



Response of Mungbean to the Residual Toxicity of Herbicides Used in Wheat under Strip Tillage System

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Authors' contributions

This work was carried out in collaboration among all authors. Author MSS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript.

Authors MSRM, MNH and TA managed the analyses of the study. Author MKH managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJAHR/2020/v5i230049

Editor(s):

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Complete Peer review History: <http://www.sdiarticle4.com/review-history/54689>

Original Research Article

Received 28 December 2019

Accepted 03 March 2020

Published 14 March 2020

ABSTRACT

The residual effect of eight herbicides (Pendimethalin, Pretilachlor, Triasulfuron Ethoxysulfuron, Pyrazosulfuron Ethyl, Carfentrazone – ethyl, Carfentrazone – ethyl+ Isoproteuron, 2, 4 –D) used in wheat of Agronomy Field Laboratory during March to June 2014 was evaluated for mungbean. The eighteen herbicide treatment combinations of the eight herbicides were used in wheat. The experiment was conducted in Random Complete Block Design (RCBD) with three replications. The effect of herbicide residues on the mungbean was evaluated in term of germination, seedling root and shoot length, leaf chlorophyll content and seeding dry matter. The result showed that seedling

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establishment of mungbean was not adversely affected by the herbicides applied the previous wheat crop. Also, the residue of herbicides applied in strip-tilled wheat did not show any adverse effect on germination, shoot length and seedling dry matter of mungbean and even shoot growth of mungbean was not inhibited by the residue of those herbicides. The reason might be related to the half-life and rate of degradation of herbicides in soil. In addition, farmers can easily grow mungbean in a cropping pattern as a subsequent crop of wheat because the study ensures that tested herbicides did not show any adverse residual effect on the establishment of this succeeding crop. However, continuous use of same herbicide or different herbicides with same mode of action in the same land year after year is strictly prohibited. Also, the prudent use of chemical/herbicide is essential to fulfill the goals of conservation agriculture by having reducing detrimental environmental impact as well as reducing herbicide resistance development in crops.

Keywords: Herbicide residues; residual toxicity; strip tillage; RCBD; mungbean and wheat.

1. INTRODUCTION

Conservation agriculture is a system designed to achieve agricultural sustainability by improving the biological functions of the agro-ecosystem with limited mechanical practices and judicious use of chemical inputs [1]. In conventional farming, farmers would plough in order to clean their fields of weeds and prepare the land before sowing or planting. Conservation agriculture is the preferred option for crop production as it conserves the soil and stabilizes yields. In respect of conservational agriculture, according to New Standard Encyclopedia, soils are a renewable resource, which means that whatever is taken out of the soil can be put back over time [2]. Thus, conservation tillage seeks to reduce tillage practices and increase residual soil covering, which may not be permanently maintained, to achieve similar goals as conservation agriculture [3]. The shift from conventional tillage practices to conservation practices can be particularly difficult with respect to weed control. Despite both environmental and production advantages offered through conservation systems, adoption rates have previously lagged in many countries due to several factors including: availability of required equipment, lack of information, producer mindsets, and initially, weed control issues [4] Derpsch and Friedrich, 2009.

Conservation Agriculture system is more economic and environment friendly but weed is one of the major problems in Conservation Agriculture. Conservation systems have been characterized by greater weed densities than conventionally tilled agricultural production [5,6]. Weeds compete with crop plants, reduce yield and cause economic losses. They can also release allelo-chemicals into the soil which

may be detrimental to nearby competing weed species with particularly for small-seeded weeds [7]. Most weed seeds can survive in the soil for at least 17 years [8] or even longer [9]. Weed management practices are targeted to reduce crop production cost as well as increasing economic profitability with less adverse effect on soil and environment. With the increase of labor cost farmers are highly reliant on herbicidal weed control in their crops under conservation agriculture system. The use of herbicide in a crop may affect the establishment of the succeeding crop under Conservation Agriculture system. Crops are grown in different sequences in Bangladesh. Viz. T. Aman – wheat – mungbean, T. Aman – mustard – mungbean, T. Aman – wheat – sunflower, T. Aman – wheat – Aus rice. But the establishment and yield performance of the crops in a cropping pattern may be influenced by the herbicides used for weed control of the previous crops. Herbicide residue may persist in the soil which can affect the succeeding crops. Some of the earlier studies reported that herbicides had residual effect on biomass and yield of the succeeding crop like wheat after lentil while some other studies found less sensitivity of herbicide residue on the succeeding crops like wheat, sunflower, grain sorghum and maize [10,11]. The residual toxicity may vary in different herbicides. Some of the herbicides like pyrazosulfuron-ethyl, butachlor, etc. had no residual phytotoxic effect on the succeeding crops like cucumber, groundnut, green gram, maize and ladies finger [12,13]. Therefore, there is a need for evaluation of the residual effect of different herbicides on the establishment and growth of the succeeding crops. The information on the response on the effect of herbicides applied in wheat on the following mungbean is highly scarce.

2. MATERIALS AND METHODS

Experiment was carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during March to June, 2014. The field was a medium high land with well drained clay loam soil texture having a pH 6.8. The climate of the experimental area was under the subtropical region and characterized by high temperature, high relative humidity and heavy rainfall with occasional gusty winds during the kharif season and scanty rainfall associated with moderately low temperature during rabi season. Mungbean was used as test crops. Each of these crops was grown after wheat. Each experimental plots used in herbicide experiments for wheat were used to grow the test crops in 1 m x 1 m micro plots. Eighteen treatments consists of No weeding (T₁), Weed free (T₂), Pendimethalin fb Pendimethalin (T₃), Pretilachlor fb Pretilachlor (T₄), Pendimethalin fb Ethoxysulfuran (T₅), pretilachlor fb Ethoxysulfuran (T₆), Pendimethalin fb Ethoxysulfuran fb Carfentrazone-ethyl(T₇), Pretilachlor fb Ethoxysulfuran fb Carfentrazone-ethyl (T₈), Pendimethalin fb Carfentrazone-ethyl (T₉), Pretilachlor fb Carfentrazone-ethyl (T₁₀), Pendimethalin fb Pyrazosulfuran Ethyl fb 2,4-D (T₁₁), Pretilachlor fb Pyrazosulfuran Ethyl fb 2,4-D (T₁₂), Pendimethalin fb 2,4-D (T₁₃), Pretilachlor fb 2,4-D (T₁₄), Pendimethalin fb (Carfentrazone-ethyl + Isoproteuron) (T₁₅), Pretilachlor fb (Carfentrazone-ethyl + Isoproteuron) (T₁₆), Triasulfuron fb (Carfentrazone-ethyl + Isoproteuron) (T₁₇), and Triasulfuron fb 2, 4-D(T₁₈).

In wheat cultivation the experiment was established in a Randomized Complete Design with three replications. The size of each unit plot was 3 m x 4 m. Three micro plots of 1 m x 1 m were prepared in each unit plot to jute to test the response to the treatment used in wheat plot. The jute was placed in the micro plots.500 Jute seed was shown in broadcasting method. During cultivation of BARI Gom-26 white variety on November 2013, experimental land was infested by weeds which were killed by applying Glyphosate @ 100 mL ha⁻¹. Pre-emergence herbicides (Pendimethalin, Pretilachlor and Thiasulfuron) were applied at 03 DAS, early post-emergence (Ethoxysulfuran and Pyrazosulfuran ethyl) at 15 days after sowing and post-emergence herbicides (Carfentrazone-ethyl, 2, 4-D and Carfentrazone- ethyl + Isoproteuron) were applied at 25 DAS in the wheat field. Weed free plots were kept weed free by four hand weeding.

Data were recorded on Germination percentage (25 DAS), Shoot length cm 15 & 30 DAS(cm), Root length 15 & 30 DAS (cm), Leaf chlorophyll content at 25 & 30 DAS (ppm), Dry weight at 30 DAS (gm). Germination counting three days after sowing and it continuous up to 25 days. Leaf chlorophyll content was taken from each micro plot from the five plants which were before selected and the average value was taken. Analysis of variance was done with the help of computer package MSTAT -C program. The mean differences among the treatments were adjudged by Duncan's Multiple Range Test (DMRT) [14].

3. RESULTS AND DISCUSSION

3.1 Plant Population

The plant population of mungbean at 25 DAS was not affected significantly by the residue of different herbicides applied in the wheat crop. The number of seedling decreased in most of the treatment except T₅over the weed free T₂ plots. In some of the treatments the number of seedling are fixed. The highest plant population was (93) and lowest plant population was (86) at the treatment of T₅ and T₁₁ (Table 1, Fig. 1). Sangeetha et al. [15] reported that the residue of imazethapyr herbicides on different doses did not influence germination, growth, yield of sunflower and pearl millet. Khokhar and charak [16] conducted an experiment bio-efficacy of herbicides against complex weed flora in wheat and their residual effects on succeeding crops herbicidal treatments applied in wheat had no significant effect on the germination of the three test crops viz., maize, green gram and cucumber.

3.2 Chlorophyll Content of Leaves (SPAD Value)

Chlorophyll content of leaves was significant to the residual toxicity of herbicides on mungbean. Total chlorophyll contents in mungbean leaves were determined as per Hiscox and Israelstam [17]. The highest value and lowest value of the chlorophyll at 15 DAS and 30 DAS was (38.70, 48.33 and 34.20, 40.20) respectively the treatment of T₁₂ and T₁₈ (Table 1, Fig. 2). Most of the treatments increased except T₁, T₃, T₉, T₁₇ and T₁₈ over the T₂ plots.

3.3 Shoot Length

Non-significant residual toxicity of the herbicides on shoot length at 15 DAS. The highest and

lowest shoot length of the mungbean were 17.81 cm and 15.45 cm of treatment T₁₂ & T₁₈ (Table 2, Fig. 3). But there was a significant residual effects of herbicides at 30 DAS. The highest shoot length was 30.73 cm & lowest shoot length was 24.65 cm for the treatments of T₁₂ and T₁₈ (Table 2, Fig. 3). The percentage of shoot length decreased by 4.05% and 2.4% in the no weeding T₁ plots over weed free T₂ plots and all the herbicides treatment plots increased except T₁₈ and T₁ for both at 15 DAS and 30 DAS. Bahrapor and Sharifi Ziveh [18] reported that seedling weight and plant height was not significantly influenced by herbicides residue.

3.4 Root Length

Root length of the mungbean at 15 & 30 DAS both have non-significant residual effect of the herbicides. The highest root length (4.83 cm and 7.17 cm) both the treatment of T₁₃ lowest root length (3.81 cm and 5.75 cm) both the treatment

of T₁₀ respectively at 15 DAS and 30 DAS (Table 2, Fig. 4). Dharumarajan et al. [19] observed the residues of pretilachlor dissipated to below detectable level within 30 days after application kg ha⁻¹ alone and gypsum+ pretilachlor at 1.5 kg ha⁻¹ persisted up to 45 days after application. The analysis of terminal residues of pretilachlor in rice grain, straw and post-harvest soil indicated that the residues were below detectable limit.

3.5 Dry Weight

Dry weight of mungbean at 30 DAS after sowing was affected significantly by different herbicides treatments applied in the wheat crop. The dry weight decreased in the no weeding (T₁) plot over weed free (T₂) plots. Due to use of herbicides most of the treatment increased over the weed free plot except T₃, T₉, T₁₀, T₁₇, T₁₈. The highest and lowest value were 7.17 gm and 5.34 gm for the treatment T₁₂ and T₁₈

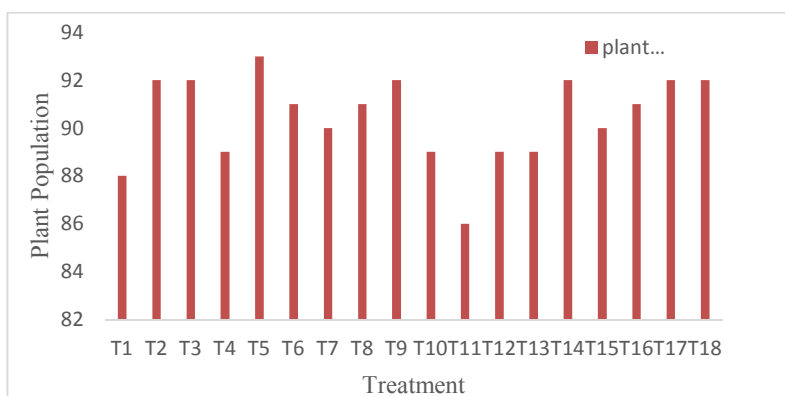


Fig. 1. Residual effect of herbicides on plant population of mungbean

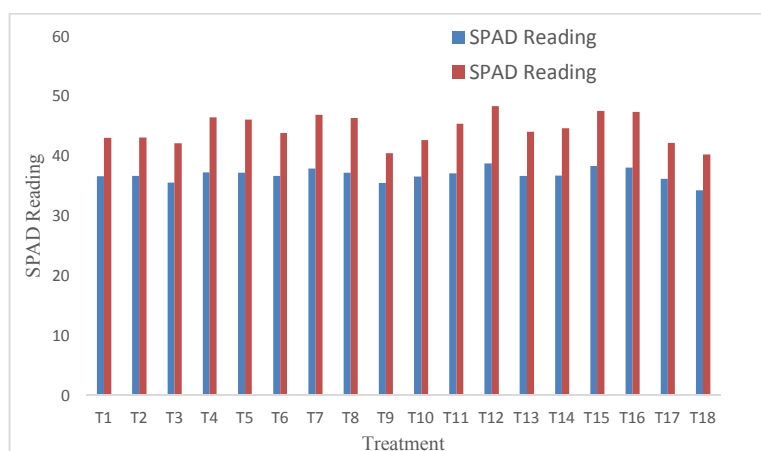


Fig. 2. Residual effect of herbicides on chlorophyll content of mungbean

Table 1. Residual effect of herbicides on plant population and chlorophyll content of mungbean

| Treatment | Plant Population m ⁻² | %inc./dec. | SPAD reading 25 DAS | %inc./dec. | SPAD reading 30 DAS | %inc./dec. |
|-----------------|----------------------------------|------------|---------------------|------------|---------------------|------------|
| T ₁ | 88 | -4.3 | 36.59 | -0.10 | 43.00 | 0 |
| T ₂ | 92 | - | 36.63 | - | 43.07 | - |
| T ₃ | 92 | 0 | 35.50 | -3.08 | 42.08 | -2.3 |
| T ₄ | 89 | -3.3 | 37.25 | +1.70 | 46.43 | +7.8 |
| T ₅ | 93 | +1.1 | 37.20 | +1.6 | 46.03 | +6.8 |
| T ₆ | 91 | -1.08 | 36.65 | +0.05 | 43.77 | +1.6 |
| T ₇ | 90 | -2.2 | 37.83 | +3.30 | 46.87 | +8.8 |
| T ₈ | 91 | -1.08 | 37.20 | +1.60 | 46.33 | +7.6 |
| T ₉ | 92 | 0 | 35.47 | -3.20 | 40.42 | -6.2 |
| T ₁₀ | 89 | -3.3 | 36.53 | -0.30 | 42.65 | -0.97 |
| T ₁₁ | 86 | -6.5 | 37.10 | +1.30 | 45.33 | +5.3 |
| T ₁₂ | 89 | -3.3 | 38.70 | +5.70 | 48.33 | +12.2 |
| T ₁₃ | 89 | -3.3 | 36.65 | +0.05 | 44.05 | +2.3 |
| T ₁₄ | 92 | 0 | 36.67 | +0.10 | 44.60 | +3.6 |
| T ₁₅ | 90 | -2.2 | 38.30 | +4.60 | 47.52 | +10.3 |
| T ₁₆ | 91 | -1.08 | 38.03 | +3.80 | 47.37 | +9.9 |
| T ₁₇ | 92 | 0 | 36.20 | -1.20 | 42.12 | -2.2 |
| T ₁₈ | 92 | 0 | 34.20 | -6.60 | 40.20 | -6.6 |
| CV (%) | 3.25 | | 3.38 | | 3.75 | |
| Level of sig. | NS | | * | | ** | |
| S _x | 1.69 | | 0.67 | | 0.96 | |

Table 2. Residual effect of herbicides on shoot length, root length and dry weight of mungbean

| Treatment | Shoot length (cm) | | | | Root length (cm) | | | | Dry weight (g) | |
|-----------------|-------------------|------------|--------|-----------|------------------|-----------|--------|------------|----------------|-----------|
| | 15 DAS | % inc./dec | 30 DAS | %inc/dec. | 15 DAS | %inc./dec | 30 DAS | % inc./dec | 30 DAS | %inc./dec |
| T ₁ | 16.07 | -4.05 | 26.80 | -2.4 | 4.45 | 0 | 6.55 | -2.8 | 5.69 | -0.35 |
| T ₂ | 16.75 | - | 27.47 | - | 4.45 | - | 6.74 | - | 5.71 | - |
| T ₃ | 17.53 | +4.7 | 28.51 | +3.8 | 4.49 | +9 | 6.86 | +1.8 | 5.37 | -5.9 |
| T ₄ | 16.03 | -4.3 | 28.75 | +4.7 | 4.16 | -6.5 | 6.30 | -6.5 | 6.16 | +7.8 |
| T ₅ | 16.74 | -0.05 | 28.37 | +3.3 | 4.27 | -4 | 6.24 | -7.4 | 6.07 | +6.3 |
| T ₆ | 17.49 | +4.4 | 27.08 | -1.4 | 4.60 | +3.4 | 6.90 | +2.4 | 5.87 | +2.8 |
| T ₇ | 17.60 | +5.07 | 27.88 | +1.5 | 4.33 | -2.7 | 6.26 | -7.1 | 6.18 | +8.2 |
| T ₈ | 17.42 | +4 | 27.69 | +0.8 | 4.53 | +1.8 | 6.82 | +1.2 | 6.09 | +6.6 |
| T ₉ | 17.62 | +5.2 | 29.68 | +8 | 4.06 | -8.8 | 5.95 | -11.7 | 5.34 | -6.5 |
| T ₁₀ | 16.83 | +0.5 | 25.57 | -6.9 | 3.81 | -14.3 | 5.75 | -14.6 | 5.65 | -1 |
| T ₁₁ | 15.60 | -6.8 | 28.51 | +3.9 | 4.29 | -3.6 | 6.15 | -8.8 | 6.07 | +6.3 |
| T ₁₂ | 17.81 | +6.3 | 30.73 | +11.8 | 4.55 | +2.2 | 6.61 | -1.9 | 7.17 | +25.5 |
| T ₁₃ | 15.63 | -6.7 | 30.69 | +11.7 | 4.83 | +8 | 7.17 | +6.4 | 6.03 | +5.6 |
| T ₁₄ | 16.85 | +0.06 | 30.31 | +9.5 | 4.38 | -2.01 | 6.39 | -5.2 | 6.04 | +5.7 |
| T ₁₅ | 17.74 | +5.9 | 27.44 | -0.1 | 4.60 | +2.9 | 6.95 | +3.1 | 6.94 | +21.5 |
| T ₁₆ | 17.41 | +3.9 | 27.75 | +1 | 4.39 | -1.8 | 6.41 | -4.8 | 6.74 | +18 |
| T ₁₇ | 16.83 | +0.5 | 28.84 | +4.9 | 4.23 | -5.4 | 6.12 | -9.2 | 5.37 | -5.9 |
| T ₁₈ | 15.45 | -7.8 | 24.65 | -10.3 | 4.45 | 0 | 6.46 | -4.2 | 4.12 | -27.8 |
| CV (%) | 6.22 | | 6.95 | | 8.29 | | 11.78 | | 8.06 | |
| Level of sig. | NS | | * | | NS | | NS | | ** | |
| S _x | 0.61 | | 1.13 | | 0.21 | | 0.44 | | 0.27 | |

respectively at 30 DAS (Table 2, Fig. 5). Bahrampor and Sharifi Ziveh [18] residue of mesotrione+ terbuthylazin+ s-metalachlor had significant effects on reduction of yield and kernel number per ear (27%), but other traits including

seedling weight and plant height was not significantly influenced by herbicides residue. Possible reason is that field condition and different doses of herbicides and their groups were also different from them.

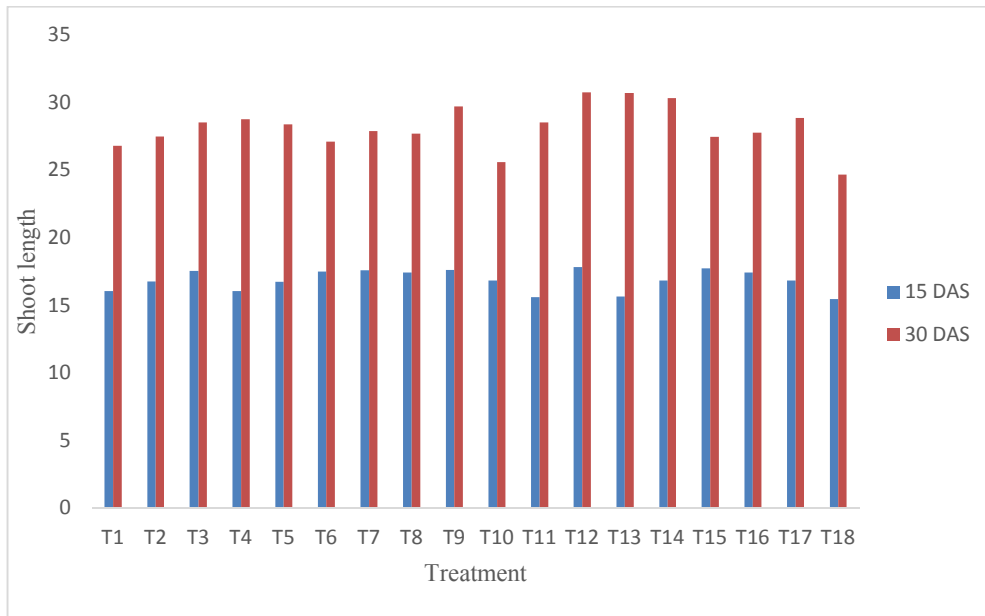


Fig. 3. Residual effect of herbicides on shoot length of mungbean

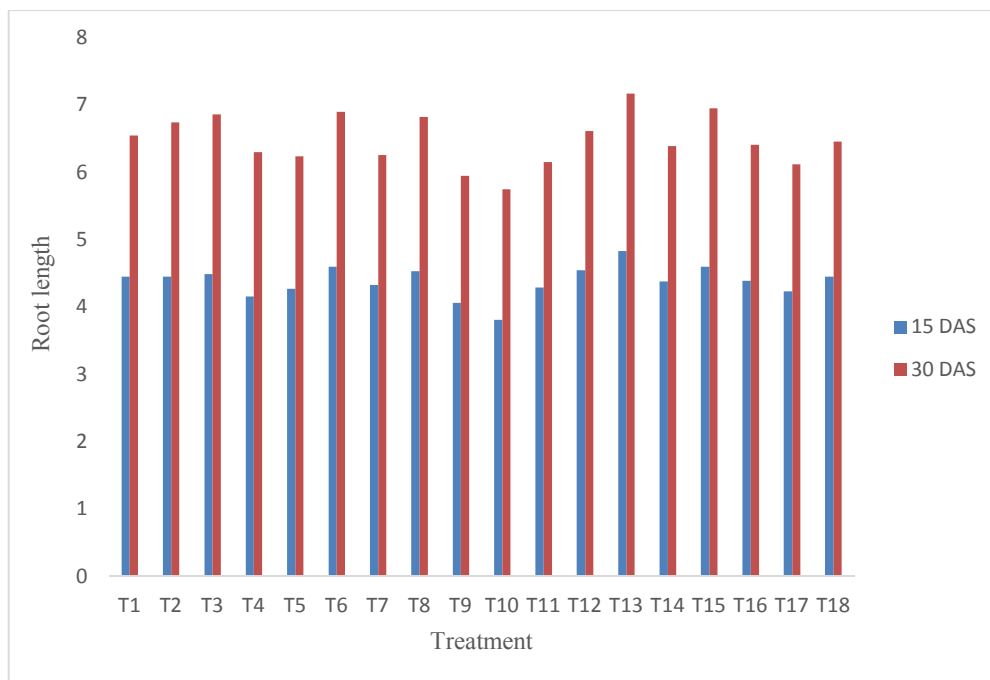


Fig. 4. Residual effect of herbicides on root length of mungbean

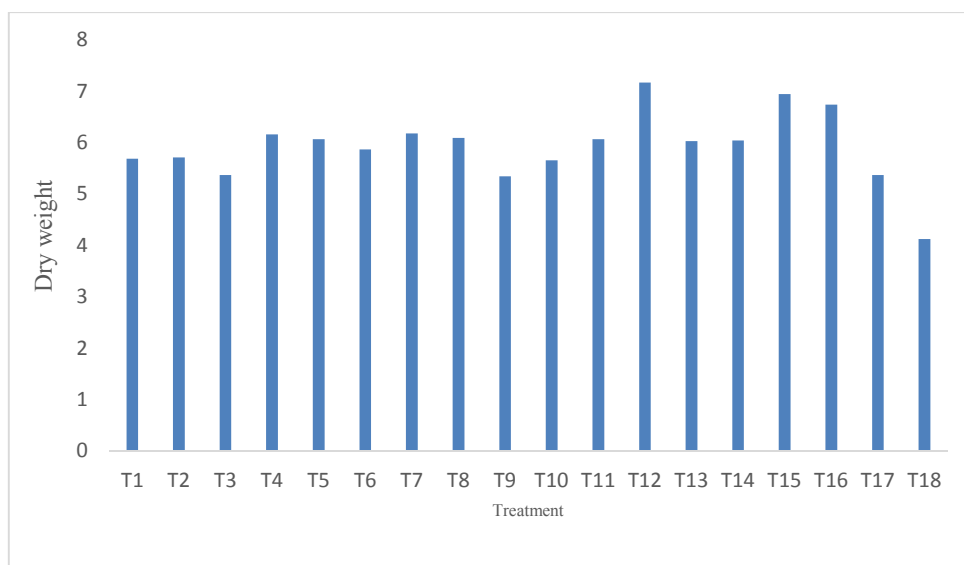


Fig. 5. Residual effect of herbicides on dry weight of mungbean

*T*₁ = No weeding,

*T*₃ = Pendimethalin fb Pendimethalin

*T*₅ = Pendimethalin fb Ethoxysulfuran

*T*₇ = Pendimethalin fb Ethoxysulfuran fb

Carfentrazone-ethyl

*T*₉ = Pendimethalin fb Carfentrazone-ethyl

*T*₁₁ = Pendimethalin fb Pyrazosulfuran Ethyl fb 2,4-D

*T*₁₃ = Pendimethalin fb 2,4-D, *T*₁₄ = pretilachlor fb 2,4-D

*T*₁₅ = Pendimethalin fb (Carfentrazone-ethyl + Isoproteuron)

*T*₁₇ = Traisulfuron fb (Carfentrazone-ethyl + Isoproteuron)

*T*₂ = Weed free (4 hand weeding)

*T*₄ = Pretilachlor fb Pretilachlor

*T*₆ = Pyrazosulfuran Ethyl fb Ethoxysulfuran

*T*₈ = Pretilachlor fb Ethoxysulfuran fb Carfentrazone-ethyl

*T*₁₀ = Pretilachlor fb Carfentrazone-ethyl

*T*₁₂ = Pretilachlor fb Pyrazosulfuran Ethyl fb 2,4-D

*T*₁₄ = Pretilachlor fb 2,4-D

*T*₁₆ = Pretilachlor fb (Carfentrazone-ethyl + Isoproteuron)

*T*₁₈ = Traisulfuron fb 2,4-D

4. SUMMARY AND CONCLUSION

Experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during March to June, 2014 to study the effect of herbicides applied in wheat on the plant density and early growth of mungbean. The result shows that herbicide did not significant effect on the plant population, root length and dry weight of jute but was significant for the shoot length and SPAD value. The residual effect of herbicides was not significant on the plant population, shoot length and root length but significant on the leaf chlorophyll content and dry weight of mungbean. The result concludes that the herbicides used in wheat had no adverse effect on germination and establishment of mungbean.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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