



## Weed control in mungbean (*Vigna radiata* L.) through *Parthenium* water extract in combination with a herbicide

Faruq Azam<sup>1</sup>, Abdul Latif<sup>2</sup>, Muhammad Irfan Ahmad<sup>\*3</sup>, Muhammad Zulfiqar Ahmad<sup>4</sup>, Jalil Ahmad<sup>5</sup>, Asad Abbas<sup>6</sup>, Muhammad Azeem<sup>7</sup>

<sup>1</sup>Department of Agriculture Extension, Mianwali, Pakistan

<sup>2</sup>School of Resources and Environment, Anhui Agricultural University, Hefei, China

<sup>3</sup>School of Agronomy, Anhui Agricultural University, Hefei, China

<sup>4</sup>State Key Lab of Tea Plant Biology and Utilization, College of Tea and Food science and Technology, Anhui Agricultural University, Hefei, China

<sup>5</sup>Institute of Vegetables and Flowers, Chinese Academy of Agricultural sciences, Beijing, China

<sup>6</sup>Department of Horticulture, Anhui Agriculture University, Hefei, China

<sup>7</sup>Department of Agriculture, Hazara University, Mansehra, KP, Pakistan

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### Abstract

Pulses are an excellent and inexpensive source of plant protein. Mungbean [*Vigna radiata* (L.) wilczek]. Mungbean is one of the most important pulse crops, belongs to family Fabaceae. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. This study is designed to check the effect of several cultural practices on the weed population i.e. *Parthenium* water extract in combination with conquest (post emergence) herbicide and hand weeding. Uncontrolled weed population result in 30-90% yield losses in mungbean. Hand weeding at 25 DAS and 45 DAS and weed free check treatments decreased weed population by 80.29% and 90.16% respectively recorded at 30 DAS. *Parthenium* Water extract application had also decreased weed density by 26.52%. When data recorded at 60 DAS then sole application of foliar spray of *Parthenium* water extract @ 16 L ha<sup>-1</sup> at 20, 30 and 45 DAS reduced weed population by 24.45% and decreased weeds fresh weight by 28.35% and 40.67%. The weeds fresh weight was reduced in weed free check treatment by 88.22% and 91.74% at 40 and 60 DAS, respectively relative to control. Similarly, the highest plant height i.e. 56.67 cm, the highest number of branches per plant i.e. 5.97, number of pods per plant i.e. 48.67, increased aerial biological yield i.e. 51.54% and increased grain yield i.e. 85.80% were recorded under the weed free check treatment. However, one foliar spray of (conquest + *Parthenium* water extract) @ 0.19 L ha<sup>-1</sup> + 16 L ha<sup>-1</sup> reduced weed population by 23.01% (60DAS), and reduced weed fresh weight by 38.21% and 51.68% recorded at 40 and 60 DAS, respectively. This treatment also resulted in the decrease of weeds dry weight i.e. 41.87 and 52.29 % recorded 40 and 60 DAS, respectively. However, combination of *Parthenium* water extract and herbicide proved an effective method to control weeds.

\* Corresponding Author: Muhammad Irfan Ahmad ✉ [irfan306@outlook.com](mailto:irfan306@outlook.com)

## Introduction

Pulses are an excellent and inexpensive source of plant protein. Mungbean [*Vigna radiata* (L.) wilczek]. Mungbean is one of the most important pulse crops, belongs to family Fabaceae. It is a short duration crop and is can be grown twice a year it is cultivated in these countries Thailand, Philippines rank, Sri Lanka, India, Burma, Bangladesh and Indonesia (Lawn and Ahn, 1985). It is known as quality pulse due to higher protein percentage (27%) in seed and excellent digestibility. (Thirumaran and Seralathan, 1988). It also known for its essential amino acid composition like that of soybean and kidney bean (Fan and Sosulski, 1974; Thompson *et al.*, 1976; El-Adawy, 1996). In Pakistan, mungbean is grown in all parts of the country on irrigated as well as rain fed areas (Government of Pakistan, 2010). It can be grown in any cropping system as it fits well in many crop rotations due to shorter duration, high adaptability and ability to fix atmospheric nitrogen (Arshad *et al.*, 2009).

Weeds are the major problem in the irrigated as well as in the rainfed mungbean. Research workers have reported different levels of yield losses ranging from 30 to 85% (Sandhu *et al.*, 1980; Singh *et al.*, 1984; Singh, 1987; PARC, 1988). Uncontrolled weeds cause yield reduction 50-90% compared with weed free crop (Poehlman, 1991). Mansoor *et al.* (2004) reported 46.5% yield losses in mungbean due to weeds infestation. About 69% reduction in mungbean grain yield due to weeds was estimated by Yadav and Sing (2005). So it is essential to control weeds in order to reduce the yield losses. Weeds can be controlled chemically but this practice is highly uneconomical due to higher costs involved and indiscriminate use of herbicides is posing environmental threats (Waller, 1987). The golden age of herbicides is lasted more than 30 years, but now due to herbicidal resistance, environmental pollution and lack of new herbicidal products have created the problems for sustainability of weed control (Lemerle, 2006). Whereas the problem of weed resistance is also arised due to the subsequent under dose applications. (Shahid *et al.*, 2006). Herbicides have induced biochemical changes in crop plants which

lowered their suitability as animal food or increased their susceptibility to disease and pests (Ries, 1976). Soil organisms were adversely affected by reductions in plant diversity in response to herbicides (House *et al.*, 1987 and House, 1989 (Shelton and Edwards 1983). Photosystem II (PSII) herbicides can readily penetrate the tissues of corals and rapidly (within minutes) reduce the quantum yield of the intracellular algal symbionts (Jones, 2005). Therefore, it is necessary to discover new weed control methods which should be natural, environment friendly and effective.

Allelo chemicals in some crops can be successfully used for weed control (Waller, 1987). The growing crops suppress growth of certain weed species while residues of some crops also reduce the seed germination of weeds by releasing phytotoxins (Narwal, 1994). Plants produce many compounds that play a useful function in their interaction with the environment (Paiva, 2000). There are many weed species that are allelopathic in nature. It is a viable weed management strategy but needs to be extensively studied. It is a natural and environment friendly technique which may prove an effective strategy for weed management America (Picman & Picman, 1984), *Parthenium* have allelopathic effect and drastically retards the growth of many species (Tefera, 2002). Khan Bahadar, Marwat *et al.* (2008) reported that *parthenium* significantly decreased the germination percentage, seedling length and seedling weight of *Triticum aestivum* L., *Avena fatua* and *Lepidium* sp. Wondimagegnehu Mersie and Megh Singh (1987) showed that *Parthenium* shoot containing water-soluble materials were toxic to root growth of velvetleaf and wheat. Such kind of Water-soluble allelochemicals contain phenolic acids and sesquiterpene lactones, particularly *Parthenium*. May research demonstrated that in the various parts of the *parthenium* weed that have toxic effects on the growth of other plants (Kanchan, 1975; Picman and Picman, 1984). The allelochemicals can also be used along with low doses of herbicides to obtain good weed control results (Jamil *et al.*, 2005).

Phytochemical analysis had reported high accumulation of growth inhibitors in leaves of *Parthenium* (Kanchan 1975). The present study was done to check the different methods to control weeds and finding out the most effective way to control weeds.

## Materials and methods

### Site and soil

The present study was conducted at PMAS- Arid Agriculture University, Rawalpindi during spring 2014. Before the sowing of crop's analyses of soil test showed pH 7.33, N 0.061 (%), Phosphorus 7.43 mg kg<sup>-1</sup> and Potash 165.33 mg kg<sup>-1</sup>. The soil characteristic are shown in Table 1.

### Experimental design and the treatments

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The individual plot size was 5m x 3m with row to row distance 30 cm and plant to plant distance 10 cm. Basal doses of fertilizer NP was applied @ 23 Kg and 60 Kg NP ha<sup>-1</sup> respectively. The seed rate was 20 kg ha<sup>-1</sup>.

### Treatments:

T1 = Weedy check

T2 = Weed free check

T3 = Hand weeding

T4 = Conquest herbicide (post emergence) @ 0.75L ha<sup>-1</sup> (recommended dose)

T5 = parthenium water extract @ 16 L ha<sup>-1</sup>

T6 = conquest + parthenium water extract @ 0.75L ha<sup>-1</sup> + 16 L ha<sup>-1</sup>

T7 = conquest + Parthenium water extract @ 0.37L ha<sup>-1</sup> + 16 L ha<sup>-1</sup>

T8 = conquest + Parthenium water extract @ 0.19 L ha<sup>-1</sup> + 16 L ha<sup>-1</sup>

### Planting material

The tested variety was Chakwal Mung -2006, according to plant character which influences the growth and yield. This variety was identified from the literature according to agronomic characters such as plant development rates, plant height and leaf area and yield. The seeds of cultivar were obtained from AYUB.

### Crop husbandry

The seed bed was prepared before the sowing for 2-3 times with tractor- mounted cultivator each followed by planking. When the seed bed is fully prepared then crop is sown with seed rate of 20 kg ha<sup>-1</sup>. The individual plot size was 5m x 3m with row to row distance 30 cm and plant to plant distance 10 cm. Basal doses of fertilizer NP was applied @ 23 Kg and 60 Kg NP ha<sup>-1</sup> respectively.

### Preparation of Parthenium water extract

Freshly growing *Parthenium* with leaves was collected from various location of PMAS- Arid Agriculture University, Rawalpindi. It was sun dried and then was cut into small pieces. These pieces were soaked in distilled water in 1:10 ratio (1 Kg of *Parthenium* pieces in 10 L of water) in container for 24 hours at room temperature to prepare *Parthenium* water extract. Extract of *Parthenium* water extract from the container was obtained by filtering the *Parthenium* water mixture through a screen. The volume of the filtrate was reduced twenty times by continuous boiling to prepare concentrated *Parthenium* water extract

### Statistical analysis

The data collected using software Statix 8.1it is subjected to statistical analysis of variance and the means obtained were compared by Least Significant Difference (LSD) Test at 5% level of probability (Montgomery, 2001).

## Results and discussion

### Weed density (weeds m<sup>-2</sup>)

The main weed species found in the experimental area were *Cynodon dactylon* L., *Convolvulus arvensis* L., *Tephresia purpurea* L., *Cyperus rotundus* L., *Amaranthus viridis* L., *Sorghum helepence* L. Data related to weed density recorded 30 DAS is shown in the Table 1. *Parthenium* water extract decreased weed population as compared control treatment. Hand weeding at 25 DAS and 45DAS and weed free check treatments decreased weed population by 80.29 and 90.16% respectively recorded at 30 DAS. *Parthenium* Water extract application had also decreased weed density by 26.52% as compared fully control treatment. These results are also in accordance with previous work of Cheema *et al.*, (2002).

**Table 1.** Effect of *Parthenium* water extract alone and in combination with different doses of conquest on weed density at 30 DAS in mungbean.

| Treatments   | Weed density (weeds m <sup>-2</sup> ) 30 DAS |
|--|--|
| Control (Weedy Check)  | 44.00 a<br>(-----)                           |
| Weed free Check  | 4.33 d<br>(90.16)                            |
| Hand weeding at 30 and 45 DAS  | 8.67 c<br>(80.29)                            |
| Conquest herbicide @ 0.75 L ha <sup>-1</sup> (recommended dose)                              | 41.66 a                                      |
| <i>Parthenium</i> water extract @ 16 L ha <sup>-1</sup> at 20, 30 and 45 DAS                 | 32.33 b<br>(26.52)                           |
| Conquest + <i>Parthenium</i> water extract @ 0.75L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 40.67 a                                      |
| Conquest + <i>Parthenium</i> water extract @ 0.37L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 40.33 a                                      |
| Conquest + <i>Parthenium</i> water extract @ 0.19 L ha <sup>-1</sup> + 16 L ha <sup>-1</sup> | 43.67 a                                      |
| LSD (0.05)   | 3.96   |

Any two means not sharing a letter in common in a column differ significantly at 5 % probability level.

Figures shown in parenthesis show percent decrease over control

DAS = Days after Sowing

LSD (0.05) = Least significant difference at 5% probability level.

**Table 2.** Effect of *Parthenium* water extract alone and in combination with different doses of Conquest on weed density at 60 DAS in mungbean.

| Treatments   | Weed density (weeds m <sup>-2</sup> ) 60 DAS |
|--|--|
| Control (Weedy Check)  | 46.33 a<br>(-----)                           |
| Weed free Check  | 3.00 f<br>(93.52)                            |
| Hand weeding at 30 and 45 DAS  | 9.33 e<br>(79.86)                            |
| Conquest herbicide @ 0.75 L ha <sup>-1</sup> (recommended dose)                              | 22.33 d<br>(51.80)                           |
| <i>Parthenium</i> water extract @ 16 L ha <sup>-1</sup> at 20, 30 and 45 DAS                 | 35.00 b<br>(24.45)                           |
| Conquest + <i>Parthenium</i> water extract @ 0.75L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 26.67 d<br>(42.33)                           |
| Conquest + <i>Parthenium</i> water extract @ 0.37L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 35.33 c<br>(23.74)                           |
| Conquest + <i>Parthenium</i> water extract @ 0.19 L ha <sup>-1</sup> + 16 L ha <sup>-1</sup> | 35.67 c<br>(23.01)                           |
| LSD (0.05)   | 4.23   |

*Weeds density after treatments*

Significant results were observed the data presented in the Table 2 showed that *Parthenium* water extract and conquest herbicide decrease the level of weeds infestation. The maximum weeds population was reduced in the weed free check by 93.52% followed by

hand weeding at 30 and 45 DAS by 79.86% as compared control recorded at 60 DAS. One foliar spray Conquest + *Parthenium* water extract @ 0.75L ha<sup>-1</sup> + 16 L ha<sup>-1</sup> decreased weeds population by 42.33% and it was as effective as full dose of conquest herbicide @ 0.75 L ha<sup>-1</sup>(recommended dose).

**Table 3.** Effect of *Parthenium* water extract alone and in combination with different doses of Conquest on weeds fresh weight in mungbean.

| Treatments   | Weeds Fresh Weight (g m <sup>-2</sup> ) |                 |
|--|---|-----------------|
|  | 40 DAS                                  | 60DAS           |
| Control (Weedy Check)  | 104.67a (-----)                         | 109.00a (-----) |
| Weed free Check  | 12.33 g (88.22)                         | 9.00 f (91.74)  |
| Hand weeding at 30 and 45 DAS  | 20.67 f (80.25)                         | 15.67 e (85.62) |
| Conquest herbicide @ 0.75 L ha <sup>-1</sup> (recommended dose)                              | 61.33 d (41.41)                         | 53.33c (51.07)  |
| <i>Parthenium</i> water extract @ 16 L ha <sup>-1</sup> at 20, 30 and 45 DAS                 | 75.00 b (28.35)                         | 64.67 b (40.67) |
| Conquest + <i>Parthenium</i> water extract @ 0.75L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 54.67 e (47.77)                         | 45.67 d (58.10) |
| Conquest + <i>Parthenium</i> water extract @ 0.37L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 59.67 d (42.99)                         | 47.33 d (56.58) |
| Conquest + <i>Parthenium</i> water extract @ 0.19 L ha <sup>-1</sup> + 16 L ha <sup>-1</sup> | 64.67 c (38.21)                         | 52.67 c (51.68) |
| LSD(0.05)  | 2.71                                    | 4.54            |
| Treatments   | Weeds Fresh Weight (g m <sup>-2</sup> ) |                 |
|  | 40 DAS                                  | 60DAS           |
| Control (Weedy Check)  | 104.67a (-----)                         | 109.00a (-----) |
| Weed free Check  | 12.33 g (88.22)                         | 9.00 f (91.74)  |
| Hand weeding at 30 and 45 DAS  | 20.67 f (80.25)                         | 15.67 e (85.62) |
| Conquest herbicide @ 0.75 L ha <sup>-1</sup> (recommended dose)                              | 61.33 d (41.41)                         | 53.33c (51.07)  |
| <i>Parthenium</i> water extract @ 16 L ha <sup>-1</sup> at 20, 30 and 45 DAS                 | 75.00 b (28.35)                         | 64.67 b (40.67) |
| Conquest + <i>Parthenium</i> water extract @ 0.75L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 54.67 e (47.77)                         | 45.67 d (58.10) |
| Conquest + <i>Parthenium</i> water extract @ 0.37L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 59.67 d (42.99)                         | 47.33 d (56.58) |
| Conquest + <i>Parthenium</i> water extract @ 0.19 L ha <sup>-1</sup> + 16 L ha <sup>-1</sup> | 64.67 c (38.21)                         | 52.67 c (51.68) |
| LSD (0.05)   | 2.71                                    | 4.54            |

*Parthenium* water extract @ 16 L ha<sup>-1</sup> at 20, 30 and 45 DAS reduced weed population by 24.45% recorded at 60 DAS. Finding of this study indicated that Conquest + *Parthenium* water extract had statistically signified reducing effect on weed density. It worked complementarily and thus *Parthenium* water extract along with reduced conquest doses decreased weed density more than that by full dose of conquest. These results support the findings of Maharjan *et al.* (2007)

who found that leaf aqueous extracts of *Parthenium hysterophorus* exhibited significant inhibitory effects on seed germination and seedling growth, Similarly Bajwa *et al.* (2004) reported that aqueous extract from shoot of *Parthenium* reduced the germination and seedling growth of sunflower.

*Weeds fresh weight (g m<sup>-2</sup>)*

*Parthenium* water extract and conquest herbicide reduced weeds fresh weight as shown in Table 3

described that significantly results were observed, the maximum weeds fresh weight was reduced in weed free check treatment by 88.22 and 91.74% at 40 and 60 DAS. One foliar spray Conquest + *Parthenium* water extract @ 0.75L ha<sup>-1</sup> + 16 L ha<sup>-1</sup> decreased weeds fresh weight by 47.77 and 58.10% recorded at 40 and 60 DAS, respectively as compared control.

Conquest + *Parthenium* water extract @ 0.37L ha<sup>-1</sup> + 16 L ha<sup>-1</sup> had reduced weeds fresh weight by 42.99 and 56.58% at 40 and 60 DAS, respectively as compared control which had a better result than conquest herbicide alone and control. *Parthenium* water extract @ 16 L ha<sup>-1</sup> at 20, 30 and 45 DAS.

**Table 4.** Effect of *Parthenium* water extract alone and combination with different doses of conquest on weed dry weight on mungbean crop.

| Treatments   | Weeds Dry Weight (g m <sup>-2</sup> ) |                    |
|--|---------------------------------------|--------------------|
|  | 40 DAS                                | 60DAS              |
| Control (Weedy Check)  | 53.33 a<br>(-----)                    | 65.67 a<br>(-----) |
| Weed free Check  | 4.33 e (91.88)                        | 3.00 e (95.43)     |
| Hand weeding at 30 and 45 DAS  | 8.67 e (83.74)                        | 7.33 e (88.84)     |
| Conquest herbicide @ 0.75 L ha <sup>-1</sup> (recommended dose)                              | 24.67 d (53.74)                       | 26.67 d (59.39)    |
| <i>Parthenium</i> water extract @ 16 L ha <sup>-1</sup> at 20, 30 and 45 DAS                 | 37.33 b (30.00)                       | 38.67 b (41.11)    |
| Conquest + <i>Parthenium</i> water extract @ 0.75L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 25.67 cd (51.87)                      | 26.00 d (60.41)    |
| Conquest + <i>Parthenium</i> water extract @ 0.37L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 27.67 cd (48.12)                      | 29.33 cd (55.34)   |
| Conquest + <i>Parthenium</i> water extract @ 0.19 L ha <sup>-1</sup> + 16 L ha <sup>-1</sup> | 31.00 c (41.87)                       | 31.33 c (52.29)    |
| LSD (0.05)   | 5.50                                  | 4.65               |

**Table 5.** Effect of parthenium water extract alone and in combination with different doses of Conquest on germination count of mungbean crop.

| Treatments   | Germination count (plants m <sup>-2</sup> ) |
|--|---|
| Control (Weedy Check)  | 25.67 (NS)                                  |
| Weed free Check  | 26.33                                       |
| Hand weeding at 30 and 45 DAS  | 25.00                                       |
| Conquest herbicide @ 0.75 L ha <sup>-1</sup> (recommended dose)                              | 25.00                                       |
| <i>Parthenium</i> water extract @ 16 L ha <sup>-1</sup> at 20, 30 and 45 DAS                 | 24.67                                       |
| Conquest + <i>Parthenium</i> water extract @ 0.75L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 26.00                                       |
| Conquest + <i>Parthenium</i> water extract @ 0.37L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 25.00                                       |
| Conquest + <i>Parthenium</i> water extract @ 0.19 L ha <sup>-1</sup> + 16 L ha <sup>-1</sup> | 25.33                                       |
| LSD (0.05)   | 2.37  |

These results are in accordance with the Marwat *et al.* (2008) who found that fresh biomass of weeds 50 DAS was decreased by increasing concentration of *Parthenium* extracts. These results also support Bajwa *et al.* (2004) who reported that root length as well as root fresh and dry weight of sunflower (*Helianthus annuus* L.) was significantly suppressed by aqueous shoot extract of *P. hysterophorus*.

#### Weeds dry weight (g m<sup>-2</sup>)

Data related to weeds dry weight recorded at 40 and 60 DAS showed that foliar spray of *Parthenium* water extract and conquest herbicide either alone or in combination decreased weeds dry matter as compared control as shown in Table 4. Conquest + *Parthenium* water extract @ 0.75L ha<sup>-1</sup> + 16 L ha<sup>-1</sup>

decreased maximum weeds dry weight by 51.87 and 60.41% recorded at 40 and 60 DAS, respectively and was statistically at par with full dose of conquest treatment. It was clear from the results of this study that weeds can be control by the application of *Parthenium* water extract in an appropriate

combination with herbicides. These results were in accordance with the findings of Cheema *et al.* (2002) who found that sorghum water extract in combination with reduced doses of herbicide had decreased weeds dry weight as decreased recommended dose of herbicide.

**Table 6.** Effect of parthenium water extract alone and in combination with different doses of Conquest on plant height of mungbean crop.

| Treatments   | Plant Height (cm) |
|--|-------------------|
| Control (Weedy Check)  | 43.33 d           |
| Weed free Check  | 56.67 a           |
| Hand weeding at 30 and 45 DAS  | 55.30 ab          |
| Conquest herbicide @ 0.75 L ha <sup>-1</sup> (recommended dose)                              | 52.20 bc          |
| <i>Parthenium</i> water extract @ 16 L ha <sup>-1</sup> at 20, 30 and 45 DAS                 | 50.40 c           |
| Conquest + <i>Parthenium</i> water extract @ 0.75L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 52.60 bc          |
| Conquest + <i>Parthenium</i> water extract @ 0.37L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 49.73 c           |
| Conquest + <i>Parthenium</i> water extract @ 0.19 L ha <sup>-1</sup> + 16 L ha <sup>-1</sup> | 48.60 c           |
| LSD (0.05)   | 4.00              |

**Table 7.** Effect of parthenium water extract alone and in combination with different doses of conquest on number of branches plant<sup>-1</sup>of mungbean.

| Treatments   | Number of Branches per plant |
|--|------------------------------|
| Control (Weedy Check)  | 3.93 e                       |
| Weed free Check  | 5.97 a                       |
| Hand weeding at 30 and 45 DAS  | 5.17 b                       |
| Conquest herbicide @ 0.75 L ha <sup>-1</sup> (recommended dose)                              | 4.93 bc                      |
| <i>Parthenium</i> water extract @ 16 L ha <sup>-1</sup> at 20, 30 and 45 DAS                 | 4.40 de                      |
| Conquest + <i>Parthenium</i> water extract @ 0.75L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 5.10 b                       |
| Conquest + <i>Parthenium</i> water extract @ 0.37L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 4.53 cd                      |
| Conquest + <i>Parthenium</i> water extract @ 0.19 L ha <sup>-1</sup> + 16 L ha <sup>-1</sup> | 4.30 de                      |
| LSD (0.05)   | 0.52                         |

#### Germination count (plants m<sup>-2</sup>)

The statistically non-significant difference was observed between these treatments, the results are present in Table 5. None of the treatments are pre-emergent so there is no impact on the germination of weeds. Highest value is of T1 with the value 26.33 followed by the T5 with the value 26.00.

#### Plant height at maturity (cm)

The height of the any crop is affected by the both genetic and environmental factors. All the treatments

combination of *Parthenium* water extract and conquest herbicide affected the plant height as shown in the Table 6. The highest plant height was observed in the treatment weed free check (56.67 cm) followed by hand weeding at 30 and 45 DAS (55.30 cm). Respectively other treatments are non-significant between each other but had significant difference from control. The results of this study showed that plant height is mire where weeds are under control which is the effect of combination of *Parthenium* water extract and conquest herbicide.

These results are similar with the findings of Chattha *et al.* (2007) who found that promising plant height was obtained which was a good indicator of better crop stand, because of effective weed eradication.

These findings are also in accordance with the results of Khan *et al.* (1999) who found that decreased weed population caused an increase in plant height. These results also support Khaliq *et al.* (2002) who reported increase in plant height due to weed suppression.

**Table 8.** Effect of *Parthenium* water extract alone and in combination with different doses of Conquest on number of pods plant<sup>-1</sup> of mungbean.

| Treatments   | Number of Pods per plant |
|--|--------------------------|
| Control (Weedy Check)  | 34.33 d                  |
| Weed free Check  | 48.67 a                  |
| Hand weeding at 30 and 45 DAS  | 45.67 ab                 |
| Conquest herbicide @ 0.75 L ha <sup>-1</sup> (recommended dose)                              | 43.00 bc                 |
| <i>Parthenium</i> water extract @ 16 L ha <sup>-1</sup> at 20, 30 and 45 DAS                 | 40.00 c                  |
| Conquest + <i>Parthenium</i> water extract @ 0.75L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 45.33 b                  |
| Conquest + <i>Parthenium</i> water extract @ 0.37L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 41.67 c                  |
| Conquest + <i>Parthenium</i> water extract @ 0.19 L ha <sup>-1</sup> + 16 L ha <sup>-1</sup> | 41.00 c                  |
| LSD(0.05)  | 3.30                     |

**Table 9.** Effect of *Parthenium* water extract alone and in combination with different doses of Conquest on number of seeds pod<sup>-1</sup> of mungbean.

| Treatments   | Number of Seeds per pod |
|--|-------------------------|
| Control (Weedy Check)  | 9.87 b                  |
| Weed free Check  | 11.27 a                 |
| Hand weeding at 30 and 45 DAS  | 11.13 a                 |
| Conquest herbicide @ 0.75 L ha <sup>-1</sup> (recommended dose)                              | 10.63 ab                |
| <i>Parthenium</i> water extract @ 16 L ha <sup>-1</sup> at 20, 30 and 45 DAS                 | 10.67 ab                |
| Conquest + <i>Parthenium</i> water extract @ 0.75L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 10.67 ab                |
| Conquest + <i>Parthenium</i> water extract @ 0.37L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 10.23 b                 |
| Conquest + <i>Parthenium</i> water extract @ 0.19 L ha <sup>-1</sup> + 16 L ha <sup>-1</sup> | 10.00 b                 |
| LSD (0.05)   | 0.89                    |

#### Number of branches per plant<sup>-1</sup>

The results given in the table 7 showed highly significant difference among the all treatments for primary and secondary number of branches per plant.

The mean values for primary and secondary branches per plant ranged from 3.99 to 5.97. Maximum number of branches per plant (5.97) was recorded in weed free check followed by hand weeding at 30 and 45 DAS (5.17). Conquest + *Parthenium* water extract @ 0.75L ha<sup>-1</sup> + 16L ha<sup>-1</sup> had more number of branches per plant (5.10) then Conquest herbicide @ 0.75 L ha<sup>-1</sup> (4.93).

The minimum no. of branches per plant (3.99) was observed in Control (Weedy Check) treatment. These results are similar to the Faida *et al.* (2009) who reported that decreased weed population resulted in increased number of branches per plant in mungbean crop.

These results are also in accordance with the findings of Chattha *et al.* (2007) who reported that less weeds compete less with the mungbean crop for growth resources due to which improvement of yield and yield component occurred.

*Number of pods per plant<sup>1</sup>*

Effect of *parthenium* water extract and conquest herbicide on the number of pods per plant is shown in the Table 8. Results showed that all treatments had effect on the number of pods per plant as compared control. Maximum number of pods 48.67 pods per plant was recorded in the weed free check followed by hand weeding at 30 and 45 DAS, 45.67 pods per plant. *Parthenium* water extract @ 16 L ha<sup>-1</sup> at 20, 30 and 45 DAS, conquest + *Parthenium* water extract @ 0.37L ha<sup>-1</sup> + 16 L ha<sup>-1</sup> and conquest + *Parthenium*

water extract @ 0.19 L ha<sup>-1</sup> + 16 L ha<sup>-1</sup> had 40.00, 41.67 and 41.00 pods per plant which was statistically at par with Conquest herbicide @ 0.75 L ha<sup>-1</sup> with 43.00 pods per plant. These results are supported by the previous findings of Rana and Pal (1997), who found that crops grown with proper weeding could produce higher yields. Similar findings were reported by Stoimenova and Mikova (1992) and Rakha (1999) who recorded more number of pods per plant which were mainly due to better weed control, low weed density and hence low weed crop competition.

**Table 10.** Effect of *Parthenium* water extract alone and in combination with different doses of Conquest on biological yield (Kg ha<sup>-1</sup>) of mungbean.

| Treatments   | Biological yield (Kg ha <sup>-1</sup> ) |
|--|---|
| Control (Weedy Check)  | 2866.7 d<br>(-----)                     |
| Weed free Check  | 4277.8 a<br>(48.19)                     |
| Hand weeding at 30 and 45 DAS  | 4344.4 a<br>(51.54)                     |
| Conquest herbicide @ 0.75 L ha <sup>-1</sup> (recommended dose)                              | 3888.9 ab<br>(35.66)                    |
| <i>Parthenium</i> water extract @ 16 L ha <sup>-1</sup> at 20, 30 and 45 DAS                 | 3288.9 cd<br>(14.73)                    |
| Conquest + <i>Parthenium</i> water extract @ 0.75L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 3980.0 ab<br>(38.84)                    |
| Conquest + <i>Parthenium</i> water extract @ 0.37L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 3800.0 b<br>(32.56)                     |
| Conquest + <i>Parthenium</i> water extract @ 0.19 L ha <sup>-1</sup> + 16 L ha <sup>-1</sup> | 3666.7 bc<br>(27.91)                    |
| LSD (0.05)   | 467.11                                  |

*Number of seeds per pod*

It is evident from the data given in Table 9 that all treatment had effect on the number of seeds per pod. Maximum number of seeds per pod i.e. 11.27 was recorded in weed free check followed by hand weeding at 30 and 45 DAS i.e. 11.13. *Parthenium* water extract @ 16 L ha<sup>-1</sup> at 20, 30 and 45 DAS and Conquest + *Parthenium* water extract @ 0.75L ha<sup>-1</sup> + 16 L ha<sup>-1</sup> had 10.67 seeds per pod each which was statistically at par with Conquest herbicide @ 0.75 L ha<sup>-1</sup> with 10.63 seeds per pod. These results were same to those of Khan, *et al.* (2005) who reported higher number of seeds per pod with good weed control and integrated management of all inputs.

These results were similar with the findings of Chattha *et al.* (2007) who found that maximum number of seeds pod<sup>-1</sup> of mungbean was obtained with good weed control.

*Biological yield (Kg ha<sup>-1</sup>)*

The data related to biological yield showed in the Table 10 indicated increased biological yield of mungbean, by the application of all treatments, as compared control. Maximum increased yield of 51.54% over control was obtained in the hand weeding with at 30 and 45 DAS followed by weed free check with 48.19% increase when compared control.

**Table 11.** Effect of *Parthenium* water extract alone and in combination with different doses of Conquest on economic yield (Kg ha<sup>-1</sup>) of mungbean.

| Treatments   | Economic yield (Kg ha <sup>-1</sup> ) |
|--|---------------------------------------|
| Control (Weedy Check)  | 232.33 f<br>(-----)                   |
| Weed free Check  | 431.67 a<br>(85.80)                   |
| Hand weeding at 30 and 45 DAS  | 394.33 b<br>(69.97)                   |
| Conquest herbicide @ 0.75 L ha <sup>-1</sup> (recommended dose)                              | 364.67 cd<br>(56.96)                  |
| <i>Parthenium</i> water extract @ 16 L ha <sup>-1</sup> at 20, 30 and 45 DAS                 | 285.67 e<br>(22.96)                   |
| Conquest + <i>Parthenium</i> water extract @ 0.75L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 376.67 c<br>(62.13)                   |
| Conquest + <i>Parthenium</i> water extract @ 0.37L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 350.67 d<br>(50.93)                   |
| Conquest + <i>Parthenium</i> water extract @ 0.19 L ha <sup>-1</sup> + 16 L ha <sup>-1</sup> | 298.33 e<br>(28.41)                   |
| LSD(0.05)  | 16.556                                |

These results are also similar with Cheema and Khaliq (2000) who reported increased biological yield due to weed control in wheat.

#### Economic yield (Kg ha<sup>-1</sup>)

Economic yield, final grain yield, of a crop is affected by various genetic and environmental factors. Any variation in these factors may result variations in the

grain yield. This is evident from the data presented in the Table 11 that all treatments significantly increased mungbean grain yield as compared control. Maximum increased grain yield of 85.80% of mungbean was recorded in the weed free check followed by hand weeding at 30 and 45 DAS with percent increase of 69.97% when compared control.

**Table 12.** Effect of *Parthenium* water extract alone and in combination with different doses of Conquest on harvest index of mungbean.

| Treatments   | Harvest Index       |
|--|---------------------|
| Control (Weedy Check)  | 8.13 c<br>(-----)   |
| Weed free Check  | 10.10 a<br>(24.23)  |
| Hand weeding at 30 and 45 DAS  | 9.13 abc<br>(12.30) |
| Conquest herbicide @ 0.75 L ha <sup>-1</sup> (recommended dose)                              | 9.40 ab<br>(15.62)  |
| <i>Parthenium</i> water extract @ 16 L ha <sup>-1</sup> at 20, 30 and 45 DAS                 | 8.70 bc<br>(7.01)   |
| Conquest + <i>Parthenium</i> water extract @ 0.75L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 9.47 ab<br>(16.48)  |
| Conquest + <i>Parthenium</i> water extract @ 0.37L ha <sup>-1</sup> + 16 L ha <sup>-1</sup>  | 9.27 ab<br>(14.02)  |
| Conquest + <i>Parthenium</i> water extract @ 0.19 L ha <sup>-1</sup> + 16 L ha <sup>-1</sup> | 8.15 c<br>(0.25)    |
| LSD(0.05)  | 1.065               |

Treatments conquest herbicide @ 0.75 L ha<sup>-1</sup> and Conquest + *Parthenium* water extract @ 0.75L ha<sup>-1</sup> + 16 L ha<sup>-1</sup> resulted an increased grain yield of 56.96 and 62.13% respectively as compared control. Sole application of *Parthenium* water extract @ 16 L ha<sup>-1</sup> at 20, 30 and 45 DAS increased grain yield by 22.96% over control. These results were similar with the findings of Chattha *et al.* (2007) who reported that with the control of weeds, increased in grain yield occurred. These results are also in line with those of Shahid *et al.* (2006) and Khan *et al.* (2004) who reported increased grain yield due to reduction in the weeds population.

#### Harvest index (%)

The results from Table 12 evaluated that *Parthenium* water extract and herbicide significantly affected the harvest index of mungbean. Increase in the harvest index was highest 24.23% in the weed free check followed by 16.48 percent in the conquest + *Parthenium* water extract @ 0.75L ha<sup>-1</sup> + 16 L ha<sup>-1</sup>. Minimum increased in harvest index 0.25% was recorded in the Conquest + *Parthenium* water extract @ 0.19 L ha<sup>-1</sup> + 16 L ha<sup>-1</sup> which was statistically at par with control. These results are in accordance with Jamil *et al.* (2005) who reported that it was may be due to weed control that increased the harvest index. Similarly, Marwat *et al.* (2005) reported that increased harvest index may be due to good weed control in wheat.

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