhibited the effect of direct application of dried powders of 12 leguminous plants integrated with water irrigation on weed density, weed biomass, rice growth, and rice biomass. The types of weed species in this soil included *Fimbristylis miliacea*, *Leptochloa chinensis*, *Sphenoclea zeylanica E. crus-galli*, *and Ludwigia hyssopifolia.* The result showed that degree of inhibiton was depended on species and the rate. The rate of 500 kg./ha showed more inhibitory effect on weed density and weed biomass than 250 kg./ha. *Canavalia ensiformis*, *Crotalaria pallida*, *C. pascuorum* cv. *Cavalcade*, *C. ternatea* and *S. guianensis* at the rate of 500 kg./ha could completely decrease weed density. However, it was noticeable that rice seedling growth was not inhibited by the powders, whereas they showed stimulation effect that observed by the height and shoot biomass of rice seedling in Table 2.

Table 1 Effects of dried powders of 12 leguminous on the germination, shoot and root length of barnyardgrass.

Plant Species	Rates (mg/Petri dish)	Inhibition (%)		
		Germination	Shoot	Root
S. hirsute	250	20.25	11.23	32.86
	500	43.03	39.76	44.29
C. caeruleum	250	13.92	12.59	12.86
	500	15.18	27.98	41.43
C. mucunoides	250	11.24	8.76	4.6
	500	18.35	25.45	38.48
C. ternatea	250	78.48	45.19	34.29
	500	98.73	86.41	85.71
S. guianensis	250	78.48	21.19	21.43
	500	98.73	86.41	85.71
M.atropurpureum	250	3.79	-5.07	-38.57
	500	29.11	33.42	21.43
P.lathyroides	250	3.79	2.17	-1.11
	500	17.72	41.12	47.14
L. purpureus	250	10.12	6.70	22.86
	500	48.10	42.93	54.29
C. pascuorum	250	67.08	21.19	-7.14
cv. *Cavalcade*	500	86.07	57.65	55.71
C. ensiformis	250	15.18	-6.43	5.71
	500	31.64	43.38	55.71
C. pallida	250	12.65	6.25	4.29
	500	25.31	8.96	-7.14
M. pruriens	250	11.39	-1.90	-7.14
	500	36.71	22.10	38.57
LSD (p=0.05)		18.73	22.64	25.67

Table 2 Effects of dried powder of 12 leguminous plants application integrated with irrigation on total weed density, shoot dried weight of total weeds, rice seedling height and shoot dried weight of rice seedling.

Plant Species	Rates (kg dried weight/ha)	Total weed density (plants/pot)	Shoot ried weight of total weeds (g)	Rice seedling height (cm.)	Shoot dried weight rice seedling (g)
Unweeded		35	1.34	21.5	3.64
Hand-weeded		-	-	26.7	4.42
S. hirsute	250	28	1.22	21.9	3.75
	500	10	0.84	23.4	4.2
C. caeruleum	250	30	1.35	21.6	3.78
	500	16	1.11	22.3	4.29
C. mucunoides	250	33	1.44	20.3	3.51
	500	21	1.22	21.4	3.62
C. ternatea	250	14	0.35	26.5	4.23
	500	0	0	27.8	4.45
S. guianensis	250	12	0.21	25.6	3.94
	500	0	0	27.1	4.56
M.atropurpureum	250	36	1.35	22.3	3.82
	500	24	1.16	22.6	3.81
P.lathyroides	250	32	1.33	22.5	3.82
	500	26	1.13	21.6	3.84
L. purpureus	250	24	1.24	22.4	3.85
	500	8	0.36	23.4	3.84
C. pascuorum	250	16	0.88	24.3	3.94
cv. *Cavalcade*	500	0	0	26.2	4.64
C. ensiformis	250	14	0.17	26.8	4.21
	500	0	0	27.9	4.78
C. pallida	250	23	1.05	26.4	4.22
	500	0	0	27.6	4.87
M. pruriens	250	29	1.32	26.5	4.32
	500	9	0.54	25.8	4.35
LSD (p=0.05)		7.84	0.45	3.2	0.52

Discussions

Rice development by directed wet seeds is extremely renowned in Thailand due to its low-input demand (Farooq *et al.*, 2011). The soil is at first furrowed and turned with water soaked soil. The soil is modify be elevation routinely. At that point, the water is then channeled from the pitch. After that, the germinated seeds are specifically sowed. The soil is unirrigated for 10 – 15 days in the wake of sowing with a specific end goal to a suitable state of rise and seedling agility. On the other hand, at this point in time, weed seeds can without much difficulty, stretch development at the same time as the rice rises. In spite of the fact that, the germinated wet seed framework is well-being on monetary expenses and the yield is the same with transplanted rice, weed infestation is the real limitation towards the achievement of a directed wet seed (Caton *et al*, 2003; Rao *et al*., 2007, Farooq *et al*., 2011). A water irrigation dependably floods since 10 - 15 days subsequent to sowing at the level of 5 – 10 cm above soil level. Weed seedlings are smaller and lower than rice seedlings when weed seedlings are constantly flooded and submerged in a watering system. Weed seedlings can develop when emerged in water, and they meddle rice development bringing about weed rivalry. Our perception demonstrated that allelopathic residues when connected with a water irrigation at 10 days in the wake of sowing, could interestingly control weeds when submerged.

Our study was intended to screen the allelopathic capability of leguminous plants keeping in mind the end goal to apply the plant in the rice field integrated with water irrigation to control weeds. Leguminous plants were engaged in this study on the grounds that it might be profited for rice development and soil richness. N, from green residues could add to the soil after their disintegration (Choi *et al*., 2008). This outcome reveals that the dried powder of *C. pascuorum* cv. *Cavalcade*, *C. ternatea* and *S. guianensis* repressed seed germination and seedling development of stable area grass in a Petri dish test. This suggested they had inhibitory substances released by plant residues. Additionally, the consequence of their buildups connected with an irrigation in pot scale had demonstrated that all species diminished weed thickness and weed biomass, while the rice development and shoot biomass had no-lethal toxins. Thus, rice development was animated by the residues that appeared on rice biomass. The highest impact had appeared by residues of *C. ensiformis*, *C. pallida*, *C. pascuorum* cv. *Cavalcade*, *C. ternatea* and *S. guianensis*. *S. guianensis* had given an account of an allelopathic impact. The use of 1 ton/ha upland parts combined to lessened paddy weed biomass by 80% and expanded rice yield by 40% when contrasted with the control (Khanh *et al*., 2006). In spite of the fact that plant residues incorporated with a water irrigation, diminished weed thickness and weed biomass, it can't be understood why the weeds faltered and died, which by shading the impact of buildups, or allelochemicals discharged by plant residues. A future study will center on 1) disconnection and to recognize the dynamic mixes from leguminous plants, 2) components of weed death 3) impacts of residues on rice development and yield, 4) how to apply the buildups into the field.

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