



***Parthenium hysterophorus* L. compost: Assessment of its Physical Properties and Allelopathic effect on Germination and Growth of *Arachis hypogaea* L.**

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Abstract

This work was designed to determine the physical properties of *Parthenium hysterophorus* L. mediated compost and analysis of its allelopathic effect on germination and growth of *Arachis hypogaea* L. We investigated various physical properties of compost such as pH, electrical conductivity, moisture content, percent pore space, bulk density, particle density were analysed. In addition to seed germination, radicle length and plumule length of *Arachis hypogaea* L. were determined for allelopathic effect of *Parthenium* mediated compost. Various concentration of cow dung and *Parthenium* mixed compost as well as parthenium alone compost were prepared. This experiment reports that 60th day old compost, the highest concentration of cow dung mixed parthenium (parthenium: cow dung) (1:4 and 1:3) compost respectively showed similar soil physical properties along with 96% of seed germination, highest growth level of radicles (87.2 and 85.3 mm) and plumule length (22 and 21.8 mm) when compared to other treatments and control.

Keywords: Allelopathic effect; *Arachis hypogaea*; Compost; Growth; *Parthenium*; Physical properties.

Introduction

Parthenium hysterophorus L. (family Asteraceae) is one of the worst weeds in the world¹. It has spread to almost every part of India². It is a poisonous, pernicious and aggressive weed and is reported to have pharmacological properties against many diseases such as rheumatism, hepatic amoebiasis and tumours³⁻⁵. On other hand, *Parthenium* is known to badly affect crop production, biodiversity, animal husbandry, human health and even ecosystem integrity⁶⁻⁹.

It has some water soluble allelopathic chemicals such as phenolic acids and parthenin—a sesquiterpene lactone of pseudoguanolide nature in various parts of the weed^{10,11}. Some researcher has been reported about allelopathic nature of *Parthenium*^{6,9,12,13,14,15}.

Naeem et al. (2012)¹⁶ carried out the allelopathic effects of root, stem and leaf aqueous extracts of parthenium (*Parthenium hysterophorus* L.) on the germination and seedling growth of four wheat cultivars (viz. Siran, Ata Habib, Sahar and Lasani) and concluded most inhibited by the parthenium root, stem and leaf extracts. Effect of *Parthenium hysterophorus* ash effect on germination, plumule and radicle length and biomass production of *Phaseolus mungo* has been reported¹⁷. Aqueous extracts of shoot (stem + branch), leaf, flower and root of *Parthenium hysterophorus* L. at different concentrations were applied on seeds of soybean (*Glycine max* L.) and haricot bean (*Phaseolus vulgaris* L.) to study their effect on percent germination, germination rate, and seedling growth (shoot and root length) and dry matter production

under laboratory conditions¹⁸. Parthenin is quickly degraded with a half life (DT50) of 59 h in soil¹⁹ however; phenols require treatment for their removal from soil and compost.

Biradar et al. (2006)²⁰ and Son²¹ reported that the high level of N, P and K in *Parthenium* compost. *Parthenium* compost contains two times more nitrogen, phosphorus and potassium than farm yard manure²². High concentration of macro and micro nutrients such as N, P, K, Fe, Mn, Cu and Zn in composted *Parthenium* may increase crop yields²³. Apurva et al.²⁴ demonstrated reduction of phenolic content in parthenium compost with help of millipede. *Parthenium* can be used as a soil supplement after removal of harmful allelochemicals. This study report the physical properties and allelopathic effects of *parthenium* compost and to investigate whether parthenium composted with different concentrations of cow dung at different time intervals have an authority on allelopathic inhibitory potential of parthenin.

Material and Methods

Raw material: Before flowering fresh *P. hysterophorus* L. were collected from in and around fallow lands of Coimbatore, Tamil Nadu, India. These weeds were chopped into small pieces. The inoculums were essentially composed of weeds and cow dung.

Composting: This study was carried out by using a factorial design on the basis of complete randomized block design with three replications at Karpagam University campus, Coimbatore (11°16'N; 76°58'E), Tamil Nadu from March-

June, 2012. The inoculums were prepared by mixing chopped parthenium and cow dung at different ratios of 1:1, 1:2, 1:3, 1:4, 2:1, 3:1 and 4:1 (w/w). Mixed compost ingredients were added and put into separate tank (1 m depths). Parthenium and cow dung were composted alone also. The tanks were covered with jute bags on the top to maintain proper heat and humidity. Moisture content was maintained by sprinkling water. A thorough turning was made after 15 days. It was taken out after 45 and 60 days.

Seed collection: *Arachis hypogaea* L.-Co-6 (Ground nut) seeds were obtained from Tamil Nadu Agricultural University, Coimbatore, Tamil nadu, India. The identical seeds were chosen for the tests where as undeveloped and damaged seeds were discarded. A preliminary test on seed germination was done and it ranged from 80% to 100%.

Analysis of physical properties: The physical properties such as pH, electrical conductivity (dSm^{-1}), moisture content (%), percent pore space, bulk density (Mg m^{-3}), and particle density (Mg m^{-3}) were analysed according to Jackson (1973)²⁵.

Seed germination and seedling growth tests: To assess the allelopathic effects of composts, seed (*Arachis hypogaea*) germination study was conducted in plastic pots with mixture of (1:3) composted material and soil and kept under laboratory conditions. Seeds were surface-sterilized with 1% sodium hypochlorite solution for 5 min by shaking and washed with de-ionized water three min before use. After 10 days of germination, radicle, plumule length and percentage of seed germination²⁶ were estimated.

Data analysis: The experiments were carried out in a randomized complete block design (RCBD) method with three replications. The study was conducted twice and the average data was used for analysis.

Results and Discussion

Weeds were collected for composting and separately treated to reduce their allelopathic effects. It was collected before flowering for its soft stem and easy to compost with in a short period. Tejinder et al. (2012)²⁷ used parthenium for compost preparation and suggested that before flowering parthenium were prolific seed producers and their flowers are rich source of allelochemicals and it is difficult to handle them after flowering.

The physical properties of 45th and 60th day's old compost are shown in Table 1. The 45th day's old compost was slightly acidic and at 60th days old compost pH increased from acidic to moderately alkaline (pH-7.8). These changes in pH values may be due to mineralization and decomposition of organic matter into intermediates of organic acids²⁸. These processes regulate the pH of compost important to a shift of pH towards neutrality, which is similar earlier studies^{27,29}. Other physical properties like electrical conductivity (dSm^{-1}), moisture content (%), percent pore space, bulk density (Mg m^{-3}), and particle density (Mg m^{-3}) were very similar to control soil at the concentration of 1: 4 and 1: 3 in 60th days old compost and slight variation was observed in parthenium alone treatment and other treatments in same day old compost. Similar results were reported by Ganga Suresh et al. (2011)³⁰ and that occurs due to enzymes, minerals and microbial growth.

Percentage of germination, radicle and plumule lengths of *Arachis hypogaea* greatly increased in 60th day's old compost when compared with 45th days old compost. The 60th days old compost significantly reduced allelopathic inhibitory effects of parthenium. Allelochemicals such as parthenin and phenols degraded at huge level in 60th day's old compost. Percentage of groundnut germination was significantly reduced by fresh parthenium. But, parthenium alone compost has moderate inhibition effect on germination percentage compared to other treatments.

Table-1

Physical analysis of composts 1:1, 2:1, 3:1, 4:1, 2:1, 3:1 and 4:1 (w/w) (Parthenium: cow dung); P.a-Parthenium alone, 1-pH; 2-electrical conductivity (dSm^{-1}); 3-moisture content (%); 4-percent pore space; 5-bulk density (Mg m^{-3}); 6-particle density (Mg m^{-3}). Values are Mean of three different experiments

Treatment	Test ratio	45 th day						60 th day					
		1	2	3	4	5	6	1	2	3	4	5	6
T1	1:1	6.60	0.32	26.15	52.12	0.42	0.92	6.80	0.35	29.16	53.8	0.50	1.42
T2	1:2	6.68	0.30	22.46	53.8	0.85	0.95	6.86	0.34	57.65	54.4	0.83	1.42
T3	1:3	6.75	0.35	26.87	61.1	0.87	0.93	6.92	0.38	38.62	64.0	0.55	1.42
T4	1:4	6.84	0.36	30.42	65.0	0.90	0.96	7.68	0.41	33.61	66.8	0.71	1.11
T5	2:1	6.69	0.20	30.02	59.2	0.83	0.91	6.72	0.30	33.86	45.2	0.83	1.42
T6	3:1	6.52	0.20	42.54	53.2	0.80	0.85	6.66	0.30	54.35	44.6	0.85	1.11
T7	4:1	6.46	0.20	42.10	51.0	0.80	0.73	6.60	0.26	53.22	43.8	0.55	0.90
T8	P.a	6.50	0.20	41.25	41.0	0.32	0.82	6.52	0.20	45.25	42.3	0.50	0.90
T9	Soil (control)	7.82	0.38	35.42	50.0	0.64	1.10	7.82	0.38	35.42	50.0	0.64	1.10

The 45th days old compost of all treatments was very sensitive to *Arachis hypogaeae* germination and radicle and plumule elongation. Tejinder et al.²⁷ reported that 30 days of composting increased enzyme activities which may be involved in degradable substances and improve the growth of microbes and its activities in the initial stage. Adani et al.³¹ found that the decreased enzymatic activities in the later stages may be due to deficiency of suitable carbon compounds for microorganisms. Decrease in inhibitory activity of the allelochemicals over time is usually related to degradation mostly by soil microorganisms^{32,33}.

Figure 1 shows germination percentage *Arachis hypogaeae* of a considerable effect of composting of parthenium with different ratio of cow dung and it was found that germination percentage was hardly reduced by use of fresh parthenium. On the other hand, composting parthenium with cow dung (1:4) ratios resulted in a similar germination percentage in control. Tiquia³⁴; Zucconi et al.²⁶ evaluated the phytotoxicity effect of compost through germination index. Seed germination and root development affected by various heavy metals, ammonia and/or low molecular weight organic compounds in compost has been reported by Brinton³⁵.

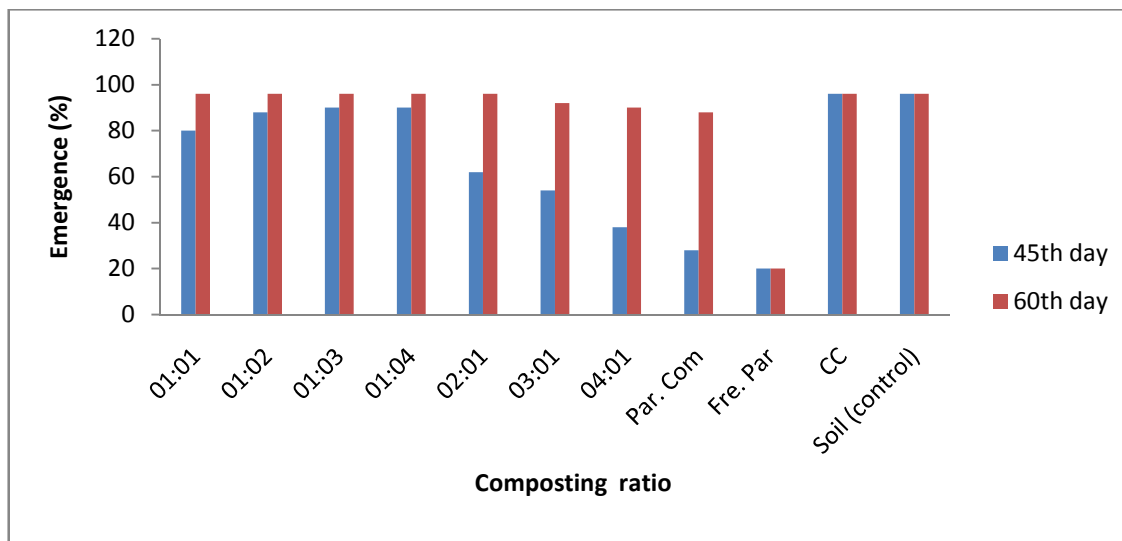


Figure-1

Assessment of allelopathic potential of parthenium composted with cow dung at different ratios on seed germination percentage. Par. Com- Parthenium Compost; Fre. Par-Fresh Parthenium; CC-Cow dung Compost. Values are Mean ± S.D of three different experiments

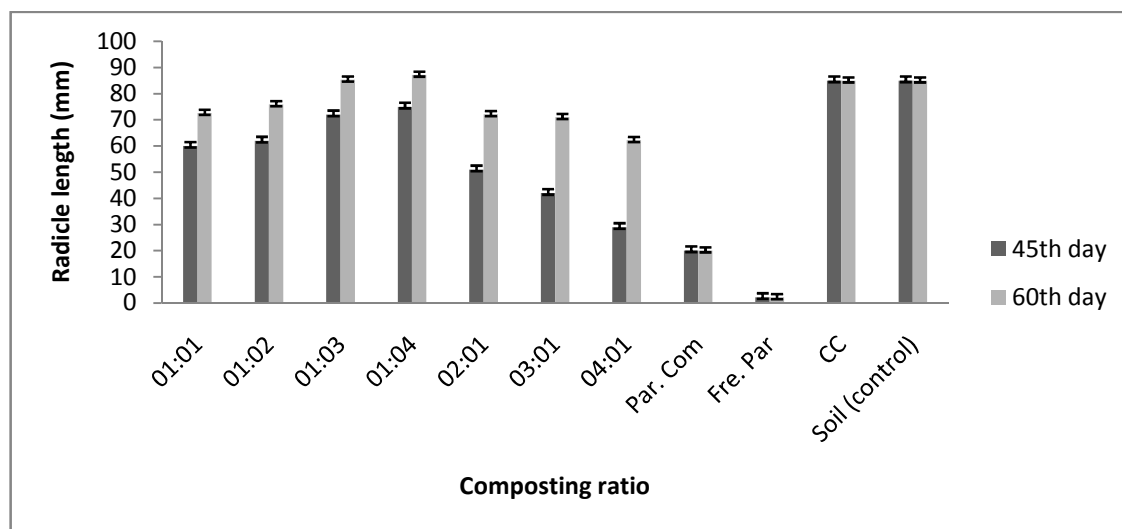


Figure-2

Assessment of allelopathic potential of parthenium composted with cow dung at different ratios on radicle length. Par. Com- Parthenium Compost; Fre. Par-Fresh Parthenium; CC-Cow dung Compost. Values are Mean ± S.D of three different experiments

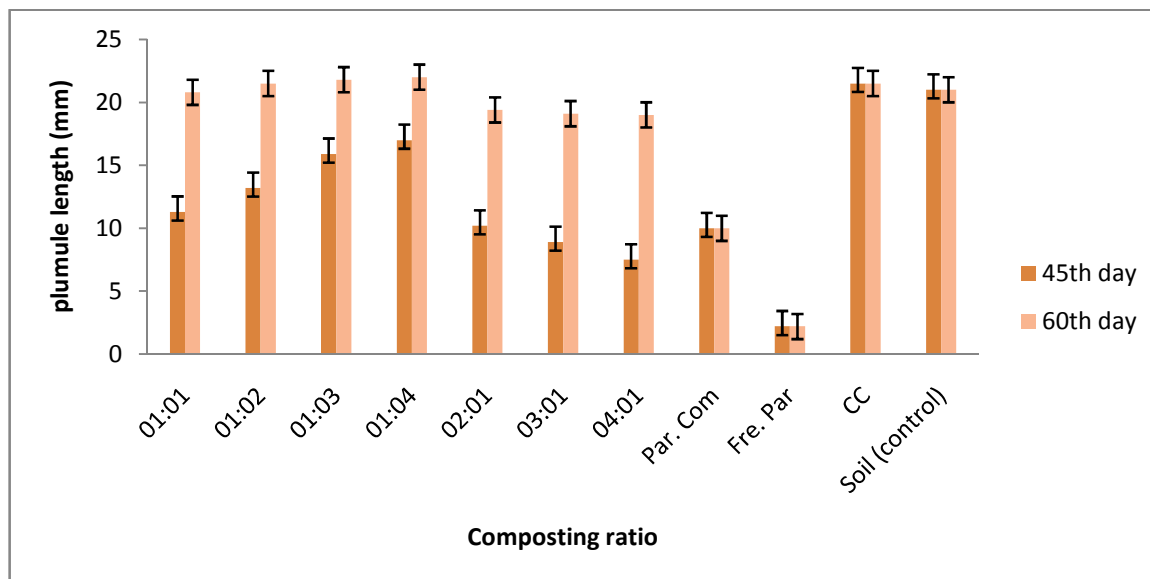


Figure-3

Assessment of allelopathic potential of parthenium composted with cow dung at different ratios on plumule length. Par. Com- Parthenium Compost; Fre. Par-Fresh Parthenium; CC-Cow dung Compost. Values are Mean \pm S.D of three different experiments

The different ratio of cow dung and constant level of parthenium (1:2, 1:3 and 1:4) significantly increased radicle (figure 2) and plumule lengths (figure 3) in 45th and 60th day's old compost, when compared to control. Conversely, radicle and plumule length was greatly inhibited by fresh parthenium followed by parthenium composted without cow dung and other treatments (2:1, 3:1 and 4:1) (figure 2 and 3) at 45th and 60th days old compost. Mulatu et al. (2009)³⁶ reported the increase in lettuce emergence rate, radicle and plumule lengths in parthenium compost at different concentrations of other plants. Tejinder et al. (2012)²⁷ found a significant increase in germination index of both *V. radiata* and *Triticum* seeds. And seeds of *V. radiata* had highest germination index with 60 days old compost but *Triticum* seeds showed similar germination index in both 30 and 60 days old combined compost

Conclusion

The innovation of this work is that compost formed from a combination of weed and cow dung and compost had enhanced nutrient value and increased germination percentage of *Arachis hypogaeae* in assessment to their individual controls because high levels of cow dung, induce growth of microbes and reduce the allelopathic potential of parthenium. It can be used as a wealthy source of nutrients because the toxicity is due to allelochemicals could be minimized.

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