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Short communication

Allelopathic potential of rice varieties against major weeds of rice and wheat

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Rice-wheat system is the major cropping system in Northern India. Direct-seeding of rice is receiving considerable attention because of decreasing availability of water and increasing labor costs. In rice shift from transplanted to direct-seeded cultural practices, weed problems are expected to increase since crop and weeds can emerge together (Rao *et al.* 2007). Yield losses of wheat due to weeds are estimated around 25-50% and in very severe cases the losses may go up to 80% (Singh *et al.* 2005). Production of large amount of straw by rice crop is one of the most serious problems in rice producing countries like India. The majority of rice straw is burnt in the fields causing environmental pollution and health hazard to public. Incorporating the residues of rice with high allelopathic activity can reduce the herbicide usage in rice-wheat system. *Echinochloa crus-galli* and *E. colona* in rice and *Phalaris minor* in wheat are the predominant and noxious grassy weeds in rice-wheat system (Walia *et al.* 2005). The use of rice germplasm that contains high allelopathic activity, combined with incorporating straw into the soil can suppress germination of weeds. So, the present study was undertaken to assess basmati and non-basmati rice varieties for their allelopathic potential against germination of *E. crus-galli*, *E. colona* and *P. minor*.

Seeds of six rice varieties, *viz. 'PR 115, PR 124, PR 118, Pusa Punjab Basmati-1509, Punjab Basmati-3* and *Basmati-386'* were procured from Rice Section, Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana. Seeds of *E. crus-galli* and *E. colona* were collected from several rice fields and *P. minor* seeds from wheat fields of Punjab. Seeds were bulked, cleaned and stored at room temperature in a laboratory in air tight plastic containers until they were used in experiments.

Uniform sized seeds of *E. crus-galli*, *E. colona* and *P. minor* were surface sterilized using 0.1% mercuric chloride for two minutes followed by thorough washing with distilled water to ward off any fungal infection. Seed germination was tested on 3 replicates of twenty seeds placed evenly on Whatman No. 1 filter paper in 9 cm Petri dishes. Dishes were moistened with 5 ml of treatment solution and incubated at 30°C (optimum temperature) for *E. crus-galli* and *E. colona* and at 20°C (optimum temperature) for *P. minor* in environmental chamber (Model MAC MSW-127, Delhi, India). Seeds germinated using distilled water served as control.

Water extracts of roots and shoots (5%) were prepared from 50 days old rice plants. Paddy straw extracts (5%) were prepared from mature rice plants. For preparing aqueous extracts, samples were shade dried followed by oven drying at 65-70°C for 48 hrs. The plant samples were chopped into 2-3 cm pieces and then grounded. Aqueous extracts (5%) were prepared by soaking 5 g plant material in 100 ml distilled water for 24 hr at room temperature followed by filtration. Allelopathic potential of aqueous extracts prepared from 50 days old plants was tested against *E. crus-galli* and *E. colona*. The allelopathic potential of paddy straw aqueous extracts was tested against *P. minor*.

Germination counts were made at 24-h intervals for 15 days after start of the experiment, with the criterion for germination being visible protrusion of the radicle. Germination (%) was calculated as: (No. of seeds germinated /total number of seeds sown) × 100. Shoot and root length of seedlings was measured on 15th day of experiment using centimeter scale. Seedling vigor index (SVI) was calculated as described by Abdul-Baki and Anderson (1973) using the formula: SVI = seedling length (cm) x germination (%)**.** Membrane leakage of 15 days old seedlings was determined as described by Fletcher and Drexlure (1980). Total chlorophyll content of seedlings was determined as described by Anderson and Boardman (1964). All the experiments were conducted in a completely randomized design with three replications and the experiment was repeated thrice. There were no significant differences between the results of the repeated experiments, so data were pooled before

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conducting analysis of variance (ANOVA) using CPCS 1 software.

Effects of aqueous extracts

Aqueous shoot extracts of all the six rice varieties significantly reduced germination of *E. crus-galli* in the range of 10-45% as compared to 86.7% germination in control. Shoot extracts of non-basmati varieties (*PR 115, PR 124* and *PR 118*) exhibited higher suppressive effect as compared to basmati varieties of rice (*Pusa Punjab Basmati-1509, Punjab Basmati-3 and Basmati-386*). Rice varieties '*PR 124'* and '*PR 118'* exhibited maximum inhibitory effect due to which germination of *E. crus-galli* was reduced to 10% (**Table 1**). Shoot extract of *'PR 124'* exhibited maximum inhibitory effect on seedling growth and seedling vigor index (SVI).

Aqueous root extracts of six rice varieties reduced germination of *E. crus-galli* to 17.5-48.3%. Aqueous root extracts of basmati varieties caused germination inhibition to greater extents as compared to non-basmati rice varieties. Maximum inhibitory effect on germination and seedling growth of *E. crus-galli* was observed due to root extract of '*Punjab Basmati-3*', which reduced germination to 17.5%; and also reduced SVI by 86.9% than control (**Table 1**). Chung *et al*. (2003) reported the inhibitory effects of rice hulls and leaf plus straw on *E. crus-galli* germination. They reported that rice variety '*CUBA 65-v-58*' caused 36.8% reduction in germination of *E. crus-galli*.

Shoot extract of '*PR118*' a non-basmati rice variety caused maximum increase in membrane leakage with 16.9% points and greatest reduction in total chlorophyll content (60.6%) as compared to their respective controls (**Table 1)**.

The aqueous shoot and root extracts of rice varieties caused significantly reduced germination of *E. colona*. (**Table 2**). Swain *et al*. (2012) studied the effect of decomposing leachates of upland rice cultivar '*Vandana*' which reduced germination and seedling growth of *E. colona*. Aqueous shoot and root extracts of rice varieties caused significant increase in membrane leakage coupled with reduction in total chlorophyll content of *E. colona* seedlings (**Table 2**). Shoot extract of '*Basmati-386*' caused maximum increase in membrane leakage (26% points) and greatest reduction in total chlorophyll content (73.2%) as compared to their respective controls. Aqueous root extract of '*Punjab Basmati-3*'

Table 1. Effect of aqueous shoot and root extracts (5%) of rice varieties on germination, seedling vigor index, membrane leakage and total chlorophyll content of *Echinochloa crus-galli* seedling

Variety	Germination (%)		Seedling vigor index		Membrane leakage of seedling (%)		Total chlorophyll content of seedling (mg/g FW)	
	Shoot extract	Root extract	Shoot extract	Root extract	Shoot extract	Root extract	Shoot extract	Root extract
PR 115	23.3	44.2	93.2	269.6	41.0	52.4	0.523	0.309
PR 124	10.0	44.1	32.0	233.7	48.8	49.5	0.415	0.343
PR 118	10.0	48.3	75.0	313.9	53.3	45.8	0.316	0.381
Pusa Punjab Basmati-1509	39.2	44.2	294.0	304.9	43.3	57.8	0.631	0.325
Punjab Basmati-3	45.0	17.5	346.5	99.7	45.8	57.5	0.661	0.209
Basmati-386	39.2	24.3	219.5	140.9	51.7	55.0	0.494	0.245
Control	86.7	86.7	763.0	763.0	36.4	41.0	0.803	0.803
LSD (p=0.05)	5.5	9.07	33.2	40.2	11.5	15.5	0.036	0.100

Table 2. Effect of aqueous shoot and root extracts (5%) of rice varieties on germination, seedling vigor index, membrane leakage and total chlorophyll content of *E. colona* seedling

Variety	Germination (%)		Seedling vigor index		Membrane leakage of seedling (%)		Total chlorophyll content of seedling (mg/g FW)	
	Shoot extract	Root extract	Shoot extract	Root extract	Shoot extract	Root extract	Shoot extract	Root extract
PR 115	30.8	24.2	169.4	135.5	58.4	55.0	0.635	0.846
PR 124	35.8	40.8	211.2	269.3	56.1	49.5	0.817	1.431
PR 118	37.5	35.8	191.2	261.3	65.1	52.5	0.809	1.176
Pusa Punjab Basmati-1509	37.5	34.2	138.7	174.4	60.0	50.5	0.967	1.804
Punjab Basmati-3	31.7	17.5	142.6	63.0	51.0	59.0	0.655	0.780
Basmati-386	23.3	23.3	81.5	88.5	68.0	56.5	0.509	0.931
Control	86.7	86.7	771.6	771.6	42.0	42.0	1.897	1.897
LSD (p=0.05)	7.5	6.9	44.2	19.8	8.6	9.0	0.059	0.135

Table 3. Effect of aqueous paddy straw extracts (5%) of rice varieties on germination, seedling vigor index, membrane leakage and chlorophyll content of *Phalaris minor* seedling

Varieties	Germination (%)	Seedling vigor index	Membrane leakage of seedling (%)	Total chlorophyll content of seedling (mg/g FW)
PR 115	32.5	289.2	34.3	0.542
PR 124	57.5	500.2	28.7	0.791
PR 118	68.3	812.8	27.9	0.824
Pusa Punjab Basmati-1509	38.3	417.5	33.3	0.665
Punjab Basmati-3	47.5	560.5	27.4	0.716
Basmati-386	60.8	784.3	29.4	0.812
Control	92.5	1332.0	26.2	0.924
LSD (p=0.05)	8.6	124.7	8.1	0.096

caused greatest increase in membrane leakage (17% points); and also caused maximum decrease in total chlorophyll content of about 58.9% than control.

Aqueous rice straw extracts (5%) of rice varieties significantly reduced germination of *P. minor* in the range of 32.5-68.3% as compared to 92.5% germination in control (**Table 3**). Variety *'PR 115'* exhibited maximum inhibitory effect and reduced germination of *P. minor* to 32.5%. Rice straw extract of this variety reduced SVI by 78.3% as compared to control. Among the basmati varieties, '*Pusa Punjab Basmati-1509*' exerted maximum suppressive effect and reduced the germination to 38.3%; and caused 68.6% reduction in SVI as compared to control. Om *et al.* (2002) also reported reduced germination of *P. minor* due to rice straw extract. Aqueous rice straw extracts of rice varieties caused significant increase in membrane leakage and decreased total chlorophyll content of *P. minor* seedlings (**Table 3**).

SUMMARY

The study was conducted to assess the allelopathic potential of three basmati (*PR 115, PR 124, PR 118)* and three non-basmati (*Pusa Punjab Basmati-1509, Punjab Basmati-3 and Basmati-386*) rice varieties against germination and seedling growth of *Echinochloa crus-galli*, *E. colona* and *Phalaris minor*. Shoot extracts (5%) of non-basmati rice varieties prepared from 50 days old plants had more detrimental effect on germination and seedling growth of *E. crus-galli* as compared to basmati rice varieties. Variety '*PR 124*' reduced *E. crus-galli* germination to 10% and seedling vigor index by 95.8% as compared to control. Root extracts (5%) of basmati varieties had higher allelopathic potential against germination and seedling growth of *E. crus-galli* than non-basmati varieties. Root extracts (5%) of '*Punjab Basmati- 3*' affected germination and SVI of *E. crus-galli* most severely. Aqueous extracts of rice varieties also significantly reduced germination of E. colona and P. minor.

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