

IMPACT OF *Vicia sativa* L. ALLELOPATHY ON THE GERMINATION AND EARLY GROWTH OF BLACK GRAM

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ABSTRACT

A laboratory experiment was conducted in 2013 at the Department of Botany, S.G.N. Govt. P.G. College, Muhammadabad Gohna, U.P., to determine the allelopathic influence of *Vicia sativa* aqueous extracts on black gram (*Vigna mungo* L.) seed germination and seedling development. Testing across multiple concentration levels (0%, 1%, 2%, 3%, and 4%) revealed a significant suppression of both germination and growth metrics compared to the untreated control. The most severe reductions in germination percentage, germination index, shoot and root lengths, seedling dry weight, and overall seedling vigour occurred at the 4% concentration level, which yielded statistically comparable results to the 3% treatment. Furthermore, HPLC profiling of the extract identified key phenolic compounds, including p-Coumaric acid, Ferulic acid, and 4-Hydroxy-3-Methoxybenzoic acid. Ultimately, this research confirms that the presence of these phenolics in *V. sativa* severely restricts black gram growth, highlighting the necessity of eradicating this weed from agricultural fields to prevent crop damage.

KEYWORDS: *Vigna mungo*, Seedling Development, Allelopathy, Germination, Phenolics

Allelopathy refers to the biological phenomenon where one plant influences the development of another through the emission of biochemicals into the surrounding environment (Rice, 1984). These secreted biochemicals, known as allelochemicals, are typically classified as secondary metabolites (Asaduzzaman *et al.*, 2010). Researchers have identified a vast array of these compounds, categorizing them based on their chemical structures into groups such as indoles, fatty acids, terpenes, alkaloids, and phenolics (Noguchi, 2008).

Phenolics represent a major category of allelochemicals known to significantly impact neighboring plants (Muzaffar *et al.*, 2012). Depending on their concentration, these compounds can either stimulate or suppress the germination and growth of receiving species (Hill *et al.*, 2006). Generally, elevated concentrations induce inhibitory effects (Femina *et al.*, 2012), whereas lower doses might actually promote plant growth and seed sprouting (Sahoo *et al.*, 2010). Allelochemicals are naturally released through various pathways, including volatilization from leaves, root exudation, leaf leaching, and the decay of plant litter (Narwal *et al.*, 2005). In agricultural settings, the primary mode of release is typically through leachates from decomposing plant residues (Singh *et al.*, 2001).

Vicia sativa is a widespread weed found across Asia, Europe, Australia, Africa, and the United States. It frequently invades winter crops like lentil, gram, barley, and winter vegetables, but it is most notoriously problematic in wheat fields (Ahmad and Shaikh, 2003). As a leguminous weed that completes its life cycle between October and March, it leaves substantial

biological residue in the soil. Black gram, an essential and highly nutritious pulse crop rich in protein, is often planted in succession after these winter crops. Consequently, leachates from leftover weed residues can severely impact the subsequent black gram crop. While previous studies have documented the significant allelopathic threat that various weeds pose to black gram (Dongre *et al.*, 2004), there is a lack of specific research evaluating the allelopathic interference of *V. sativa* on this specific pulse. Therefore, this study aims to assess how varying concentrations of *V. sativa* aqueous extracts influence the germination and early growth stages of black gram.

MATERIALS AND METHODS

An experiment was conducted to evaluate the allelopathic effect of *V. sativa* on germination and seedling growth of black gram in Laboratory, Department of Botany, SGN Govt. P.G. College, Muhammadabad Gohna, UP, during 2013. The experiment was laid out using completely randomized design with four replications. Whole plants of *V. sativa* were uprooted from wheat field at maturity. The plants were dried at room temperature followed by drying in oven at 70°C for 24 hours. The dried plants were cut into small pieces with the help of scissor. The dried small pieces of whole plants were soaked in distilled water in a ratio of 1:25 (w/v) at 25°C for 24 hours to prepare 4% aqueous water extract. The water extracts were filtered with sieve followed by filtration with Whatman No. 1 filter paper to obtain the uncontaminated aqueous water extract. The extract was poured in plastic bottle, tagged and used for bioassay studies. This prepared water extract was treated as stock

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solution and dilutions were made to perform experiment at different concentrations.

The experiment was conducted to assess the allelopathic effect of water extract of *V. sativa* at 1%, 2%, 3% and 4% concentrations on black gram. Ten seeds of the crops were placed on filter paper in Petri plates of 9 cm diameter, separately. In each Petri plate 5 ml of extract and distilled water as control was poured as per treatment. The Petri dishes were kept moistened during the whole period of study. The number of seeds germinated was counted on daily basis up to 5 days following the procedure of seedling evaluation in the Handbook of Association of Official Seed Analysts (AOSA, 1990). Seed was counted as germinated when the radical size was observed to be 2 mm. The germination percentage was calculated by using the following formula:

$$\text{Germination \%} = (\text{No. of germinated seeds} / \text{Total No. of seeds}) \times 100$$

The germination index was calculated according to the Association of Official Seed Analysts (AOSA, 1983) using the following formula:

$$\text{Germination Index} = N_i / D_i + \dots + N_f / D_f$$

Where N_i is number of seeds germinated on D_i (days of first count) and N_f is the number of seeds

Table 1: Allelopathic effect of water extract of *V. sativa* on germination percentage (%), germination index (days) and root length (cm), shoot length (cm), seedling dry weight (mg) and seedling vigour index of black gram

Treatment	Germination percentage	Germination index	Root length	Shoot length	Seedling dry weigh	Seedling vigour index
Control	91.00 a	9.12 a	3.24 a	10.21 a	32.23 a	294.84 a
1%	76.67 b	7.67 c	1.90 b	9.56 b	29.83 b	145.67 b
2%	91.00 a	9.10 b	1.47 c	4.30 c	29.30 c	113.15 c
3%	62.00 c	4.83 e	0.96 d	1.52 d	7.19 d	32.70 d
4%	62.00 c	5.50 d	0.94 e	1.33 e	5.83 e	19.95 e
LSD	12.328	1.201	0.195	0.969	4.278	29.140

Any two means not sharing a letter in common differ significantly at $p \leq 0.05$

DISCUSSION

The data clearly demonstrates that aqueous leaf extracts of *V. sativa* exert a strong, statistically significant inhibitory effect on black gram germination and seedling development when compared to the untreated control. This growth suppression is primarily driven by the allelochemicals present within the weed's tissues. Scientific literature indicates that these compounds restrict plant growth by disrupting cellular development, altering hormonal balances, and interfering with vital processes like photosynthesis, respiration, and enzyme activity (Li *et al.*, 2010; Muscolo *et al.*, 2001). Furthermore, Gao *et al.* (2011) documented similar

germinated on D_f (days of final count). At the completion of experiment the seedlings from each replication were taken, washed with water followed by measurement of root and shoot length of seedlings in centimetres. Seedlings were oven dried at 70°C and weighed using electric balance in milligrams till constant weight. Seedling vigour index was calculated using the equation of Abdul-Baki and Anderson (1973):

$$\text{SVI} = \text{Germination percentage} \times \text{Radical length}$$

RESULTS

The application of *V. sativa* leaf extract led to a marked, statistically significant decrease in both the germination and early development of black gram across the tested concentration levels. The lowest germination percentage occurred at the 4% concentration, which yielded results statistically identical to the 3% treatment. Similarly, the germination index was most severely suppressed by the 4% extract. All major growth metrics—including minimum root length, shoot length, seedling dry weight, and the seedling vigour index—reached their absolute lowest points under the 4% treatment, though the outcomes at 3% were statistically comparable (Table 1).

growth and germination inhibition in *Microcystis aeruginosa* due to phenolic exposure. Our observations closely align with the findings of Khan *et al.* (2011), who noted that *Silybum marianum* aqueous extracts suppressed the germination indices and seedling vigour of several legumes. Likewise, previous research by Dongre *et al.* (2004) and Kavitha and Arumugam (2012) confirmed that leachates from various other weeds drastically reduce root length, shoot length, and dry weight in black gram.

This study highlights a clear dose-dependent response: as the concentration of the *V. sativa* extract increased, the severity of the growth inhibition in the black gram increased correspondingly. This is a direct

result of the higher volume of allelochemicals present in the stronger dilutions. These findings are consistent with Dongre and Singh (2011), who tested weed leaf leachates on wheat at higher concentration brackets (5% to 20%) and noted severe growth restriction. Comparable dose-dependent allelopathic toxicity against wheat was also reported by Dongre and Singh (2007).

Interestingly, the data reveals that the seedling vigour index and overall germination were the parameters most vulnerable to the *V. sativa* extract. This points to a differential behavioural response within the plant's biological systems when subjected to allelopathic stress. This concept of differential susceptibility is reinforced by Katoch *et al.* (2012), who discovered that wheat and rice were much more negatively affected by weed extracts than maize was. Similarly, Chatiyanon *et al.* (2012) demonstrated varying levels of susceptibility among different seedling species when exposed to *Hyptis suaveolens* extracts.

CONCLUSION

The findings of this experiment confirm that aqueous leaf extracts of *V. sativa* possess potent allelopathic properties that severely restrict the germination and early seedling growth of black gram. HPLC analysis points to phenolic compounds as the primary agents responsible for this biological inhibition. Consequently, to protect pulse crops from these damaging secondary metabolites, proactive agricultural management is required to prevent *V. sativa* from establishing itself, and any remaining weed residues must be thoroughly cleared from fields prior to sowing.

REFERENCES

- Ahmad R. and Shaikh A.S., 2003. Common weeds of wheat and their control. *Pak. J. Water Res.*, **7**: 73-76.
- Asaduzzaman M., Islam M.M. and Sultana S., 2010. Allelopathy and allelochemicals in rice weed management. *Ban. Res. Pub. J.*, **4**: 1-14.
- Chatiyanon B., Tanee T., Talubmook C. and Wongwattana C., 2012. Effect of *Hyptis suaveolens* Poit leaf extracts on seed germination and seedling growth of *Pennisetum setosum* (Swartz.) L.C. Rich and *Mimosa invisa* Mart. *Agri. J.*, **7**: 17-20.
- Dongre P.N. and Singh A.K., 2007. Inhibitory effects of weeds on growth of wheat seedlings. *Allelopathy Journal*, **20(2)**: 387-394.
- Dongre P.N. and Singh A.K., 2011. Inhibitory allelopathic effects of weed leaf leachates on germination and seedling growth of wheat (*Triticum aestivum*). *Crop Res.*, **42(1,2 & 3)**: 27-34.
- Dongre P.N. and Singh A.K. and Chaubey K.S., 2004. Allelopathic effects of weed leaf leachates on seed germination of black gram (*Phaseolus mungo* L.). *Allelopathy Journal*, **14(1)**: 65-70.
- Femina D., Lakshmipriya P., Subha S. and Manonmani R., 2012. Allelopathic effects of weed (*Tridax procumbens* L.) extract on seed germination and seedling growth of some leguminous plants. *Intl. Res. J. Pharm.*, **3**: 90-95.
- Gao Y.N., Liu B.Y., Xu D., Zhou Q.H., Hu C.Y., Ge F.J., Zhang L.P. and Wu Z.B., 2011. Phenolic compounds exuded from two submerged fresh water macrophytes and their allelopathic effects on *Microcystis aeruginosa*. *Pol. J. Environ. Stud.*, **20**: 1153-1159.
- Hill E.C., Ngouajio M. and Nair M.G., 2006. Differential response of weeds and vegetable crops to aqueous extracts of hairy vetch and cowpea. *Hort Sci.*, **41**: 695-700.
- Katoch R., Singh A. and Thakur N., 2012. Allelopathic influence of dominant weeds of North-Western Himalayan region on common cereal crops. *Intl. J. Environ. Sci.*, **3**: 84-97.
- Kavitha D. and Arumugam K., 2012. Allelopathic potential of *Cynodon dactylon* (L.) Pers. and *Ammania baccifera* L. on growth and biochemical changes of black gram (*Vigna mungo* (L.) Hepper.). *Plant Archiv.*, **12**: 891-897.
- Khan R., Khan M.A., Waheedullah, Waqas M., Khan A.M., Hussain Z., Khan A. and Raza M.A., 2011. Allelopathic potential of *Silybum marianum* L. against the seed germination of edible legumes. *Pak. J. Weed Sci. Res.*, **17**: 293-302.
- Li Z.H., Wang Q., Ruan X., Pan C.D. and Jiang D.A., 2010. Phenolics and plant allelopathy. *Molecules* **15**: 8933-8952.
- Muscolo A., Panuccio M.R. and Sidari M., 2001. The effects of phenols on respiratory enzymes in seed germination-respiratory enzyme activities during germination of *Pinus laricio* seed treated with phenols extracted from different forest soils. *Plant Growth Regul.*, **35**: 31-35.
- Muzaffar S., Barkat A. and Niyaz A.W., 2012. effect of catechol, gallic acid and pyrogallol on the

- germination, seedling growth and the level of endogenous phenolics in cucumber (*Cucumis sativus* L.). Intl. J. Life Sci. Biotech. Pharm Res., **1**: 50-55.
- Narwal S.S., Palaniraj R. and Sati S.C., 2005. Role of allelopathy in crop production. Herb, **6**: 4-23.
- Noguchi H.K., 2008. Allelochemicals released from rice plants. Jap. J. Plant Sci., **2**: 18-25.
- Rice E.L., 1984. Allelopathy, 2nd Ed. *Academic Press*, London, UK.
- Sahoo U.K., Jeecelee L., Vanlalhriatpuia K., Upadhyaya K. and Lalremruati J.H., 2010. Allelopathic effects of leaf leachate of *Mangifera indica* L. on initial growth parameters of few home garden food crops. World Appl. Sci. J., **10**: 1438-1447.
- Singh H.P., Batish D.R. and Kohli R.K., 2001. Allelopathy in Agroecosystems: An overview. J Crop Prod., **4**: 1-41.