



## Allelopathic effect of *parthenium hysterophores* plant and its component on the growth attributes of greengram and soybean

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### Abstract

Parthenium is known for its allelopathic potential on other plants including weeds and crops by releasing allelochemicals into its environment directly from aerial parts through washing of the plants by rain and/or through roots and/or by decay of the plants and remaining residue in soil. The extracts of various parts of parthenium plants namely leaves, flowers, stem and roots, as well as whole plant were assessed for their allelopathic effect on two leguminous plants namely greengram and soybean. Six different treatments were set up with the aqueous extracts (1% and 10%) of the various plant parts of parthenium, whole plant and parthenium vermicompost. The seedlings of green gram and soybean were allowed to grow for a period of 60 and 75 days respectively and uprooted at different time intervals, and analysed for various biometric and yield parameters. In both the crop plants studied, all the yield characters were influenced to a maximum level with the 1% and 10% parthenium compost application. Among the weed extracts, flower, followed by whole plant extracts, exhibited maximum number of pods per plant and pod length. The highest number of seeds per pod was observed in the crop plants, which received whole plant extract of parthenium both at 1% and 10% levels.

### Keywords:

Parthenium, Allelopathic Potential, Allochemicals, Vermicompost

### Introduction:

Allelopathy is relatively a new branch of science and is defined as a direct or indirect harmful or beneficial effect of one plant on another through the production of chemical compounds released to the environment (Oudhia, 2000; Rice, 1984). The secondary metabolites produced by plants (donors) when released into the environment, play a key role in ecology, physiology and growth of other plants (recipients) in their vicinity (Singh and Rao, 2003). Parthenium is known for its allelopathic potential on other plants including weeds and crops by releasing allelochemicals into its environment directly from aerial parts through washing of the plants by rain and/or through roots and/or by decay of

the plants and removing residue in soil (Towers *et al.*, 1977). The sesquiterpene lactone parthenin that is biosynthesized by this species is thought to play a role in its allelopathic interference with surrounding plants (Regina *et al.*, 2007). In the present study an attempt was made to evaluate the allelopathic effects of the extracts of parthenium plant and compost on the growth and yield attributes of greengram and compare with that of soybean.

### Materials and methods

A pot culture study was carried out in complete randomized block design with three replications. Six different treatments (C-Control, T1 - Leaf, T2 - Flower, T3 - Stem, T4 - Root, T5 - Whole plant and T6 - Compost) were set up with the aqueous extracts (1% and 10%) of the various plant parts of parthenium, whole plant and parthenium vermicompost and evaluated against control. The seedlings of *Vigna radiata* and *Glycine max* were allowed to grow for a period of 60 and 75 days respectively and uprooted at different time intervals, i.e., 30, 45 and 60 DAS for greengram and 25, 50 and 75 DAS for soybean and analysed for various biometric and yield parameters.

### Results and Discussion:

The allelopathic effect of 1% and 10% extracts of parthenium weed and compost on germination and seedling length of greengram and soybean is indicated in **Table 1**.

The percent germination was not affected in both greengram and soybean treated with the 1% aqueous extracts of parthenium plants and compost. At the 10% level, extracts of all the aerial parts of parthenium plant, as well as the whole plant caused a drastic reduction in the extent of germination. The root extract and the compost extract, however, did not affect the germination percentage in both greengram and soybean. The extracts of *Parthenium hysterophorus* induced profound effects on the process of seed germination and seedling growth in crop plants with variation in concentrations and

durations of exposure (Rahman, 2005). Oudhia and Tripathi (2000) reported that the stem and whole

plant extract of *Parthenium hysterophorus* showed a significant allelopathic effect on rice seedling vigour.

**Table 1:**  
**GERMINATION PERCENTAGE, SEEDLING LENGTH AND VIGOUR INDEX OF *Vigna radiata***

| Treatment        | Germination percentage |              | Seedling length (cm) |              | Vigour index |              |
|------------------|------------------------|--------------|----------------------|--------------|--------------|--------------|
|                  | 1% extract             | 10 % extract | 1% extract           | 10 % extract | 1% extract   | 10 % extract |
| C - Control      | 100                    | 100          | 6.4                  | 6.4          | 640          | 640          |
| T1 - Leaf        | 100                    | 30           | 4.3                  | 1.6          | 430          | 48           |
| T2 - Flower      | 100                    | 20           | 3.05                 | 0.65         | 305          | 13           |
| T3 - Stem        | 100                    | 40           | 7.3                  | 3.35         | 735          | 135          |
| T4 - Root        | 100                    | 100          | 7.0                  | 7.1          | 700          | 710          |
| T5 - Whole plant | 100                    | 30           | 7.1                  | 2.05         | 710          | 615          |
| T6 - Compost     | 100                    | 100          | 7.25                 | 7.85         | 725          | 785          |

The effects of the various extracts of parthenium weed, whole plant and compost on plant height was studied at 30, 45 and 60 DAS in greengram and 25, 50 and 75 days in soybean and the data are depicted in Table 2.

**Table 2**  
**PLANT HEIGHT (cm) OF GREENGRAM AND SOYBEAN**

| Treatment        | Greengram  |      |      |             |      |      | Soybean    |      |      |             |      |      |
|------------------|------------|------|------|-------------|------|------|------------|------|------|-------------|------|------|
|                  | 1% extract |      |      | 10% extract |      |      | 1% extract |      |      | 10% extract |      |      |
|                  | 30         | 45   | 60   | 30          | 45   | 60   | 25         | 50   | 75   | 25          | 50   | 75   |
| C - Control      | 39.4       | 44.2 | 48.8 | 39.4        | 44.2 | 48.8 | 40.2       | 44.3 | 49.6 | 40.1        | 44.3 | 49.6 |
| T1 - Leaf        | 42.3       | 46.4 | 58.7 | 41.8        | 49.2 | 57.5 | 43.3       | 47.4 | 55.5 | 42.5        | 49.6 | 55.5 |
| T2 - Flower      | 39.7       | 45.4 | 56.4 | 51.4        | 56.6 | 65.2 | 41.3       | 46.6 | 53.5 | 50.3        | 55.4 | 65.9 |
| T3 - Stem        | 40.2       | 45.1 | 59.5 | 47.5        | 53.0 | 58.8 | 41.6       | 45.8 | 58.6 | 48.3        | 51.6 | 60.5 |
| T4 - Root        | 37.3       | 42.4 | 48.4 | 43.9        | 52.9 | 65.9 | 42.2       | 46.3 | 49.4 | 44.6        | 51.7 | 65.6 |
| T5 - Whole plant | 38.8       | 45.1 | 56.2 | 41.6        | 48.8 | 59.6 | 45.3       | 50.3 | 56.5 | 48.2        | 54.7 | 62.5 |
| T6 - Compost     | 39.9       | 44.2 | 52.7 | 41.4        | 48.6 | 56.7 | 46.5       | 49.4 | 52.6 | 48.2        | 54.2 | 59.7 |
| C.D (0.05)       | 1.22       |      |      | 1.32        |      |      | 9.22       |      |      | 8.78        |      |      |

The 1% extract of leaf and 10% extract of flower were found to be effective in promoting the plant height in greengram during the vegetative and flowering stages and the 1% stem extract and 10% root extract in the harvesting stage. A differential response was shown by soybean plants to the various extracts at 1% level. Compost extract in the initial stage, whole plant extract in the flowering stage and the stem extract in the harvesting stage influenced the plant height positively. At 10% level, the flower extract exhibited higher plant length at all the three stages of the growth. The observations made in the present study could be attributed to the fact that the responses of the seeds to allelochemicals vary according to the sensitivity of the test plants. Janagoudar *et al.* (1997) reported that stimulatory effect of parthenium on plant growth might be due to the presence of auxin like substances in the extract of parthenium. Flower, root and stem extracts of weed

had a stimulatory effect on plant height of tef plant as observed by Singh *et al.* (2003).

Table 3 reveals the number of nodules in greengram and soybean.

In the present study, a positive impact was observed on the nodule number of test plants treated with parthenium weed extract and compost extracts. This might be suggested to be due to the influence of the weed extracts on the soil microflora, in particular the rhizobial species which are associated with nodulation in legumes. Tripathi *et al.* (2000) reported that the application of the extract of *Dalbergia sissoo* led to an increase in the nodule number in greengram as compared to control. The decrease in the number of nodules at the harvest stage in both the plants with the weed extract treatment was in line with the findings of Prakash *et al.* (2002) who reported that the maximum nodule number was recorded in lowering stage which then declined during the harvest stage in soybean.

**Table 3**  
**NUMBER OF NODULES OF GREENGRAM AND SOYBEAN**

| Treatment        | Greengram  |     |     |             |     |     | Soybean    |     |     |             |     |     |
|------------------|------------|-----|-----|-------------|-----|-----|------------|-----|-----|-------------|-----|-----|
|                  | 1% extract |     |     | 10% extract |     |     | 1% extract |     |     | 10% extract |     |     |
|                  | 30         | 45  | 60  | 30          | 45  | 60  | 25         | 50  | 75  | 25          | 50  | 75  |
| C - Control      | 2.1        | 3.6 | 5.3 | 2.1         | 3.6 | 5.4 | 1.9        | 2.5 | 3.7 | 1.9         | 2.5 | 3.7 |
| T1 - Leaf        | 2.9        | 4.5 | 5.7 | 3.1         | 4.7 | 6.0 | 3.0        | 3.4 | 4.4 | 3.0         | 3.7 | 4.5 |
| T2 - Flower      | 2.7        | 3.4 | 5.5 | 2.9         | 3.6 | 5.7 | 2.1        | 4.5 | 5.3 | 2.7         | 3.1 | 4.4 |
| T3 - Stem        | 3.3        | 4.6 | 4.8 | 3.6         | 4.7 | 5.0 | 3.0        | 4.4 | 4.7 | 2.8         | 3.7 | 4.6 |
| T4 - Root        | 2.0        | 3.9 | 4.3 | 2.2         | 4.2 | 4.6 | 1.8        | 2.6 | 3.8 | 1.9         | 2.6 | 3.6 |
| T5 - Whole plant | 3.6        | 4.9 | 5.2 | 3.8         | 5.0 | 5.4 | 1.7        | 2.7 | 3.7 | 2.9         | 3.9 | 4.6 |
| T6 - Compost     | 3.4        | 4.7 | 5.4 | 3.6         | 4.9 | 5.7 | 2.7        | 4.2 | 4.7 | 2.6         | 3.5 | 4.3 |
| C.D (0.05)       | 0.401      |     |     | 0.573       |     |     | 2.643      |     |     | 2.5         |     |     |

The Fresh and dry weight of the greengram and soybean indicated in Tables 4 and 5 respectively. Fresh and dry weights of the plants are important indices of quantity and quality of the plants as a whole.

**Table 4:**  
**FRESH WEIGHT (gm) OF GREENGRAM AND SOYBEAN**

| Treatment        | Greengram  |      |      |             |      |      | Soybean    |     |     |             |     |     |
|------------------|------------|------|------|-------------|------|------|------------|-----|-----|-------------|-----|-----|
|                  | 1% extract |      |      | 10% extract |      |      | 1% extract |     |     | 10% extract |     |     |
|                  | 30         | 45   | 60   | 30          | 45   | 60   | 25         | 50  | 75  | 25          | 50  | 75  |
| C - Control      | 4.7        | 6.7  | 4.0  | 4.7         | 6.7  | 4.0  | 3.2        | 4.1 | 3.1 | 3.2         | 4.1 | 3.1 |
| T1 - Leaf        | 8.0        | 10.7 | 7.3  | 10.3        | 14.7 | 9.3  | 5.2        | 6.3 | 3.6 | 6.2         | 6.5 | 4.2 |
| T2 - Flower      | 7.7        | 11.0 | 9.3  | 10.7        | 14.0 | 12.7 | 5.0        | 8.2 | 7.9 | 5.6         | 8.4 | 7.9 |
| T3 - Stem        | 10.7       | 14.3 | 10.3 | 10.7        | 14.7 | 10.3 | 6.6        | 9.3 | 9.1 | 7.0         | 9.5 | 9.2 |
| T4 - Root        | 7.0        | 9.7  | 7.7  | 7.7         | 10.3 | 8.0  | 4.6        | 6.3 | 6.0 | 5.2         | 6.6 | 6.1 |
| T5 - Whole plant | 8.0        | 11.0 | 8.3  | 15.0        | 20.7 | 9.3  | 5.6        | 7.1 | 7.1 | 6.9         | 9.5 | 9.0 |
| T6 - Compost     | 5.7        | 10.3 | 7.0  | 12.3        | 15.7 | 8.3  | 4.0        | 4.6 | 4.1 | 6.3         | 8.2 | 7.1 |
| C.D (0.05)       | 1.058      |      |      | 1.228       |      |      | 2.832      |     |     | 2.552       |     |     |

There was a gradual increase in the plant biomass from the vegetative to the harvesting stage. Greengram plants treated with 1% extract of the whole parthenium plant registered maximum fresh weight in the vegetative and flowering stages and 1% leaf extract in the harvesting stage when compared to all other treatments and control. A similar trend was observed with 10% extract. In soybean, there was a wide variation in the effect of the extracts of various parts of parthenium and compost on the fresh weight of the plant, 1% and 10% leaf extract on the vegetative stage (25 DAS), 1% extract of the flower on the flowering and harvesting stages (50 and 75 DAS). The 10% whole plant extract led to higher fresh weight in the flowering and harvesting stage of soybean plant. Maximum dry weight of greengram plant was recorded in T1 (1% leaf extract) on 30 and

60 DAS which was on par with T5 (1% whole plant extract). 10% extracts of leaf (T1) and flower (T2) of parthenium exhibited an increase in the dry weight of greengram plant on 30, 45 and 60 DAS respectively, whereas treatment with 1% extract of leaf (T1) resulted in significant increase in the dry weight of soybean when compared to control. Beers and Kaziniczi (2002) proved that the shoot residues of all weed species stimulated the fresh weight and dry weight in the seedlings of wheat and barley. The total biomass of soybean, barley and sesame also decreased with increasing concentration of both the tuber and shoot extracts of nut sedge (Yadav and Chavhan, 1998).

Table 5  
**DRY WEIGHT (gm) OF GREENGRAM AND SOYBEAN**

| Treatment        | Greengram  |     |     |             |     |     | Soybean    |     |     |             |     |     |
|------------------|------------|-----|-----|-------------|-----|-----|------------|-----|-----|-------------|-----|-----|
|                  | 1% extract |     |     | 10% extract |     |     | 1% extract |     |     | 10% extract |     |     |
|                  | 30         | 45  | 60  | 30          | 45  | 60  | 25         | 50  | 75  | 25          | 50  | 75  |
| C - Control      | 0.7        | 0.9 | 1.2 | 0.7         | 0.9 | 1.2 | 0.6        | 0.8 | 1.3 | 0.6         | 0.8 | 1.3 |
| T1 - Leaf        | 1.0        | 1.3 | 1.7 | 1.0         | 1.1 | 1.5 | 0.9        | 1.3 | 1.6 | 1.0         | 1.2 | 1.6 |
| T2 - Flower      | 0.7        | 1.1 | 1.5 | 1.0         | 1.2 | 1.7 | 0.8        | 1.0 | 1.5 | 0.9         | 1.1 | 1.6 |
| T3 - Stem        | 0.9        | 1.3 | 1.6 | 0.9         | 1.1 | 1.6 | 0.8        | 1.1 | 1.2 | 0.9         | 1.2 | 1.2 |
| T4 - Root        | 0.7        | 0.9 | 1.2 | 0.6         | 1.0 | 1.3 | 0.5        | 1.1 | 1.1 | 0.6         | 1.1 | 1.2 |
| T5 - Whole plant | 1.0        | 1.3 | 1.8 | 0.6         | 1.0 | 1.2 | 0.9        | 1.2 | 1.3 | 1.1         | 1.3 | 1.3 |
| T6 - Compost     | 0.9        | 1.7 | 1.5 | 0.7         | 1.1 | 1.5 | 0.9        | 1.2 | 1.2 | 1.2         | 1.3 | 1.4 |
| C.D (0.05)       | 0.116      |     |     | 0.067       |     |     | 0.08       |     |     | 0.08        |     |     |

The lower concentration of extracts of *Parthenium hysterophorus* namely 1% and 10% concentration had stimulatory effect on biomass accumulation (Mehta *et al.*, 2001). Garg and Nagendra (2000) observed a progressive increase in the dry weight of wheat plant with the advancement of maturity. The fresh and dry weights of plants treated with parthenium compost were found to be increased when compared to control. This is in accordance with Sudeshkumar and Sharma (1999) who suggested that organic manure provides a favorable environment to

the sorghum plant resulting in increased height and dry matter accumulation. Nainawat (1997) found that the application of vermicompost to two cultivars of wheat resulted in higher total dry matter production.

The yield parameters such as number of pods per plant, pod length and number of seeds per pod in greengram and soybean plants treated with the 1% and 10% extracts of the various parts of parthenium weed, whole plant and parthenium compost are presented in Table 6.

Table 6

**YIELD PARAMETERS OF *Vigna radiata* and *Glycine max***

| Treatment        | <i>Vigna radiate</i> |             |                 |             |                 |             | <i>Glycine max</i> |             |                 |             |                 |             |
|------------------|----------------------|-------------|-----------------|-------------|-----------------|-------------|--------------------|-------------|-----------------|-------------|-----------------|-------------|
|                  | No of pods/plant     |             | Pod length (cm) |             | No of seeds/pod |             | No of pods/plant   |             | Pod length (cm) |             | No of seeds/pod |             |
|                  | 1% extract           | 10% extract | 1% extract      | 10% extract | 1% extract      | 10% extract | 1% extract         | 10% extract | 1% extract      | 10% extract | 1% extract      | 10% extract |
| C - Control      | 10.7                 | 10.7        | 6.6             | 6.7         | 9.7             | 9.7         | 10.5               | 10.5        | 5.1             | 5.1         | 4.1             | 4.1         |
| T1 - Leaf        | 10.7                 | 11.0        | 6.5             | 6.8         | 10.0            | 10.3        | 10.2               | 10.6        | 5.4             | 5.4         | 3.3             | 3.6         |
| T2 - Flower      | 11.7                 | 12.3        | 6.7             | 7.0         | 10.0            | 10.7        | 12.6               | 12.9        | 5.4             | 5.8         | 3.6             | 3.8         |
| T3 - Stem        | 10.3                 | 11.7        | 6.5             | 6.8         | 9.3             | 10.3        | 10.3               | 10.9        | 5.4             | 5.7         | 3.0             | 3.1         |
| T4 - Root        | 10.7                 | 11.3        | 6.7             | 6.7         | 9.7             | 11.0        | 10.7               | 11.3        | 5.4             | 5.4         | 3.9             | 4.1         |
| T5 - Whole plant | 11.3                 | 11.7        | 6.7             | 6.9         | 10.7            | 11.7        | 11.3               | 11.8        | 5.5             | 5.7         | 4.2             | 4.2         |
| T6 - Compost     | 12.3                 | 13.0        | 6.9             | 7.1         | 11.3            | 12.7        | 12.9               | 13.3        | 6.1             | 6.3         | 4.4             | 4.6         |
| C.D (0.05)       | 0.999                |             | 0.25            |             | 1.06            |             | 1.056              |             | 0.21            |             | 0.873           |             |

From the table, it is evident that in both the crop plants studied, all the yield characters were

influenced to a maximum level with the 1% and 10% parthenium compost application. The influence of different extracts of parthenium was variable on the yield parameters with the compost extract causing consistent effects. The results of the present study are in agreement with Tripathi *et al.* (2000) who have indicated that the leaf and root extracts varied in influencing the number of seeds per pod in greengram. Singh *et al.* (2001) have shown that the grain yield of soybean was reduced significantly by the incorporation of weed extracts of *A. conyzoids*, *C. album* and *M. indica* at high concentration.

### Conclusion

The present study suggests that parthenium influences positive effects on seed germination, seedling growth, nodulation, biomass and yield parameters in the selected plants such as greengram and soybean. However, this allelopathic activity of the weed may be different in field conditions due to the large difference of environmental conditions. Therefore, further studies are suggested to confirm this activity under field conditions.

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