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Original Research Article

Jatropha Curcas, Pongamia Pinnata Plantation with *Glycine Max* as Safe and Potent Green Energy Source

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Abstract: The exploration of alternative source *i.e.* green energy is being searched through growing non-edible oil yielding plants like *Jatropha curcas* and *Pongamia pinnata* in India. In the present investigation, the effect of leaf leachates of *Jatropha curcas* and *Pongamia pinnata* on *Glycine max var.* Pusa Komal-1042 have been carried out. % germination, root length, moisture content, vigour index, tolerance index and speed of germination of *G. max* increased with increasing concentration of *J. curcas* and *P. pinnata* leaf leachate up to 5% followed by a reduction, as compared to control. All parameters were found maximum in 2% leaf leachate of both *J. curcas* and *P. pinnata.* Hence, mixed cropping system i.e. *J. curcas* and *G. max* or *P. pinnata* and *G. max* could be recommended for national energy security, food security and environmental security.

Keywords: Glycine max, vigour index, tolerance index.

Introduction

Secure energy, environment and food are national priorities. Exploitation of fossil fuel has been increasing day by day due to mechanized life and it has threatened the environment. Hence, the exploitation of alternative eco-friendly source i.e. green energy (biodiesel) of compatible quality and cost is supposed to serve the purpose**.** Currently, the demand of edible oils of soyabean, corn and palm has risen tremendously in some countries for making bio-diesel affecting the prices of these crops. Rising food prices as a result of growing demand is a concern of global food security. India imported US dollar 2.4 billion worth of vegetable oils for edible purpose amounting to 63.4% of total agri-imports (www.esi.com) and it would not be prudent to use either edible oil or existing agricultural land for biodiesel. The development of non-edible oil based bio-diesel production can decrease the risk of food security by growing plants like *Jatropha curcas* and *Pongamia pinnata* in India (www.ceg.ncl.ac.uk, 2009). Thus, Agroforestry models where sustainable land management system that increases the yield of the land, combining the production of crops and forest plants simultaneously, on the same unit of land[5] are preferred.

Due to co-existence with the agricultural crops, the allelopathic compatibility of trees may be crucial to determine the success of an agroforestry system. A survey of the available information reveals that most of the agroforestry species have negative allelopathic effects on food and fodder crops by releasing allelochemicals, particularly phenolic acids affecting fundamental plant processes such as germination[18], growth, stomatal conductance, water utilization, chlorophyll synthesis, photosynthesis, protein synthesis, respiration[10] and membrane permeability[4]. Hence, in the present investigation the effect of leaf leachates of *J. curcas* and *P. pinnata* on *Glycine max* var. Pusa Komal – 1042 have been carried out, to further the researches aimed at searching for positive to neutral allelopathic agroforestry models.

Materials and Methods

The experiments were conducted at Department of Botany C.C.S. University Campus Meerut (Latitude 29^0 01'N; Longitude 77^0 43' E; 730 feet asl) in U.P. For the present study, the leachates were prepared by soaking 100 g of air dried senescent leaves each of *Jatropha curcas* and *Pongamia pinnata* in 1 litre of double distilled water separately for 24 hours at room temperature. The solution was filtered using whatmann filter paper No.40 and made up to 1 litre with double distilled water (i.e. 10% concentration) which was further diluted to 1, 2, 5, and 10% with the double distilled water.

Healthy seeds of *Glycine max* var. Pusa Komal-1042 were disinfected with 0.1% $HgCl_2$ solution for 5 minutes and washed 5-6

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times with distilled water to remove its traces. 150 healthy seeds (30 in each replicate) were allowed to germinate under each treatment (1, 2, 5 and 10% of *J. curcas* and *P. pinnata* leaf leachates) in thermocol bowls filled with washed and oven dried sand and were saturated on alternate days with 1, 2, 5 and 10% leachates at room temperature inside the laboratory. Distilled water treatment was used as control.

Morpho-physiological observations were recorded on 10th day after radicle emergence. Germination %, root length, shoot length, fresh weight, dry weight per seedling and moisture % were measured as per standard methods[8]. Germination speed was calculated according to ISTA (1976)[7].

$$\text{Germination Speed} = \frac{\%\ \text{Germination}}{\text{Day of completion of germination}} \times 100$$

Vigour Index was calculated according to the method adopted by Abdul Baki and Anderson (1973)[1].

$$\text{Vigour Index (V.I.)} = \text{Root length} + \text{Shoot length of seedling} \times \%\ \text{germination}$$

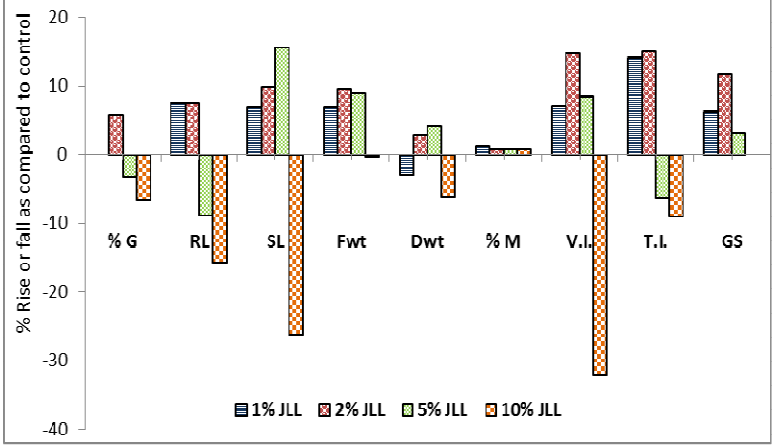
The tolerance index was calculated according to the formula given by Turner and Marshal (1972)[16].

$$\text{Tolerance Index} = \frac{\text{Mean length of longest root in test solution}}{\text{Mean length of longest root in control}} \times 100$$

Results and Discussion

Morpho-physiological attributes of *G. max* var. Pusa Komal-1042 were recorded in terms of % germination, root and shoot length, fresh and dry mass, vigour index, tolerance index and germination speed in leaf leachates of *J. curcas* and *P. pinnata*. Germination %, root length and tolerance index increased up to 2% leaf leachate treatment, while shoot length, biomass, moisture %, vigour index and germination speed increased up to 5% *J. curcas* leaf leachate and all these parameters decreased in the highest concentration used (10%) compared to control (Fig.1). It indicates that *J. curcas* leaf leachate is stimulatory for *G. max* growth at lower concentrations and inhibitory at higher concentrations. These results are in conformity with Channal *et al.,*(2002)[6] who reported that % germination, seedling length, seedling dry weight and vigour index of soyabean increased under the treatment of leaf extracts of *Tectona grandis, Tamarandus indica* and *Samania saman* at 5% and 10% concentration. Sherchan *et al.,* (1989)[12] reported that *J. curcas* biomass applied as green manure in rice fields, improved the crop yield. Sahoo *et al.,*(2009)[11] reported that *J. curcas* planted on boundaries of wheat fields do not show any adverse effect on crop yield but it supports healthy growth of natural vegetation. Singh *et al.,* (2013)[14] have also shown good growth of *Brassica campestris* grown with deoiled *J.curcas*.

Fig. 1: % Rise or fall in morpho-physiological attributes of 10 days old seedlings of *Glycine max* var. PK-1042 grown in different concentrations of *J.curcas* leaf leachate, as compared to control.



On the other hand, in *P. pinnata* leaf leachate germination %, shoot length, vigour index, tolerance index and germination speed of *G. max* var. P.K-1042 seedlings increased up to treatment with 5% and decreased in highest concentration (10%) of *P. pinnata* leaf leachate. Interestingly, the biomass (fresh and dry weight) of soyabean seedling increased in all treatments of *P. pinnata* leaf leachate (Fig.2). The results are in conformity with Tripathi *et al.,* (1998)[15] who reported that leaf extracts of *Tectona grandis, Albizia procera* and *Acacia nilotica* showed stimulatory effect on germination, growth, chlorophyll, protein, carbohydrate and proline content of soyabean. The results are also in conformity with Ahalavat and Vimala (2008)[2] who reported the stimulatory effect of *Populus deltoides* leaf extracts on percent germination, root length, shoot length and vigour index in French bean seedlings. Similar results were recorded by Konar (2003)[9] who reported that 2.5% leachate of mature senescent leaves of *P. pinnata* increased the chlorophyll, nitrogen content and biomass in *Costus speciosus* and promoted its growth with increase in diosgenin content.

Fig. 2: % Rise or fall in morpho-physiological attributes of 10 days old seedlings of *Glycine max* var. PK-1042 grown in different concentrations of *P. pinnata* leaf leachate, as compared to control.

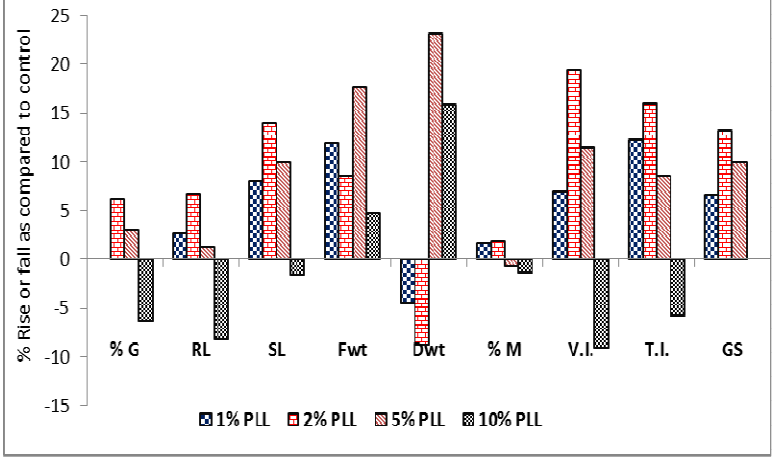
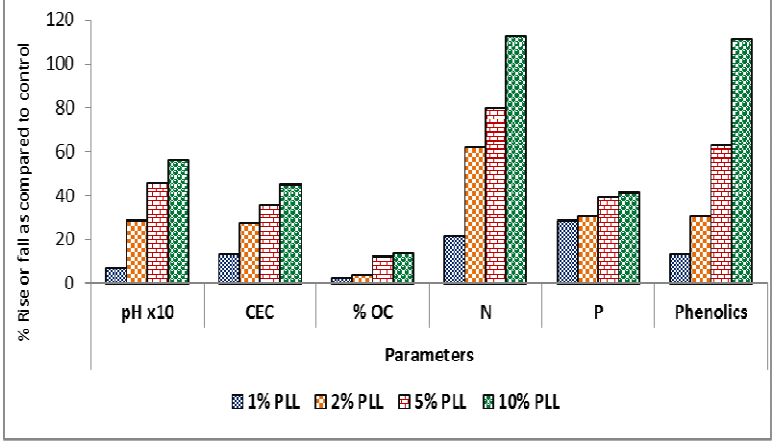
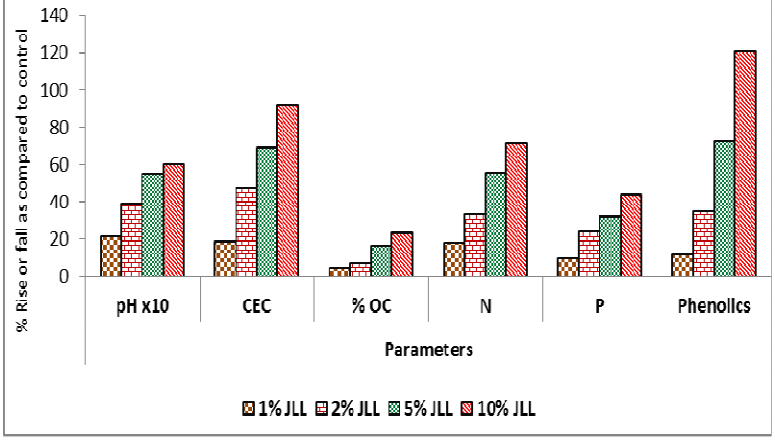


Fig.-4: % Rise or fall in physiochemical profile of sand suplemented with different concentrations of *P. pinnata* leaf leachate after 10 days of *Glycine max* var. PK-1042 seedling growth as compared to control.



Impact on fertility of soil: In sand treated with different concentrations of *J. curcas* and *P. pinnata* leaf leachates, pH, CEC, % OC, N, P and phenolics were recorded to increase with increase in concentrations of leaf leachates of both plants, as compared to control (Fig.3 & 4). Results of Shivakumar *et al.*,(2011)[13] also suggested that oil cake of pongamia, mahua and neem and NPK through inorganic fertilizers increases organic carbon, available N, P_2O_5 and K_2O of soil.

Fig.-3: % Rise or fall in physiochemical profile of sand suplemented with different concentrations of *J. curcas* leaf leachate after 10 days of *Glycine max* var. PK-1042 seedling growth as compared to control.



Conclusion

Leaf leachates of both *J. curcas* and *P. pinnata* are reported to exhibit promoting effect on seedlings of important edible oil yielding crop, *G. max* var. PK-1042, when applied in lower concentration, followed by an inhibition when applied in higher concentrations. All parameters were found maximum in 2% leaf leachate of both *J. curcas* and *P. pinnata*. This promotion may be due to the release of nutrients like organic carbon, nitrogen (N), phosphorous (P) and potassium (K) from the leaves of *J. curcas* and *P. pinnata* which are good source of these nutrients as reported by Ahalavat and Vimala (2010)[3] and Vimala and Ahalavat (2006)[17]. Higher concentration of leachate probably interferes with metal ion (nutrient) absorption and hence, becomes inhibitory for the studied crop plant.

Hence, mixed cropping system i.e. *J. curcas* and *G. max* or *P. pinnata* and *G. max* could be advised for national energy security, food security and environmental security.

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