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# Response of Sunflower 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 MAB designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MAKA, MSS, MNH and SP managed the analyses of the study. Author MKH managed the literature searches. All authors read and approved the final manuscript.*

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## ABSTRACT

The residual effect of eight herbicides (Pendimethalin, Pretilachlor, TriasulfuronEthoxysulfuron, 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 the sunflower. The eighteen herbicide treatment combinations of the eight herbicides used in wheat. The experiment was conducted in Random Complete Block Design (RCBD) with three replications. The effect of herbicide residues on the sunflower was evaluated in terms of germination, the seedling root and shoot length, leaf chlorophyll content and seeding dry matter. The result showed that the seedling establishment of sunflower was not adversely affected by the herbicides applied to the previous wheat crop.

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*Keywords: Sunflower; residual effect; herbicide residue; RCBD.*

## 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 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. The shift from conventional tillage practices to conservation practices can be particularly difficult with concerning 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 [2,3], Derpsch and Friedrich, 2009; [3].

Conservation Agriculture system is more economical and environmental-friendly but weed is one of the major problems in Conservation Agriculture. Weeds compete with crop plants, reduce yield and cause economic losses. Weed management practices are targeted to reduce crop production costs as well as increasing economic profitability with a less adverse effect on soil and environment. With the increase of labour cost, farmers are highly reliant on herbicidal weed control in their crops under the conservation agriculture system. The use of herbicide in a crop may affect the establishment of the succeeding crop under the 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. The residual toxicity may vary in different herbicides. Therefore, there is a need for evaluation of the residual effect of different herbicides on the establishment and growth of the succeeding crops [4,5]. The information on the response on the effect of herbicides applied in wheat on the following sunflower is highly scaring.

## 2. MATERIALS AND METHODS

The experiment was carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh from March to June 2014. The field was a medium high land with well - drained clay loam soil texture having a pH value of 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. Jute was used as test crops. Each of these crops was grown after wheat. Each experimental plot used in herbicide experiments for wheat was used to grow the test crops in 1 m x 1 m micro plots. Eighteen treatments consist of No weeding($T_1$), Weed-free (4 hand weeding, $T_2$), Pendimethalin fb Pendimethalin ($T_3$), Pretilachlor fb Pretilachlor ($T_4$), Pendimethalin Ethoxysulfuron ($T_5$), pretilachlorfbEthoxysulfuran ($T_6$), Pendimethalin fb Ethoxysulfuran fb Carfentrazone-ethyl ($T_7$), Pretilachlor fb Ethoxysulfuran fb Carfentrazone-ethyl ($T_8$), Pendimethalin fb Carfentrazone-ethyl ($T_9$), Pretilachlor fb Carfentrazone-ethyl ($T_{10}$), Pendimethalin fb Pyrazosulfuran Ethyl fb 2,4-D ($T_{11}$), Pretilachlor fb Pyrazosulfuran Ethyl fb 2,4-D ($T_{12}$), Pendimethalin fb 2,4-D ($T_{13}$), Pretilachlor fb 2,4-D ($T_{14}$), Pendimethalin fb (Carfentrazone-ethyl+Isoproteuron) ($T_{15}$), Pretilachlor fb (Carfentrazone-ethyl+Isoproteuron) ($T_{16}$), Triasulfuron fb (Carfentrazone-ethyl+ Isoproteuron) ($T_{17}$), and Triasulfuron fb 2, 4-D ($T_{18}$).

In wheat cultivation, the experiment was established in a Randomized Complete Design with three replications. The size of each unit plot was 3 m × 4 m. Three micro plots of 1 m x 1 m was prepared in each unit plot to jute to test the response to the treatment used in the wheat plot. The jute was placed in the micro plots.500 Jute seed was shown in the broadcasting method. During the cultivation of BARI Gom-26 white variety in 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) was 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) was applied at 25 DAS in the wheat field. Weed-free plots were kept weed-free by four hand weeding.

Data was 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 continues up to 25 days. Leaf chlorophyll content was taken from each micro plot from the five plants which was before selected and the average value was taken. Analysis of variance was done with the help of a computer package MSTAT -C program. The mean differences among the treatments were adjudged by Duncan's Multiple Range Test (DMRT) [6].

## 3. RESULTS AND DISCUSSION

### 3.1 Plant Population

The plant population of sunflower at 25 DAS after sowing was not affected significantly by different herbicide treatments applied in the wheat crop. The number of sunflower seedling increased by 3.5% in the no weeding plots over a weed-free plot. The number of sunflower seedling increased in all the herbicides treatment plots over control plots ($T_2$). (Table 1, Fig. 1). The highest plant population was (94) and the lowest plant population was (81) in the treatment of $T_{17}$ (Traisulfuronfb (Carfentrazone-ethyl + Isoproteuron) and $T_{15}$ (Pendimethalin fb (Carfentrazone-ethyl + Isoproteuron) respectively. Saha and WasimAktar [7] reported that the residues of the herbicide were found in soil up to 30 days after spraying. This result was supported by Sangeetha et al. [8] who reported that the residues of imazethapyr at different doses did not influence germination, growth, The yield of sunflower and pearl millet and was statistically at par with checks.

### 3.2 Chlorophyll Content of Leaves (SPAD value)

Chlorophyll content of sunflower was non-significant to the residual toxicity of herbicides both at 25 DAS and 30 DAS. The leaves' chlorophyll content of sunflower decreased by 12.8% and 7.2% in the no weeding plots over the weed-free plots. The leaves chlorophyll content of sunflower increased in all the herbicide treatment plots except $T_{14}$ (pretilachlor fb 2,4–D ) for both the 15 DAS and 30 DAS. The highest value of chlorophyll content was (32.36, 33.07) and the lowest value of chlorophyll content was (23.05, 25.30) in the treatment of $T_4$ (Pretilachlor fb Pretilachlor), T1 (no weeding) at the 25 DAS and 30 DAS respectively. (Table 1. Fig. 2).

### 3.3 Shoot Length

The result of Table 2 and Fig. 3 shows that shoot length of sunflower at 15 DAS and 30 DAS was significant to the residual toxicity of herbicides used in wheat. All the herbicides treatment increased over the weed-free plot. The highest shoot length at 15DAS and 30 DAS was (17.59 cm and 33.36 cm) and the lowest shoot length at 15 DAS and 30 DAS was (13.08 cm and 24.65 cm) in the treatment $T_7$ = Pendimethalin fb Ethyl sulfur fb Carfentrazone -ethyl and $T_2$ (weed-free) plots respectively.

### 3.4 Root Length

Table 2 shows that the result was not significant to the residual toxicity of herbicides which used in the previous crop at 15 DAS but significant at 30 DAS. The root length of sunflower decreased by 0.8% and 4.5% in the no weeding plot over weed-free plots both at 15 DAS and 30 DAS. The highest value of the root length was (3.83 cm and 5.97 cm) both for the treatment of $T_3$ at 15 DAS and 30 DAS respectively. The lowest value of the root length was (3.23 cm and 3.72 cm) for the treatment $T_{12}$ at 15 and 30 DAS respectively (Table 2, Fig. 4). Sharifi Ziveh and Taghi zadeh [9] reported that residue of mesotrione+ terbuthylazin+ s-metalachlor (2.4 l ha-1, post-emergence) had significant effects on reduction of yield and kernel number per ear (27%), but other traits including seedling weight and plant height were not significantly influenced by herbicide residue. The possible reason is that field conditions, herbicide doses and different from them.

### 3.5 Dry Weight

The dry weight of sunflower at 30 DAS after sowing was not affected significantly by different herbicides treatments applied in the wheat crop. The dry weight decreased in the no weeding plot over weed-free plots. Due to the use of herbicides, most of the treatment increased over the weed-free plot except T10 (Pretilachlor fb Carfentrazone -ethyl), (Table 2, Fig. 5). The

highest and lowest dry weight of sunflower at 30 DAS was (4.16 gm and 3.02 gm) in the treatment T4 (Pretilachlor fb Pretilachlor) and T1 (no weeding) respectively. Bahrampor and Sharifi Ziveh [10] Residue of mesotrione+ terbuthylazin+ s-metalachlor had significant effects on the reduction of yield and kernel number per ear (27%), but other traits including seedling weight and plant height were not significantly influenced by herbicides residue.

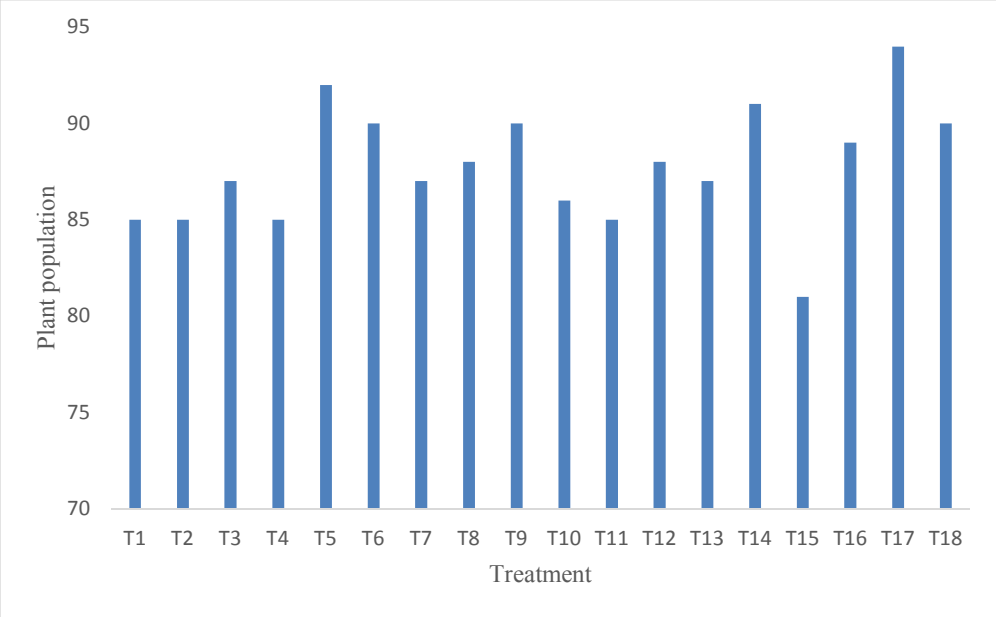


**Fig. 1. The residual effect of herbicides on germination of sunflower**

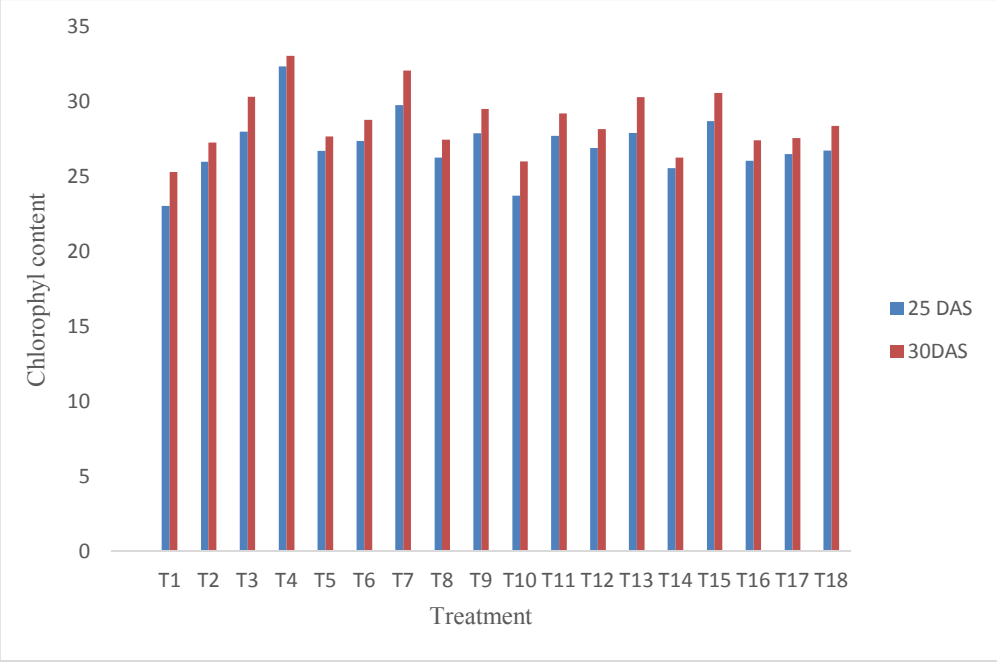


**Fig. 2. The residual effect of herbicides on chlorophyll content of sunflower**

**Table 1. The residual effect of herbicides on plant population and chlorophyll content of sunflower**

| Treatment | Plant population $m^{-2}$ | %inc/ Dec. | Chlorophyll content of leaves (SPAD ) | | | |
|---|---|---|---|---|---|---|
| | 25 DAS | | 25 DAS | %inc/ Dec. | 30 DAS | %inc/ Dec. |
| $T_1$ | 85 | 0 | 23.05 | -12.8 | 25.30 | -7.2 |
| $T_2$ | 85 | - | 26.00 | - | 27.27 | - |
| $T_3$ | 87 | +2.4 | 28.00 | +7.1 | 30.33 | +11.2 |
| $T_4$ | 85 | 0 | 32.36 | +2.4 | 33.07 | +21.3 |
| $T_5$ | 92 | +8.3 | 26.72 | +2.8 | 27.67 | +1.5 |
| $T_6$ | 90 | +5.8 | 27.37 | +5.3 | 28.80 | +5.6 |
| $T_7$ | 87 | +2.4 | 29.77 | +14.5 | 32.07 | +17.6 |
| $T_8$ | 88 | +3.5 | 26.27 | +2.9 | 27.47 | +0.73 |
| $T_9$ | 90 | +5.9 | 27.90 | +7.3 | 29.53 | +8.3 |
| $T_{10}$ | 86 | +1.2 | 23.73 | -8.7 | 26.03 | -4.5 |
| $T_{11}$ | 85 | 0 | 27.72 | +6.6 | 29.23 | +7.2 |
| $T_{12}$ | 88 | +3.5 | 26.90 | +3.5 | 28.17 | +3.3 |
| $T_{13}$ | 87 | +2.4 | 27.92 | +7.4 | 30.30 | +11.1 |
| $T_{14}$ | 91 | +7 | 25.57 | -1.7 | 26.27 | -3.7 |
| $T_{15}$ | 81 | -4.7 | 28.70 | +10.4 | 30.58 | +12.1 |
| $T_{16}$ | 89 | +4.7 | 26.07 | +0.3 | 27.43 | +0.6 |
| $T_{17}$ | 94 | +10.6 | 26.50 | +1.92 | 27.58 | +1.1 |
| $T_{18}$ | 90 | +5.8 | 26.75 | +2.9 | 28.38 | +4 |
| CV(%) | 4.85 | | 9.91 | | 11.21 | |
| Level of sig. | NS | | NS | | NS | |
| $S_x^-$ | 2.47 | | 1.55 | | 1.85 | |

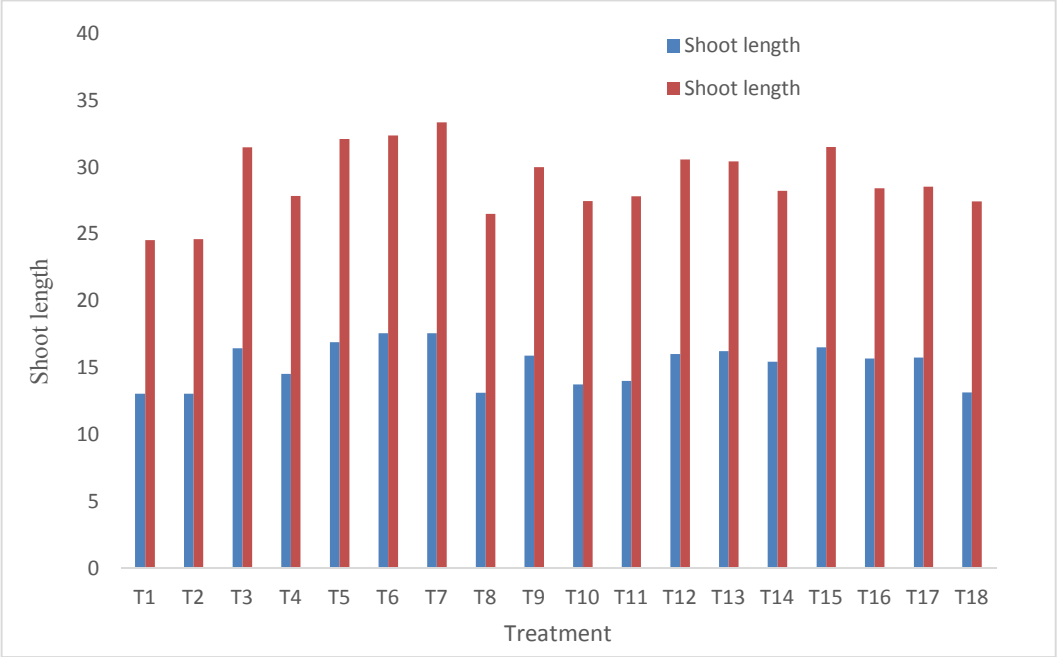


**Fig. 3. The residual effect of herbicides on shoot length of sunflower**

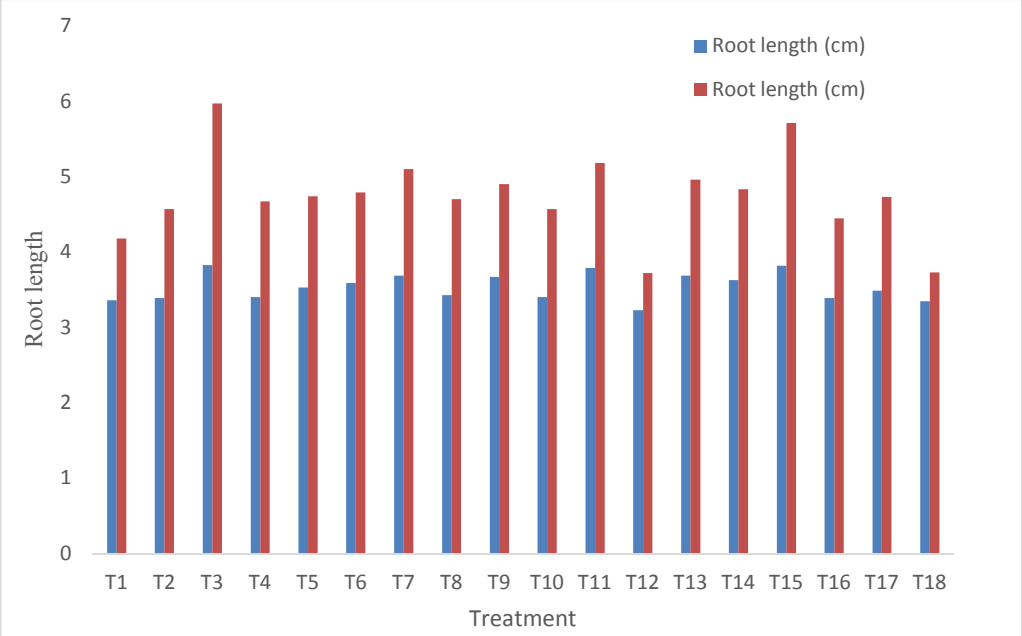


**Fig. 4. The residual effect of herbicides on root length of sunflower**

**Table 2. The residual effect of herbicides on shoot length, root length and dry weight of sunflower**

| Treatment | Shoot length (cm) | | | | Root length (cm) | | | | Dry weight (g) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 15 DAS | %inc./ dec. | 30 DAS | %inc./ dec. | 15 DAS | %inc./ dec. | 30DAS | %inc./ dec. | 30DAS | %inc./ dec. |
| $T_1$ | 13.08 | 0 | 24.55 | -0.4 | 3.36 | -0.8 | 4.18 | -8.5 | **3.02** | **-8.2** |
| $T_2$ | 13.08 | - | 24.65 | - | 3.39 | - | 4.57 | - | 3.29 | - |
| $T_3$ | 16.45 | +25.7 | 31.49 | +27.7 | 3.83 | +12.9 | 5.97 | +30.6 | 3.74 | +13.6 |
| $T_4$ | 14.56 | +11.3 | 27.86 | +13 | 3.40 | +0.3 | 4.67 | +2.2 | 4.16 | +26.4 |
| $T_5$ | 16.92 | +29.4 | 32.13 | +30.3 | 3.53 | +4.1 | 4.74 | +3.7 | 3.38 | +2.7 |
| $T_6$ | 17.57 | +34.3 | 32.39 | +31.3 | 3.59 | +5.8 | 4.79 | +4.8 | 3.42 | +3.9 |
| $T_7$ | 17.59 | +34.5 | 33.36 | +35.3 | 3.69 | +8.8 | 5.10 | +11.5 | 4.09 | +24.3 |
| $T_8$ | 13.14 | +.46 | 26.53 | -7.6 | 3.43 | +1.2 | 4.70 | +2.8 | 3.33 | +1.2 |
| $T_9$ | 15.92 | +21.7 | 30.02 | +21.8 | 3.67 | +8.3 | 4.90 | +7.2 | 3.46 | +5.2 |
| $T_{10}$ | 13.77 | +5.3 | 27.49 | +11.5 | 3.40 | +0.3 | 4.57 | 0 | 3.26 | -0.9 |
| $T_{11}$ | 14.02 | +7.2 | 27.85 | +12.9 | 3.79 | +11.7 | 5.18 | +13.3 | 3.46 | +5.2 |
| $T_{12}$ | 16.03 | +22.5 | 30.60 | +24.1 | 3.23 | -4.7 | 3.72 | -18.5 | 3.40 | +3.4 |
| $T_{13}$ | 16.26 | +24.3 | 30.46 | +23.5 | 3.69 | +8.8 | 4.96 | +8.5 | 3.59 | +9.1 |
| $T_{14}$ | 15.47 | +18.3 | 28.25 | +14.6 | 3.63 | +7 | 4.83 | +5.6 | 3.29 | 0 |
| $T_{15}$ | 16.54 | +26.5 | 31.55 | +27.9 | 3.82 | +12.6 | 5.71 | +24.9 | 3.83 | +16.4 |
| $T_{16}$ | 15.70 | +20 | 28.45 | +15.4 | 3.39 | 0 | 4.45 | -2.6 | 3.30 | +0.3 |
| $T_{17}$ | 15.77 | +20.5 | 28.57 | +15.9 | 3.49 | +2.9 | 4.73 | +3.5 | 3.35 | +1.8 |
| $T_{18}$ | 13.15 | +.53 | 27.47 | +11.4 | 3.35 | -1.2 | 3.73 | -18.3 | 3.41 | +3.6 |
| CV (%) | 6.55 | | 3.09 | | 11.64 | | 13.01 | | 11.43 | |
| Level of sig. | ** | | ** | | NS | | * | | NS | |
| $S_x^-$ | 0.58 | | 0.53 | | 0.24 | | 0.36 | | 0.23 | |

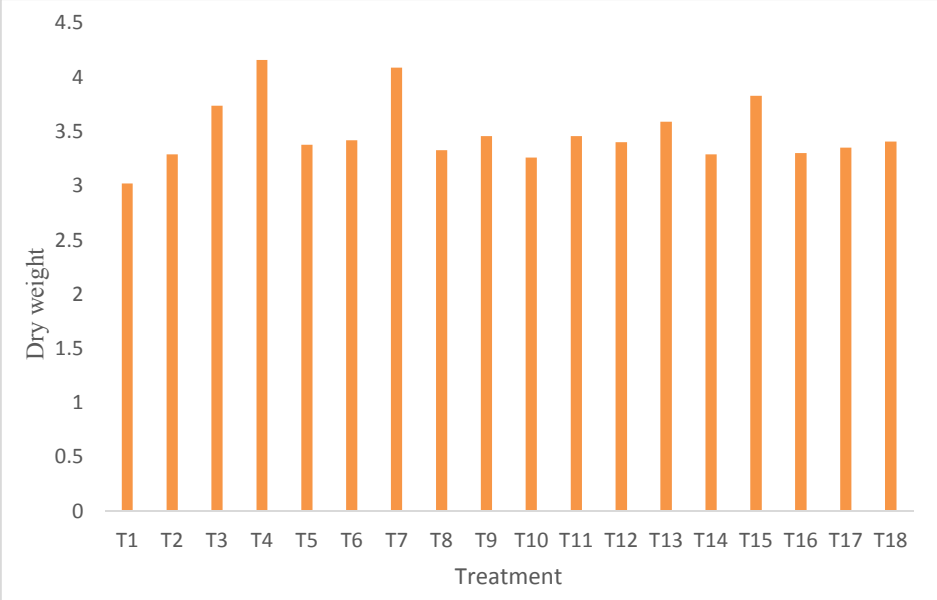


**Fig. 5. The residual effect of herbicides on the dry weight of sunflower**

## 4. SUMMARY AND CONCLUSION

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, during From March to June 2014 to study the effect of herbicides applied in wheat on the plant density and early growth of jute. There was 18 treatment combinations for wheat. The design was the Randomized Complete Block Design (RCBD) with three replications. The wheat was planted by strip tillage with VMP on 23 November the crop was harvested on 19 March. There was pendimethalin, pretilachlor pre-emergence herbicides, and Ethoxysulfuron, Pyrazosulfuron and 2, 4 –D post-emergence herbicides in this experiment. The influence of these herbicides was tested for jute by planting 500 seeds $m^{-2}$ for jute in the micro plots (1 m× 1 m). Data on plant population, shoot length, root length, SPAD value and dry weight was recorded and analyzed with ANOVA table. BARI Sunflower-2 was used as a test crop.

The result shows that herbicide did not significantly affect on the plant population, root length and dry weight of jute but was significant for the shoot length and SPAD value. So, the herbicides used in wheat had no adverse effect on germination and establishment of sunflower.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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