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SHORT COMMUNICATION

Effects of pulp extract of *Syzygium cumini* (L.) Skeels fruits on rice, maize and green gram crops

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ABSTRACT

In bioassay and pot culture, the allelopathic influence of pulp extract of *Syzygium cumini* L. fruit on 3-crops, [*Oryza sativa* Linn. (cv. Ranjit), *Zea mays* Linn. (Cv. Vijay Composite) and *Vigna radiata* Linn. (Cv. SG-1)] were determined. The pulp extracts significantly ($P < 0.05$) suppressed the germination, growth and biomass yield in both bioassay and pot culture. The *O. sativa* test crop was more susceptible to toxins in pulp extract followed by *Zea mays*. Irrespective of test crops, the pulp extract reduced the germination, shoot length, root length and biomass yield by 22.2, 28.1, 27.8 and 32.5%, respectively.

Key words: Allelopathy, bioassay, *Syzygium cumini* (Black plum), *Vigna radiata* (green gram), *Zea mays* (maize), *Oryza sativa* (rice), phytotoxicity, pot culture, pulp extract, rice

INTRODUCTION

Allelopathy is a phenomenon, where allelochemicals released from one plant affects the development and growth of other plant (14). Several modes of action or physiological mechanisms are involved in the inhibition and modification of plant growth and development (9, 18, 21). Unlike the synthetic herbicides, allelochemicals do not have common mode of action or physiological target site (13) and some plant extracts affects the cell division, pollen germination, nutrient uptake, photosynthesis and specific enzymes (2). The release of allelochemicals into the soil inhibits the germination and establishment of agricultural crops and vegetation (17). The allelopathic interactions play a vital role in agro-ecosystems (10). In most cases, allelopathic effects are selective and vary with crops (3, 10).

In home gardens of Eastern Himalayan region, many woody perennials are grown with food crops (4). *S. cumini*, (family Myrtaceae), is a large evergreen and medicinal tree, whose different parts possess hypoglycemic, antibacterial, anti-HIV and anti-diarrhoea activities (8, 16). Its leaf and bark has anti-inflammatory activity (15, 19). In Eastern Himalaya (up to 900m altitude), farmers usually cultivate this tree-crop for fruit and timber

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production. In agricultural fields, pulp extract of *S. cumini* is toxic to growth of agricultural crops in rainfed agroecosystems (Personal observations of authors). Hence, this experiment was conducted to determine the allelopathic potential of fruit pulp extract of *S. cumini* on germination, root-shoot length and dry matter yield of rice (*O. sativa*), maize (*Z. mays*) and green gram (*V. radiata*), through bioassay and pot culture, so as to find the magnitude of *S. cumini* fruits toxicity.

MATERIALS AND METHODS

These studies were conducted in the experimental garden of ICAR, located at Medziphema, India ($25^0 45' 24''$ N latitude, $93^0 50' 26''$ longitude and 250 m altitude) during July and August 2009. The mature fruits were harvested from 10-12 years old trees in first week of July, 2009. The study was done in Petri plates for bioassay in laboratory environment and in pot culture for field environment.

Bioassays: The experimental treatments consisted of two factors, (i) *S. cumini* fruit pulp extract concentration: 4 (0, 1, 2, 5 % w/v) and (ii). Test crops: 3 [(*O. sativa* L. cv. Ranjit), Maize (*Z. mays* L. cv. Vijay Composite) and green gram (*V. radiata* L. Cv. SG-1)]. To prepare extract, mature fruit pulp was sun-dried and ground in a mechanical grinder. The powdered sample, i.e., 1, 2 and 5 g were weighed and added to 100 ml distilled water and kept for 48 h at room temperature to make 1, 2 and 5% extract. The extracts were filtered through three layers of Whatman No. 1 filter paper. Its pH was 3.98 and stored in refrigerator at low temperature until required. The bioassay experiment was conducted in complete randomized design with three replications. Twenty five seeds of each test crop were placed in sterilized Petri dishes (13.0 cm dia.), lined with 3-layers of Whatman no. 1 filter paper. Ten ml pulp extract was added to each Petri plate on first day as per treatments and distilled water was used as control. Petri dishes were kept moist by adding 2 ml extract or distilled water as and when required. The seed germination, radicle and plumule growth was recorded at 7 days after sowing (5). Ambient room temperature during the experiment was 26^0C with relative humidity of 70.1%.

Pot culture: The same experiment was repeated in pot culture during July-August, 2009 in net house in complete randomized design with three replications and seeds were sown on 28th July, 2009 and harvested after 30 days for data recording. Mean maximum and minimum air temperature were 31.13 and 25.25^0C, respectively, with total rainfall of 318.80 mm and relative humidity of 75.3% at the experimental site. The garden soil used for the study was sandy loam in texture (pH 5.1-5.5, organic carbon 1.6-2.0%, and available N, P, K of 233, 10.2 and 202 kg/ha, respectively). About 5 kg of garden soil was filled into each earthen pot (40 x 25 cm) and irrigated before sowing with 100 ml (1, 2 and 5%) pulp extract prepared as per Hollis *et al.* (11). Five plants of each crop were left per pot after thinning. Pots were irrigated as and when required. Seed germination was recorded 7 days after sowing. The test crops were harvested 30 days after sowing to record the data of root-shoot length and dry matter production.

Statistical Analysis: The statistical analysis of data was done using test of significance at 5% level of probability.

RESULTS AND DISCUSSION

BIOASSAY

The pulp extract of *S. cumini* significantly (P = 0.05) suppressed the germination (%) of all the test crops. The magnitude of inhibition in germination increased with increasing conc. of pulp extract. The germination (%) of *O. sativa* was inhibited maximum (30.44%), followed by *V. radiata* (18.8%) and *Z. mays* (17.78%) (Table 1 and Fig. 1).

Table 1. Effect of aqueous pulp extracts of *Syzygium cumini* on germination, seedling growth and dry matter yield of rice, maize and green gram at 7 days after sowing in Laboratory bioassay.

Pulp extract conc. (%)	Germination (%)	Mean shoot length (cm)	Mean root length (cm)	Dry matter yield (g/plant)
Oryza sativa				
0	100.00[a]	3.93[a]	5.99[a]	0.79[a]
1	86.67[a]	2.59[ab]	4.02[ab]	0.66[a]
2	68.67[ab]	1.45[b]	3.23[b]	0.55[ab]
5	53.33[b]	0.92[b]	2.50[b]	0.37[b]
CD at 5%	32.50	2.12	2.39	0.28
Zea mays				
0	100.00[a]	6.99[a]	9.49[a]	3.21[a]
1	96.67[a]	5.20[ab]	8.00[ab]	2.33[ab]
2	83.67[ab]	3.55[b]	6.66[b]	1.85[ab]
5	66.33[b]	2.38[b]	5.37[b]	0.97[b]
CD at 5%	24.31	3.19	2.82	1.49
Vigna radiata				
0	100.00[a]	7.86[a]	4.11[a]	1.65[a]
1	93.33[a]	5.83[ab]	2.58[ab]	1.44[a]
2	86.67[ab]	4.41[b]	2.02[b]	1.06[ab]
5	63.67[b]	2.90[b]	1.08[b]	0.76[b]
CD at 5%	25.14	3.36	2.02	0.63

For each test crop, means followed by the same letter are not significantly (P = 0.05) different.

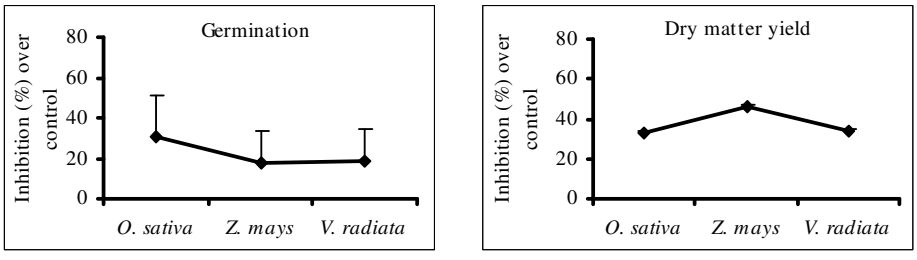

Figure 1. Inhibitory effects of aqueous pulp extracts of *Syzygium cumini* fruits on germination and dry matter yield of test crops at 7 days after sowing.

Similar was the case for shoot length of test crops and 5% pulp extract proved most toxic. The inhibition in shoot length of *O. sativa, Z. mays* and *V. radiata* was 57.93, 46.92 and 44.27%, respectively. Likewise, the inhibition in root length of *V. radiata, O. sativa* and *Z. mays* was 53.93, 45.74 and 29.65%, respectively, irrespective of pulp extract concentrations (Table 1 and Fig. 2). In dry matter content, the maximum inhibition was recorded in *Z. mays* (46.52%), followed by *V. radiata* (34.14%) and *O. sativa* (33.33%), respectively (Table 1 and Fig. 1).

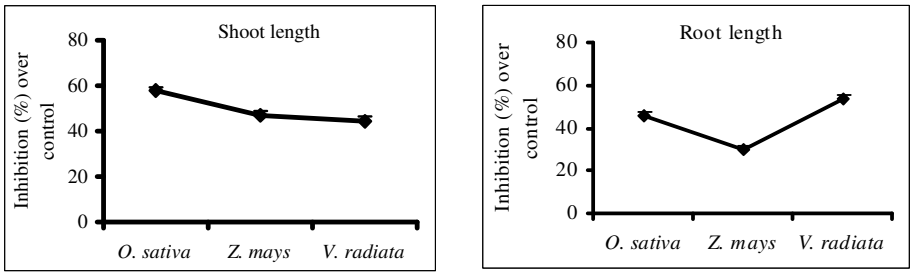

Figure 2. Inhibitory effects of aqueous pulp extracts of *Syzygium cumini* fruits on shoot and root length of test crops at 7 days after sowing.

In bioassay study irrespective of test crops, germination was suppressed by > 20%, whereas, the root-shoot length was inhibited by > 40%,. Likewise, dry matter yield of test crops was suppressed by > 30%.

POT CULTURE

The pot culture experiment also followed the similar trend. Inhibition in germination (%) of test crops increased with increasing conc. of pulp extract. However irrespective of pulp extracts concentrations, maximum inhibition was recorded in *Z. mays* (25.56%), followed by *O. sativa* (21.11%) and *V. radiata* (20.0%) (Table 2 and Fig. 3).

However, the shoot length was suppressed maximum in *O. sativa* (29.55%), closely followed by *V. radiata* (Table 2 and Fig. 4). Compared to germination and growth attributes of test crops, inhibitory effect was most drastic in dry matter yield of test crops. The dry matter of all test crops was suppressed by > 30% with highest reduction in *O. sativa* (35.90%) and lowest in *Z. mays* (30.22%).

In pot culture, root-shoot length was suppressed by > 25%. However, dry matter content was inhibited by > 30%. The data also indicated that the pulp extract of *S. cumini* was more toxic to the growth attributes and dry matter content of *O. sativa*, followed by *Z. mays* and *V. radiata*. The pulp extract was most inhibitory to biomass yield and growth than germination of all the test crops and the magnitude of inhibition increased with the increasing conc. of pulp extracts. In an earlier investigation, Bhatt *et al*. (6) also recorded the inhibitory effects of pulp extract of *Terminalia* spp. on germination, growth and dry matter yield of the test crops [*O. sativa*, *Z. mays* and *V. radiata*]. Hence, the present findings are in conformity with earlier findings of Bhatt *et al* (5) and Bhatt and Singh (7).

Table 2. Effect of aqueous pulp extracts of *Syzygium cumini* on germination, seedling growth and dry matter yield of rice, maize and green gram at 30 days after sowing in pot culture.

Pulp extract conc. (%)	Germination (%)	Mean shoot length (cm)	Mean root length (cm)	Dry matter yield (g/plant)
Oryza sativa				
0	100.00[a]	15.59[a]	6.47[a]	1.30[a]
1	96.67[a]	13.88[a]	5.90[a]	1.02[ab]
2	73.33[b]	10.93[a]	4.47[a]	0.82[b]
5	66.67[b]	8.14	3.43	0.66[b]
CD at 5%	26.47	5.23	2.19	0.44
Zea mays				
0	100.00[a]	58.52[a]	35.96[a]	5.03[a]
1	93.33[a]	53.63[a]	32.29[a]	4.55[a]
2	76.67[ab]	44.82[a]	27.23[a]	3.40[a]
5	53.33[b]	32.48	17.06	2.58
CD at 5%	33.08	18.18	13.05	1.76
Vigna radiata				
0	100.00[a]	30.27[a]	18.23[a]	1.79[a]
1	93.67[a]	26.29[a]	16.30[a]	1.57[a]
2	80.00[a]	20.36[b]	13.85[a]	1.16[b]
5	66.33	17.63[b]	10.57	0.95[b]
CD at 5%	23.84	9.09	5.26	0.61

For each test crop, means followed by the same letter are not significantly (P = 0.05) different.

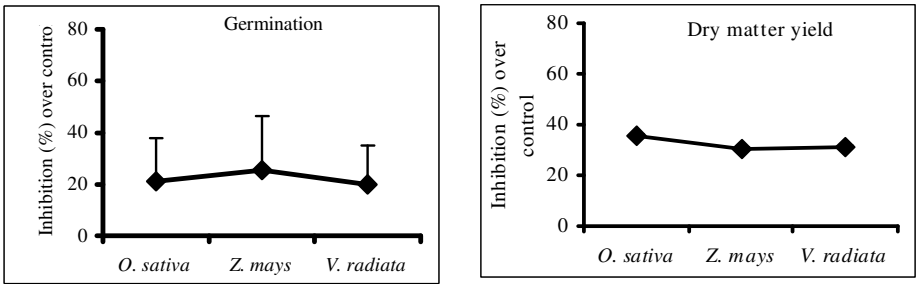

Figure 3. Inhibitory effects of aqueous pulp extracts of *Syzygium cumini* fruits on germination and dry matter yield of test crops at 30 days after sowing

In many cases, the allelopathic influences of tree species were found to be species specific, however, in present investigation, germination, growth and dry matter content of all the test crops were severely suppressed by pulp extract of *S. cumini*, indicating that cultivation of cereals and pulses underneath the *S. cumini* trees is not economical. Earlier studies have also proved that legume test crops are most susceptible to phytotoxic response of tree crops than cereal crops: *O. sativa*, *Triticum aestivum* and *Hordeum* spp. (12, 14, 20). However in this study, all test crops were equally susceptible to toxic pulp extracts of *S. cumini*. Allelopathic effects of *S. cumini* might be attributed to the presence of phenolics, anthocyanins and flavonoid in its fruit pulp (1).

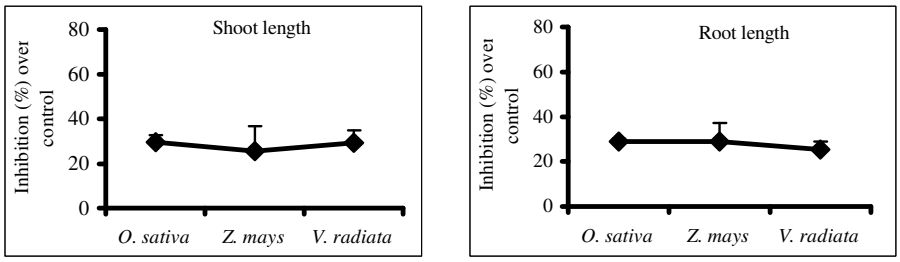

Figure 4. Inhibitory effects of aqueous pulp extracts of *Syzygium cumini* fruits on shoot length and root length of test crops at 30 days after sowing

CONCLUSIONS

The fruit pulp extract of *S. cumini* proved most toxic to germination, growth attributes and dry matter content of all test crops. The growing of *O. sativa*, when underneath the *S. cumini* tree caused significant reduction in yield. The susceptibility of test crops to toxicity of pulp extract of *S. cumini* followed the order : *O. sativa* > *Z. mays* > *V. radiata.* Further experiments are required to test the toxic impact of pulp extract of *S. cumini* on germination and yield of shade loving crops like turmeric, ginger, large cardamom etc.

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