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Allelopathic Effect of Sesame Varieties on Germination and Seedling Growth of Cowpea and Okra

Arunima Babu C.S., Sheeja K. Raj*, Jacob D.[1] and Shalini Pillai P.

Department of Agronomy, College of Agriculture, Vellayani- 695 522, India
[1]On Farm Research Centre, Kayamkulam- 690 502, India
**E-mail: sheeja.raj@kau.in*

Abstract: A study was undertaken to examine the allelopathic effect of leachates prepared using different sesame varieties of India on germination and seedling growth of cowpea and okra seeds. The allelopathic potential of sesame varied with the varieties. The leachates of sesame varieties reduced the germination percentage of cowpea and okra by 5 to 62.5 % and 8.33 to 53.85 %, respectively, compared to control. Impairment of metabolic activities due to the application of leachates resulted in decreased root and shoot length of both the test crops. Compared to control, the leachates inhibited the seedling fresh weight by 23.02 to 55.77 % and 7.27 to 52.73 %, respectively in cowpea and okra. The sesame varieties, GT-10 and TMV-7 recorded the highest inhibitory effect on the germination parameters, seedling growth attributes, soluble protein content and ascorbic acid content of both the test crops. The presence of higher concentration of allelochemicals like phenolic acids, flavonoids, alkaloids etc. in the varieties might have attributed the inhibitory effect. Therefore, cowpea and okra might not be suitable for sequential cropping with sesame.

Keywords: Allelochemicals, Germination, Inhibition, Leachate, Sesame

Allelopathy refers to the effect of plants on other plants in its vicinity or associated microflora/microfauna through the release of allelochemicals that intercede with the growth of plants (IAS 2018). Allelochemicals are secondary metabolites that possess defence against microbial and herbivore attack or competition from other plants (Kong et al 2019) and directly affect neighbouring plants by disrupting germination and seedling growth (Zhang et al 2020). The complex allelopathic inhibition involves interaction of different chemical classes, such as phenolic compounds, terpenoids, alkaloids and nitrogen containing compounds (Palaniswamy et al 2020). Allelopathic crops in the intercropping system, release allelochemicals into the environment *via* root exudation, volatilization, leaching or decay of crop debris. Allelopathy is considered as a chemical warfare amongst several plant species in which various biochemical and physiological processes like cell division and elongation, respiration, photosynthesis, enzyme activity, water relations, hormone levels, mineral availability and antioxidant system are affected (Zeng et al 2001). Sesame belong to Pedaliaceae family, encompasses a wide range of allelopathic properties and contains allelochemicals like phenols, saponins, flavonoids, tannins and alkaloids (Fasola and Ogunsola 2014). The alleochemicals present in sesame whole plant extracts *viz*., terpenes, hydrocarbons, fatty acids, phenolic acids and alkaloids delayed growth and germination of canola (Soleymani and Shahrajabian 2012). Allelopathic effects varied among different varieties of the same crop and study on the allelopathic effect of different sesame varieties on other crops are scanty. Sesame is usually raised in the summer rice fallows and followed by vegetables like cowpea and okra in Kerala. A study was conducted to envisage the effect of leachates from different sesame varieties on germination and seedling growth of cowpea and okra.

MATERIAL AND METHODS

Seeds of sesame varieties, Kayamkulam- 1, Thilathara, Thilarani, and Thilak, were procured from Onattukara Regional Agricultural Research Station (ORARS), Kerala, varieties, GT- 3, GT -5 and PKDS-8 from All India Coordinated Research Project (AICRP) on Sesame and Niger, Jabalpur, variety GT -10 from Agricultural Research Station (ARS), Amreli and varieties, TMV- 7, TMV -5 and VRI-1 from Regional Research Station (RRS), Vridhachalam. All the varieties were black seeded. The crop was raised at College of Agriculture, Vellayani from June to August 2022. The site was located at 8°30'N latitude, 76°54'E longitude and at an altitude of 29 m above mean sea level. Fresh plant samples were collected at active growth stage (30 DAS) for the conduct of experiment. The samples were thoroughly washed with water to remove the soil and dirt adhered to it. Allelopathic study was conducted using whole plant leachate of different sesame varieties.

Preparation of leachate: Sesame varieties were chopped separately into small pieces of 2 cm length using a plant cutter. The leachates of 1:10 (w/v) concentration was prepared by soaking 100 g of each variety in 1000 mL distilled water for 72 h (Tomar et al 2015). The leachates were filtered using Whatman No.1 filter paper (pore size 11 µm) was used for treating cowpea and okra seeds.

Bioassay: Cowpea variety Vellayani Geethika and okra variety Salkeerthi were used as the test crops for bioassay. Ten seeds of each test crop were placed in the petri dish of diameter 9 cm, lined with filter paper**.** The filter paper was moistened with 5 mL of leachate prepared from eleven sesame varieties in alternate days. Petri dish moistened using distilled water was taken as control. The experiment was replicated 4 times and repeated twice for confirmation. The seeds of okra and cowpea were kept for germination, for a period of 21 days and 8 days, respectively (Agrawal 1994). Seeds with emerged radicle (2mm) were considered as germinated. Observations on the number of seeds germinated, seedling shoot and root length, seedling fresh and dry weight were recorded. The seedlings were dried in hot air oven at 65 ± 5°C to record the dry weight. From the above observations, germination percentage, seedling vigour index I and seedling vigour index II were computed.

1. Seedling vigor index I (SVI I) = Seedling length (cm) × Germination percentage
2. Seedling vigor index II (SVI II) = Seedling dry weight (g) × Germination percentage

The soluble protein content (mg/g) of cowpea and okra seedlings were estimated by Bradford, simple protein- dye binding bioassay using bovine serum albumin as standard. The ascorbic acid content of the test plants was volumetrically estimated by the method developed by Sadasivam and Manickam (2008) and expressed in mg/100g.

Statistical analysis: The statistical analysis was done using grapes Agri 1 software (Gopinath et al 2021).

RESULTS AND DISCUSSION

Germination parameters of cowpea and okra: The leachates prepared from different varieties had an inhibitory effect on germination parameters *viz*., germination percentage, SVI-I and SVI-II of both the test crops. Leachate prepared using variety GT-10 recorded the lowest germination percentage in cowpea (37.50 %) and was statistically comparable with TMV-5 (42.50 %). Sesame variety GT- 10 recorded the lowest SVI-I and SVI-II (111.00 and 4.26 respectively) and was statistically on par with TMV-5 (146.25 and 5.09 respectively). The SVI-I and SVI-II of cowpea seedlings treated with GT- 10 were 85.15 and 78.52 % lower than control (Table 1). The lowest germination percentage in okra was observed with the leachate prepared using TMV-5 (45.00 %) and was on par with GT-10 (50.00 %). The lowest SVI-I in okra was recorded by TMV-5 (222.75) which was statistically on par with GT-10. The SVI-I of okra seedlings treated with TMV-5 was 77.44% lower than control. However, the lowest SVI-II was in GT- 10 (0.69) which was statistically comparable with TMV-5. The SVI-II of okra seedlings treated with TMV-5 was 96.43 % lower than control. Oudhia and Tripathi (2000) observed that, sesame leaf extract (1:10 w/v) had significant inhibitory effect on germination and seedling vigour of rice. Duary (2002) documented the inhibitory effect of sesame leaf extract on

Table 1. Effect of leachates on germination of cowpea and okra

Varieties	Germination percentage		SVI I		SVI II	
	Cowpea	Okra	Cowpea	Okra	Cowpea	Okra
Kayamkulam-1	75.00	85.00	391.25	614.50	12.10	15.61
Thilathara	87.50	70.00	453.25	495.60	13.62	10.50
Thilarani	90.00	67.50	472.50	531.50	14.24	10.41
Thilak	67.50	77.50	342.00	571.50	12.89	10.86
GT-10	37.50	50.00	111.00	240.25	4.26	0.69
TMV-7	77.50	62.50	372.75	520.50	11.67	11.22
TMV-5	42.50	45.00	146.25	222.75	5.09	0.81
GT-3	50.00	57.50	178.00	413.75	6.46	10.09
GT-5	82.50	75.00	344.75	521.75	10.82	10.84
PKDS-8	87.50	82.50	521.25	729.25	15.75	14.85
VRI-1	95.00	90.00	567.25	781.00	15.96	16.94
Control	100.00	97.50	747.50	987.50	19.83	19.33
LSD (p=0.05)	8.736	11.128	54.211	92.174	1.593	1.854

seed germination, seedling growth and dry matter production of black gram and rice. Sesame contains 776 secondary metabolites, among which phenolic acids (18 %), lipids (16 %), flavonoids (14 %), organic acids (9 %) and amino acid derivatives (9 %) are dominant (Dossou et al 2021).

High level of phenolic compounds delay seed germination, enhances cell membrane permeability, lipid peroxidation and seed mortality (John 2012). The inhibition on germination of cowpea and okra seeds by application of leachates prepared from varieties GT-10 and TMV-5 might be due to the presence of higher concentration of secondary metabolites in the varieties. The phenolic acids in sesame leachate inhibit the activity of gibberellic acid by triggering the activity of abscisic acid, salicylic acid and jasmonic acid and thus inhibiting the seed germination (Kang et al 2015). Sesame leaves contains chemical compounds like epigallocatechin, 3-epibartogenic acid and kaempferol derivatives that hinder the activity of α- amylase, required for seed germination (Dat et al 2016). Bais et al (2003) observed that allelochemicals inhibit the germination parameters by triggering the production of reactive oxygen species (ROS) which cause a cascade of Ca^{2+} signaling that lead to genomic changes and lethal effects on the plant.

Seedling growth parameters of cowpea and okra: The shoot length of cowpea seedlings was significantly inhibited by GT-10 (1.20 cm) which was on par with GT-3 (1.43 cm). The lowest seedling root length was observed in GT- 10 (1.75 cm) which was comparable with TMV-5 (1.88 cm). The fresh weight and dry weight of seedlings were significantly decreased by the application of leachate prepared using variety GT-10, (0.23 g and 0.11 g respectively) which was on par withTMV-5 (0.25 and 0.12 g) (Table 2). Similar trend was observed in okra also. Leachate prepared using variety GT-10 (2.85 cm) recorded the lowest seedling shoot length which was on par with TMV-5. The root length of okra seedlings was significantly inhibited by GT- 10 (1.98 cm) which was statistically comparable with TMV-5. The fresh weight (0.26 g) and dry weight (0.01g) of okra seedlings were significantly decreased by the application of GT-10 leachate. It was statistically on par with TMV-5, for fresh weight and dry weight, respectively. Zhu et al (2005) opined that allelopathic response of plants depends on the type and concentration of allelochemicals. The leachates of TMV-5 and GT-10 might have contained higher concentration of allelochemicals, which lead to higher level of inhibition. Impaired metabolic activities in response to allelochemicals might have decreased shoot length and root length of both the test crops. Shah et al (2016) revealed that sesame had an inhibitory effect on the growth and yield attributes of green gram grown in replacement series. Premature lignification caused by allelochemicals results in arrested growth of plants (Santosh et al 2004). The phenolic allelochemicals inhibits cell division, alters the cell structure and could impede the absorption of water and nutrients leading to production of dwarf plants (John 2012, Scavo et al 2018).

Ascorbic acid and soluble protein content of cowpea and okra: The soluble protein content and ascorbic acid content of cowpea and okra varied significantly in response to application of different leachates (Fig. 1 and 2). The soluble protein content of cowpea seedlings was significantly decreased by the application of GT-10 (0.29 mg/g) which was on par with TMV-5. While, GT-10 (0.22 mg/g) recorded the

Table 2. Effect of leachates on seedling growth of cowpea and okra

Varieties	Seedling shoot length (cm)		Seedling root length (cm)		Seedling fresh weight (g)		Seedling dry weight (g)	
	Cowpea	Okra	Cowpea	Okra	Cowpea	Okra	Cowpea	Okra
Kayamkulam-1	2.25	4.18	2.98	3.05	0.32	0.51	0.16	0.18
Thilathara	2.48	3.85	2.70	3.23	0.35	0.35	0.16	0.15
Thilarani	2.33	5.10	2.93	2.78	0.34	0.34	0.16	0.15
Thilak	2.25	4.43	2.83	2.95	0.39	0.36	0.19	0.14
GT-10	1.20	2.85	1.75	1.98	0.23	0.26	0.11	0.01
TMV-7	2.35	5.38	2.45	2.95	0.40	0.51	0.15	0.18
TMV-5	1.55	2.93	1.88	2.03	0.25	0.28	0.12	0.02
-3	1.43	4.23	2.15	3.00	0.29	0.47	0.13	0.18
GT-5	1.95	4.18	2.23	2.78	0.29	0.36	0.13	0.15
PKDS-8	2.88	5.55	3.08	3.28	0.39	0.46	0.18	0.18
VRI-1	2.78	5.63	3.20	3.05	0.36	0.45	0.17	0.19
Control	3.35	6.30	4.13	3.83	0.52	0.55	0.20	0.20
LSD (p=0.05)	0.251	0.340	0.306	0.327	0.032	0.032	0.009	0.006

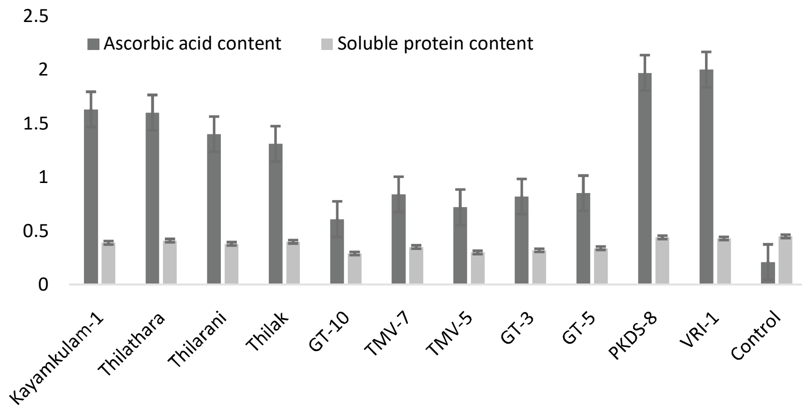

Fig. 1. Effect of sesame leachate on ascorbic acid content (mg/100g) and soluble protein content (mg/g) of cowpea

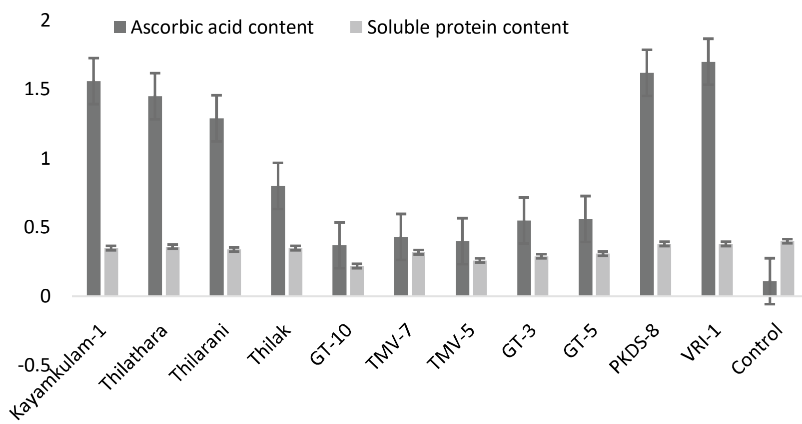

Fig. 2. Effect of sesame leachate on ascorbic acid content (mg/100g) and soluble protein content (mg/g) of okra

lowest soluble protein content in okra seedlings. The reduction in soluble protein content of both the test crops were attributed to the oxidative damage imparted with the application of leachates. The seedlings of the test crops with the lowest soluble protein content recorded the lowest growth parameters. Allelochemicals like phenolics could inhibit the amino acid transport, protein synthesis and subsequent growth of plants (He and Lin 2001). The ascorbic acid content was significantly lower for cowpea seedlings treated with GT-10 (0.61 mg/100g), which was on par with TMV-5. Similar trend was observed in okra also. The lowest ascorbic acid content in okra was recorded by the application of GT-10 (0.37 mg/100g) which was statistically on par with TMV-5 and TMV -7. The non -enzymatic anti-oxidant, ascorbic acid was produced as a defensive mechanism against the phytotoxic stress induced by the allelochemicals present in the leachates. The ascorbic acid content was remarkably reduced by the application leachate prepared from varieties GT- 10 and TMV-5. The decrease in the antioxidant content might have impeded the germination and seedling growth.

CONCLUSION

The inhibitory effect of leachates from different sesame varieties on germination and growth of cowpea and okra revealed that leachates prepared using varieties GT-10 and TMV-5 significantly inhibited germination and growth of both the test crops. The allelopathic compounds in sesame leachates like phenolic acids, flavonoids, alkaloids and nitrogen compounds might have attributed to the inhibitory response. The study indicate that cowpea and okra is not suitable for simultaneous cropping or sequential cropping with sesame.

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