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Amit Ghosh
Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

Debasis Mahata
Department of Agronomy, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India

Ashim Chandra Sinha
Department of Agronomy, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India

Correspondence
Amit Ghosh
Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Benga, India

Effect of different herbicide on ricebean (*Vigna umbellata*) under Terai region of West Bengal

Amit Ghosh, Debasis Mahata and Ashim Chandra Sinha

Abstract
A field experiment was conducted during the post - kharif season of 2013 at Instructional Farm of U.B.K.V, Pundibari, Cooch Beahar, W.B. to study the "Integrated weed management practices in Ricebean (*Vigna umbellata*) under rainfed condition'' with the following objectives: i) to identify the efficiency of Pendimethalin & Butachlor as pre-emergence, Quizalofop-p-ethyl as post-emergence herbicide in ricebean under Terai Agro - Climatic situation (ii) to assess the performance of pre - emergence application of herbicide as compared to the standard hand weeding/ hoeing in controlling weeds of ricebean and (iii) work out the economics of various treatments for ricebean cultivation. The field experiment was carried out in Randomized block design, having eleven (11) treatments with three replications. Finally, it may be concluded that highest weed control efficiency was recorded under hand weeding twice (T7) followed by pre-emergence application of Pendimethalin along with one hand weeding at 30 DAS (T5). Hand weeding (once) at 20 DAS & wheel hoeing once at 30 DAS (T9) and Pre- emergence applications of Butachlor @ 1kg a.i / ha with one hand weeding at 30 DAS (T2). Hand weeding once at 30 DAS (T6), Wheel hoeing twice at 20 & 30 DAS (T8), Pendimethalin (Stomp- extra 38.7% E.C) as Pre-emergence @ 1.0 kg a.i/ ha (T4) and Post-emergence application of Quizalofop-p-ethyl (Turga super) @ 60 g ha-1 at 20 DAS (T3).

Keywords: Ricebean, herbicide, hand weeding and weed

Introduction
The field experiment was carried out at the Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal. The farm is situated at $26^0 19' 86''$ N latitude and $89^0 23' 53''$ E longitude, at an elevation of 43 meter above mean sea level. The northern region of West Bengal (*terai zone*) is placed along Kalimpong hills, Kurseong hills and Bhutan hills in northern side and Bangladesh in southern side. Assam border is located at the eastern side. Bihar border is located at the western side. It includes Siliguri subdivision of Darjeeling, entire portion of Jalpaiguri and Cooch Behar and Islampur subdivision of North Dinajpur district. Total geographical area of this zone is 1025 sq. Km which occupies 13.5% of the total state area. Ricebean (*Vigna umbellata*) is one of the kharif/post kharif legumes grown by sustaince farmers in hilly and plain areas. Pulses along with cereals complete the diet of human beings. As compared to any other country. Pulses are very important in Indian agriculture. As most of the pulses are originated in India and became integral part of Indian agriculture. Among them Rice bean is one of the most important pulse, botanically known as *Vigna umbellata*. Unlike any other pulse it is little known, little researched and little exploited hence, comes in category of underutilized pulse crop. But with increasing demand for nutritional security rice bean recently gained attention as highly nutritive pulse with sound productivity. It belongs to Fabaceae family with diploid chromosome number 22. The centre of domestication is Indo-China. Progenitor of rice bean is *V. umbellate* var *gracilis*. It is short-lived warm-season annual pulse, mostly grown as an intercrop, of maize, sorghum and cowpea as well as a sole crop in the uplands. Grows well on any type of soil, establishes rapidly and has the potential to produce large amounts of nutritious animal fodder and high quality grain. It is used as dried pulse, vegetable, animal fodder and as green manure.

Nutrient content of rice bean change it category from underutilised pulse to potential crop for nutritional security. The nutritional quality of rice bean is higher as compared to many other legumes of Vigna family. Rice bean occupy an important place in human, animal nutrition and soil health improvement. Along with protein it contains essential amino acids, essential fatty acids, vitamins and minerals.

Thus it acts as supplementary to the cereal based diet by enhancing their protein nutritive value.

Rice bean is Nitrogen-fixing legume that improves the Nitrogen status of the soil, thus providing N to the following crop. is important as green manure for supply of nitrogen and replenishing the nutrient balance to make soil healthy. Its taproot has a beneficial effect on soil structure and, when ploughed in, returns organic matter and N to the soil. It produces high biomass in a very short period of time, can be easily incorporate into the soil, and decomposes rapidly all this characteristics made It also by providing good soil cover. After harvesting its seed, the dry plant can be utilized for soil cover for the dry season, resulted in reduction in soil erosion. Rice bean is considered as best legume for green manure.

Materials and Methods

The experiment was laid out in a Randomized Block Design (RBD) with 11 treatments and replicated thrice giving a total of 33 unit plots each measuring 5.0 m × 3.0 sq. m the plan of layout of the field experiment is given in fig. 3.4 the treatments were allotted randomly in each plots using Fisher and Yates random number. Experimental design: Randomized Block Design (RBD Name of Crop: Ricebean (Vigna *umbellata*) Variety: RBL -6 Replication: 3 (Three) Plot size: 5.0 m × 3.0 m Number of treatment combination: 11 (eleven) T1 – Butachlor (Pre- emergence) @ 1kg a.i/ha, T2 – Butachlor (Pre- emergence) @ 1kg a.i/ha + One (1) Hand Weeding at 30DAS, T3 – Quizalofop-p- ethyl (Turga super) @ 60 g ha^{-1} at 20 DAS as post- emergence, T4- Pendimethalin (Stomp- extra 38.7% E.C) as Pre-emergence @ 1.0 kg a.i/ ha, T5 - Pendimethalin (Stomp- extra 38.7% E.C) as Pre-emergence @ 1.0 kg a.i/ ha + One Hand weeding at 30 DAS (T5), T6 – Hand weeding (once) at 30 DAS, T7 – Hand Weeding (Twice) at 20& 30DAS, T8 – Wheel hoeing (Twice) at 20 &30 DAS, T9 – Hand weeding (once) at 20 DAS & Wheel hoeing at 30 DAS, T10 – Weed- free control and T11 – Weedy check.

Results and discussion:

1. Effect of treatments on total weed population

Data on the effect of treatments on the total weed population have been presented in Table 1. Critical examination of the data pertaining to the total number of weeds per metre square revealed that the weed population went on increasing till the last observation recorded at harvest during the year of observation. During investigation year the rate of increase in weed population per meter square was highest in weedy check treatment (T11) from the 40 DAS to at harvest.

Both initial weed population per unit area and weed population per meter square throughout the period of crop growth were very high in weedy check treatment (T11*)* during the year of investigation indicating greater weed crop competition from the early stage of crop growth.

The data in Table.1. also revealed that none of the herbicide treatments alone gave satisfactory weed control so far as weed population per unit area was concerned. However, among the herbicidal treatments, pre-emergence application of Pendimethalin @ 1kg ha-^{1} (T4) followed by post-emergence application of Quizalofop-p-ethyl @ 60 gm. ha^{-1} *(T3)* gave the best performance in this regard. This was also reported by Bera and Patra (1995).

Hand weeding twice (T7) at 20 and 30 DAS during the year of investigation gave the efficient weed control followed by Pre-emergence application of Pendimethalin 1 kg ha^{-1} along with one hand weeding at 30 DAS (T5).

2. Effect of treatments on Grass weeds population.

It would be seen from the Table 2 that there was highest number of grassy weeds per unit area was observed in weedy check (T11) in all the observation during the year of investigation recorded at different stages of crop growth compared to any treatment tried in this investigation (Table 2) Irrespective of the year of experimentation, hand weeding twice at 20 & 30DAS (T7) was found to be the most effective one in controlling grassy weeds population per-unit area and recorded in general, the lowest number of grassy weeds per metre square. Removal of grassy weeds twice at the early stage of crop growth and when the competing ability of the crop was less, led to the fullest manifestation of growth and development of the crop to have a good canopy at the later stages of the growth and this was reflected in the reduced number of grassy weeds per-metre square. Among the herbicidal treatments, lowest number of grassy weeds was recorded when Preemergence application of Pendimethalin combined with one hand weeding at 30 DAS (T5) was done followed by Butachlor as pre-emergence application integrated with one hand weeding at 30 DAS (T2). Pre-emergence application of Pendimethalin @1kg ha^{-1} (T4), post-emergence application of Quizalofop-p-ethyl @ 60 g ha^{-1} (T3) and Butachlor as pre- emergence @ 1 kg ha^{-1}(T1) when applied alone was not quite effective in controlling grassy weeds population. Grassy weeds population was quite less under hand weeding once at 30 DAS (T6) followed wheel hoeing (twice) at 20 & 30 DAS than pre-emergence application of Pendimethalin, Butachlor and Quizalofop-p-ethyl at all the stages of crop growth during year of experimentation as reported by (Table 2).

3. Effect of treatments on sedge weeds population

It would be seen from the data in Table 3 that the crop had low infestation of sedge weeds during the year of experimentation at all the stages of crop growth. Among the herbicidal treatments tried in this investigation, pre-emergence application of Pendimethalin @ 1 kg. ha^{-1} followed by one hand weeding at 30 DAS (T5) was found to be the most effective in reducing sedge weeds population per unit area and was significantly superior to pre-emergence application of Butachlor (T1), Pendimethalin (T4) and post-emergence application of Quizalofop-p- ethyl (Turga super) @ 60 g ha-1 at 20 DAS (T3) when applied alone. Hand weeding (Once) at 30 DAS (T6) and Wheel hoeing (Twice) at 20 & 30 DAS (T8) also recorded lower sedge weeds population over weedy check (T11). The lowest sedge weeds population was recorded under hand weeding (twice) at 20 & 30 DAS (T7) and the highest sedge weeds population was recorded under weedy check (T11) Rathi *et al*. (2004) [5].

4. Effect of treatments on broad leaved weed population

It would be seen from the data in Table 4 that the crop had a high infestation of broad leaved weeds at all the stages crop growth during the year of experimentation. This is explainable from the fact that lesser number of grassy and sedge weeds per unit area (Table 4) offered least competition to the broad leaved weeds and this allowed heavy infestation and rank growth of broad leaved weeds in this experimental situation. It would be seen from the Table 4 that broad leaved weeds population per metre square went on increasing with the age of the crop in all the treatments during the year of the investigation. Number of broad leaved weeds per unit area was the highest in weedy check (T11) at all the stage of crop growth (Table 4). Hand weeding (twice) at 20 and 30 DAS

(T7) reduced broad leaved weed population per unit area as compared to other treatments at all the stages of crop growth. Among the herbicidal treatments, pre-emergence application of Pendimethalin (Stomp- extra 38.7% E.C) @ 1.0 kg a.i/ ha along with one hand weeding at 30 DAS (T5) gave the best control of broad leaved weeds at all the stages of crop growth during the year of experimentation. This was closely followed by pre-emergence applications of Butachlor @ 1kg a.i / ha combined with one hand weeding at 30 DAS (T2). Hand weeding (once) at 30 DAS (T6), Wheel hoeing (Twice) at 20 & 30 DAS (T8), Hand weeding (Once) at 20 DAS & Wheel hoeing (Once) at 30 DAS (T9) recorded lower broad leaved weeds over the application of the herbicides when applied alone (T1, T3 and T4) at all the stages of crop growth during the year of investigation (Table 4). Kumar and Tewari (2004) these finding suggested that more number of hand weeding was needed to cope with the flushes of broad leaved weeds that came up during the period of crop growth.

5. Effect of treatments on Weed Control Efficiency and Weed index

The data on weed control efficiency (Table 5) revealed that the values of weed control efficiency was found higher to lower rate from 40 DAS to at harvest.

At 40 DAS: Among the different method of weed control practices, the highest weed control efficiency was obtained in hand weeding (twice) at 20 & 30 DAS (T7) followed by pre-emergence application of Pendimethalin (Stomp- extra 38.7% E.C) @ 1.0 kg a.i/ ha along with one hand weeding at 30 DAS (T5), Hand weeding (once) at 20 DAS & wheel hoeing once at 30 DAS (T9) and Pre- emergence applications of Butachlor @ 1kg a.i / ha with one hand weeding at 30 DAS (T2). Hand weeding once at 30 DAS (T6), Wheel hoeing twice at 20 & 30 DAS (T8), Pendimethalin (Stomp- extra 38.7% E.C) as Pre-emergence @ 1.0 kg a.i/ ha (T4) and Post-emergence application of Quizalofop-p- ethyl (Turga super) @ 60 g ha-1 at 20 DAS (T3). The lowest weed control efficiency was recorded under Pre- emergence application of Butachlor @ 1kg.a.i / ha (T1) Singh *et al.* (2002) [6] (Table 5).

At 60 DAS: Among the different method of weed control practices, the highest weed control efficiency was obtained in hand weeding twice (T7) at 20 & 30 DAS followed by the pre-emergence application of Pendimethalin (Stomp- extra 38.7% E.C) @ 1.0 kg a.i/ ha along with one hand weeding at 30 DAS (T5), Hand weeding (once) at 20 DAS & Wheel hoeing (Once) at 30 DAS (T9), pre-emergence application of Butachlor with one hand weeding at 30 DAS (T2), Hand weeding (once) at 30 DAS (T6), Wheel hoeing (twice) at 20 & 30 DAS (T8), Pendimethalin (Stomp- extra 38.7% E.C) as Pre-emergence @ 1.0 kg a.i/ ha (T4) and Post-emergence application of Quizalofop-p- ethyl (Turga super) @ 60 g ha-1 at 20 DAS (T3). Lowest weed control efficiency was recorded under Pre- emergence application of Butachlor @ 1kg.a.i / ha (T1) Mandal *et al.* (2006) (Table 5).

At Harvest: Highest weed control efficiency was recorded under hand weeding twice (T7) followed by pre-emergence application of Pendimethalin along with one hand weeding at 30 DAS (T5). Hand weeding (once) at 20 DAS & wheel hoeing once at 30 DAS (T9) and Pre- emergence applications of Butachlor @ 1kg a.i / ha with one hand weeding at 30 DAS (T2). Hand weeding once at 30 DAS (T6), Wheel hoeing twice at 20 & 30 DAS (T8), Pendimethalin (Stomp- extra 38.7% E.C) as Pre-emergence @ 1.0 kg a.i/ ha (T4) and Post-emergence application of Quizalofop-p- ethyl (Turga super) @ 60 g ha-1 at 20 DAS (T3). Similar results also reported by Jain *et al.* (1997) [2] and Rathi *et al.* (2004) [5]. Lowest value of weed control efficiency was recorded when Preemergence application of Butachlor (T1) was applied (Table 5).

Table 1: Effect of treatments on total weed population (m^{-2}) at different stages of crop growth

Treatments	Total no of weed population (m^{-2})		
	Days	after	sowing
	40	60	At Harvest
T1 = Pre- emergence application of Butachlor @ 1kg.a.i / ha	12.64 (159.30)	13.68 (186.74)	16.88 (284.41)
T2= Pre- emergence applications of Butachlor @ 1kg a.i / ha + One hand weeding at 30 DAS	7.27 (52.34)	8.83 (77.47)	11.21 (125.61)
T3= Quizalofop-p- ethyl (Turga super) @ 60 g ha-1 at 20 DAS	10.13 (102.12)	11.25 (126.13)	13.99 (195.25)
T4= Pendimethalin (Stomp- extra 38.7% E.C) as Pre-emergence @ 1.0 kg a.i/ ha	9.25 (85.19)	10.57 (111.26)	13.39 (178.96)
T5= Pendimethalin (Stomp- extra 38.7% E.C) as Pre-emergence @ 1.0 kg a.i/ ha + One hand weeding at 30 DAS	5.48 (29.61)	6.58 (42.87)	8.39 (69.95)
T6= Hand weeding (Once) at 30 DAS	7.74 (59.61)	9.31 (86.16)	11.90 (141.84)
T7= Hand weeding (Twice) at 20 DAS & 30 DAS	4.75 (22.06)	5.63 (31.39)	7.48 (55.62)
T8= Wheel hoeing (Twice) at 20 & 30 DAS	8.51 (72.12)	9.95 (98.50)	12.50 (156.65)
T9= Hand weeding (Once) at 20 DAS & Wheel hoeing (Once) at 30 DAS	6.23 (38.41)	8.32 (68.83)	10.56 (111.16)
T10= Weed free control	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T11= Weed Check	13.98 (194.89)	14.99 (224.24)	18.40 (338.38)
S.E m (±)	0.14	0.18	0.28
C.D. (P = 0.05)	0.42	0.53	0.82

Data subjected to square root of transformations (X + 0.5). Figure in parenthesis indicates original value

Table 2: Effect of treatments on grassy weed population at different stages of crop growth

Treatments	Grassy weed population(m^{-2})		
	Days after sowing		
	40	60	At Harvest
T1 = Pre- emergence application of Butachlor @ 1kg.a.i / ha	6.47 (41.47)	7.28 (52.47)	9.36 (87.12)
T2= Pre- emergence applications of Butachlor @ 1kg a.i / ha + One hand weeding at 30 DAS	4.47 (19.53)	5.40 (28.72)	6.96 (48.07)
T3= Quizalofop-p- ethyl (Turga super) @ 60 g ha-1 at 20 DAS	5.61 (31.06)	6.43 (40.92)	8.13 (65.62)
T4= Pendimethalin (Stomp- extra 38.7% E.C) as Pre-emergence @ 1.0 kg a.i/ ha	5.02 (24.79)	6.02 (35.74)	7.85 (61.21)
T5= Pendimethalin (Stomp- extra 38.7% E.C) as Pre-emergence @ 1.0 kg a.i/ ha + One hand weeding at 30 DAS	3.05 (8.84)	3.64 (12.87)	4.68 (21.60)
T6= Hand weeding (Once) at 30 DAS	4.27 (17.78)	5.76 (32.74)	7.40 (54.60)
T7= Hand weeding (Twice) at 20 DAS & 30 DAS	2.56 (6.24)	3.42 (11.21)	4.55 (20.29)
T8= Wheel hoeing (Twice) at 20 & 30 DAS	4.82 (22.82)	5.82 (33.44)	7.47 (55.62)
T9= Hand weeding (Once) at 20 DAS & Wheel hoeing (Once) at 30 DAS	3.39 (11.04)	5.29 (27.57)	6.81 (45.99)
T10= Weed free control	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T11= Weed Check	8.54 (72.49)	9.26 (85.19)	10.99 (120.43)
S.E m (±)	0.18	0.15	0.19
C.D. (P = 0.05)	0.53	0.44	0.57

Data subjected to square root of transformation (X + 0.5). Figure in parenthesis indicates original value

Table 3: Effect of treatments on sedges weed population at different stages of crop growth

Treatments	Sedges weed population(m^{-2})		
	Days after sowing		
	40	60	At Harvest
T1 = Pre- emergence application of Butachlor @ 1kg.a.i / ha	7.47 (55.40)	8.11 (65.23)	10.16 (102.68)
T2= Pre- emergence applications of Butachlor @ 1kg a.i / ha + One hand weeding at 30 DAS	3.91 (14.84)	5.12 (25.72)	6.45 (41.46)
T3= Quizalofop-p- ethyl (Turga super) @ 60 g ha-1 at 20 DAS	6.00 (35.56)	6.75 (45.05)	8.35 (69.17)
T4= Pendimethalin (Stomp- extra 38.7% E.C) as Pre-emergence @ 1.0 kg a.i/ ha	5.49 (29.69)	6.34 (39.69)	7.91 (62.13)
T5= Pendimethalin (Stomp- extra 38.7% E.C) as Pre-emergence @ 1.0 kg a.i/ ha + One hand weeding at 30 DAS	3.27 (10.22)	4.04 (15.82)	5.09 (25.43)
T6= Hand weeding (Once) at 30 DAS	4.74 (21.99)	5.35 (28.13)	6.80 (46.09)
T7= Hand weeding (Twice) at 20 DAS & 30 DAS	2.98 (8.39)	3.27 (10.30)	4.36 (18.54)
T8= Wheel hoeing (Twice) at 20 & 30 DAS	5.01 (24.60)	5.85 (33.77)	7.30 (53.17)
T9= Hand weeding (Once) at 20 DAS & Wheel hoeing (Once) at 30 DAS	3.64 (12.78)	4.57 (20.48)	5.86 (33.91)
T10= Weed free control	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T11= Weed Check	7.61 (57.45)	8.27 (67.94)	10.65 (112.97)
S.E m (±)	0.147	0.13	0.20
C.D. (P = 0.05)	0.436	0.39	0.61

Data subjected to square root of transformations (X + 0.5). Figure in parenthesis indicates original value.

Table 4: Effect of treatments on broad leaved weed population at different stages of crop growth

Treatments	Broad leaved weed population(m^{-2})		
	Days after sowing		
	40	60	At Harvest
T1 = Pre- emergence application of Butachlor @ 1kg.a.i / ha	7.93 (62.42)	8.34 (69.04)	9.75 (94.61)
T2= Pre- emergence applications of Butachlor @ 1kg a.i / ha + One hand weeding at 30 DAS	4.29 (17.98)	4.85 (23.03)	6.04 (36.08)
T3= Quizalofop-p- ethyl (Turga super) @ 60 g ha-1 at 20 DAS	6.00 (35.50)	6.37 (40.17)	7.81 (60.46)
T4= Pendimethalin (Stomp- extra 38.7% E.C) as Pre-emergence @ 1.0 kg a.i/ ha	5.58 (30.71)	6.02 (35.84)	7.49 (55.62)
T5= Pendimethalin (Stomp- extra 38.7% E.C) as Pre-emergence @ 1.0 kg a.i/ ha + One hand weeding at 30 DAS	3.32 (10.55)	3.81 (14.19)	4.84 (22.93)
T6= Hand weeding (Once) at 30 DAS	4.48 (19.70)	5.08 (25.30)	6.44 (41.16)
T7= Hand weeding (Twice) at 20 DAS & 30 DAS	2.81 (7.44)	3.22 (9.88)	4.15 (16.79)
T8= Wheel hoeing (Twice) at 20 & 30 DAS	5.01 (24.71)	5.63 (31.29)	6.95 (47.87)
T9= Hand weeding (Once) at 20 DAS & Wheel hoeing (Once) at 30 DAS	3.88 (14.59)	4.61 (20.79)	5.63 (31.26)
T10= Weed free control	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T11= Weed Check	8.08 (64.95)	8.46 (71.11)	10.27 (104.98)
S.E m (±)	0.14	0.16	0.14
C.D. (P = 0.05)	0.42	0.49	0.43

Data subjected to square root of transformations (X + 0.5). Figure in parenthesis indicates original value.

Table 5: Effect of treatments on weed control efficiency, weed index at different stages of crop growth

Treatments	Weed control efficiency (%)			Weed index at harvest (%)
	40 DAS	60 DAS	At harvest	
T1 = Pre- emergence application of Butachlor @ 1kg.a.i / ha	28.11	27.72	23.90	45.91
T2= Pre- emergence applications of Butachlor @ 1kg a.i / ha + One hand weeding at 30 DAS	73.91	60.42	56.11	21.69
T3= Quizalofop-p- ethyl (Turga super) @ 60 g ha-1 at 20 DAS	53.12	34.96	28.69	40.13
T4= Pendimethalin (Stomp- extra 38.7% E.C) as Pre-emergence @ 1.0 kg a.i/ ha	59.25	39.50	33.55	34.77
T5= Pendimethalin (Stomp- extra 38.7% E.C) as Pre-emergence @ 1.0 kg a.i/ ha + One hand weeding at 30 DAS	82.15	69.25	65.85	12.16
T6= Hand weeding (Once) at 30 DAS	68.33	54.71	49.87	23.45
T7= Hand weeding (Twice) at 20 DAS & 30 DAS	87.21	74.55	71.91	6.73
T8= Wheel hoeing (Twice) at 20 & 30 DAS	61.11	47.91	42.42	27.30
T9= Hand weeding (Once) at 20 DAS & Wheel hoeing (Once) at 30 DAS	77.83	63.02	59.04	16.22
T10= Weed free control	100.00	100.00	100.00	0.00
T11= Weed Check	0.00	0.00	0.00	55.63

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