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Evaluation of Preemergence Herbicide and Hand Weeding on the Weed Control Efficiency and Performance of Transplanted *Aus* Rice

[1]Mirza Hasanuzzaman, [1]M.H. Ali, [1]M.M. Alam, [2]Mujahid Akther and [3]Kazi Fakhrul Alam

[1]Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh
[2]Bayer CropScience, Dhaka, Bangladesh
[3]Department of Agricultural Extension, Hathazari, Chittagong

Abstract: An experiment was conducted at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during March-August, 2009 to evaluate preemergence herbicides and hand weeding on the weed control efficiency and performance of transplanted *aus* rice. The experiment was carried out with seven (7) weed management treatments viz. W_1 = Control (no weeding); W_2 = 1 hand weeding at 25 days after transplanting (DAT); W_3 = 2 hand weeding at 25 and 50 DAT; W_4 = Topstar® 400 SP (Oxadiargyl 400 g/l) @ 190 ml ha^{-1}; W_5 = Sunrice 13.75 WG (Ethoxysulfuron 125 g/kg + Idiosulfuran 12.5 g/kg) @ 100 g ha^{-1}; W_6 = Topstar 80 WP (Oxadiargyl 800 g/kg) @ 75 g ha^{-1} and W_7 = Topstar® 400 SP (Oxadiargyl 400 g/l) @ 190 ml ha^{-1} + 1 hand weeding at 25 DAT. The results showed that the treatment W_7 controlled the weeds most effectively which produced significantly highest yield and yield contributing characters. The treatment W_3 also produced identical yield to W_7. The grain yield produced by W_7 (Topstar® 400 SP @ 190 ml ha^{-1} + 1 hand weeding at 25 DAT) and W_3 (2 hand weeding at 25 and 50 DAT) was 104.90% and 92.65% higher than the yield obtained from unwedded control (W_1). Among the preemergence herbicides, Sunrice 13.75 WG showed better performance to control weed. Considering weed control cost W_7 found to be most economic weed control method for transplanted *aus* rice.

Key words: Paddy · Herbicide · Weed control efficiency · Yield

INTRODUCTION

Rice (*Oryza sativa* L.) is the vital food for more than two billion people in Asia and four hundreds of millions of people in Africa and Latin America [1]. The people in Bangladesh depend on rice as staple food and have tremendous influence on agrarian economy of Bangladesh. Rice alone constitute of 95% of the food grain production in Bangladesh [2]. The average yield of rice in Bangladesh is 2.45 t ha^{-1} [3]. This average yield is almost less than 50% of the world average rice grain yield. Infestation of weed is one of the most important causes for low yield of rice.

Weeds grow profusely in the rice fields and reduce crop yields drastically. Normally the loss in yield ranges between 15-20 % yet in severe cases the yield losses can be more than 50 %, depending upon the species and intensity of weeds. In Bangladesh, weed infestation reduces the grain yield by 70-80% in *Aus* rice (early summer), 30-40% for Transplanted (T) *Aman* rice (late summer) and 22-36% for modern *Boro* rice (winter rice) cultivars [3,4]. Production cost of rice increased due to increases in weed control cost. The prevailing climatic and edaphic conditions are highly favorable for luxuriant growth of numerous species of weeds that strongly compete with rice crop.

In Bangladesh the traditional methods of weed control practices include preparatory land tillage, hand weeding by hoe and hand pulling. Usually two or three hand weeding are normally done for growing a rice crop depending upon the nature of weeds, their intensity of infestation and the nature of crop grown. Weed control in transplanted rice by mechanical and cultural is an expensive method. Especially at the time of peak period of labor crisis sometimes weeding becomes late causing drastic losses in grain yield. In contrast to this chemical weed control is sufficient to control the weeds. Nowadays use of herbicides is gaining popularity in rice culture due

Corresponding Author: Mirza Hasanuzzaman, Department of Agronomy Faculty of Agriculture,
Sher-e-Bangla Agricultural University Dhaka-1207, Bangladesh

to their rapid effects and less cost involvement compared to traditional methods. Mechanical weeding and herbicides are the alternative to hand weeding. Herbicides are effective in controlling weeds alone or in combination with hand weeding [5]. In Bangladesh, few studies have attempted to establish the most suitable and economic integrated weed management system in *aus* rice. Thus this study was conducted to evaluate the appropriate herbicide and find out the effective weed management practices in *aus* rice which will ensure an economic rice production.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during August, 2008 to January 2009. The soil of the experimental field belongs to the Shallow Red Brown Terrace Soils. The experiment was carried out with seven (7) weed management treatments viz. W_1 = Control (no weeding); W_2 = 1 hand weeding at 25 days after transplanting (DAT); W_3 = 2 hand weeding at 25 and 50 DAT; W_4 = Topstar® 400 SP (Oxadiargyl 400 g/l) @ 190 ml ha^{-1}; W_5 = Sunrice 13.75 WG (Ethoxysulfuron 125 g/kg + Idiosulfuran 12.5 g/kg) @ 100 g ha^{-1}; W_6 = Topstar 80 WP (Oxadiargyl 800 g/kg) @ 75 g ha^{-1} and W_7 = Topstar® 400 SP (Oxadiargyl 400 g/l) @ 190 ml ha^{-1} + 1 hand weeding at 50 DAT. The experiment was laid out with completely randomized block design (RCBD) with 3 replications.

The rice variety 'IRATOM' was used in this study. A common procedure was followed for raising seedling in seed bed. Seedlings of 35 days old were uprooted from the nursery beds carefully. Seedlings were transplanted according to the treatments in the well-puddled experimental plots. Spacing's were given 15 cm × 20 cm. A fertilizer dose of 80-50-50-10 kg ha^{-1} of N, P_2O_5, K_2O and S were applied as urea, triple superphosphate, muriate of potash and gypsum were applied in the field. One-third urea and full dose of triple super phosphate, muriate of potash and gypsum were applied as basal dose at the time of final land preparation and incorporated well into the soil. Besides, cowdung at the rate of 10 t ha^{-1} was applied before final ploughing. Rest two-third of urea was applied in two equal splits at 30 and 55 days after transplanting (DAT).

All intercultural operations were done carefully. Hand weedings were done as per treatments. Topstar® was applied at 2 DAT and Sunrice was applied during final land preparation. Up to 10 DAT 5-7 cm water level was maintained in the field. Irrigation was done by alternate wetting and drying from transplanting to maximum tillering stage. From panicle initiation (PI) to hard dough stage, a thin layer of water (2-3 cm) was kept on the plots. Water was removed from the plots during ripening stage.

Data regarding weeds were recorded at 35 and 60 days after transplanting (DAT). Dry weights of weeds were taken by drying them in electric oven (Perkin-Elmer Corporation, USA) at 60^0 C for 72 hours followed by weighing by digital balance (Kaifeng Group Co., Ltd., China). Relative weed density (RWD) and Weed control efficiency (WCE) were calculates as follows:

$$\text{Relastive weed density (RWD)} = \frac{\text{Density of individual weed species in the community}}{\text{Total density of all weed species in the community}} \times 100$$

$$\text{Weed control efficiency (WCE)} = \frac{\text{DWC - DWT}}{\text{DWC}} \times 100$$

Where,
DWC = dry weight of weeds in weedy check plots
DWT = dry weight of weeds in treated plots

Ten samples hills were collected from each plot for collection of data on plant characters and yield components. The grain and straw weights for each plot were recorded after proper sun drying and then converted into t ha^{-1}. The grain yield was adjusted at 12% moisture level. The data were analysed following Analysis of Variance (ANOVA) technique and mean differences were adjusted by the Multiple Comparison test [6] using the statistical computer based programme CoStat v.6.400 [7]. Means were compared by using DMRT test.

RESULTS AND DISCUSSION

Weed Infestation: In this study the rice field was infested with different types of weeds. The relative density of these weed species were also different (Table 1). Sixteen different weed species were observed in the unweeded plots of study where most of them were broadleaf weed. Among the weed species maximum relative weed density was observed for *Sagittaria guyanensis* (32.50%) at 35 DAT which was followed by *Sphenoclea zeylanica* (19.32%) and *Echinochloa colona* (8.90%). Some (3) new weeds such as *Echinochloa cruss-galli*,

Table 1: Relative density (%) of different weed species in the untreated control plots at two different growth stages of transplanted *aus* rice

Weed species			Relative density (%)	
Botanical name	Family	Types of weed	35 DAT	60 DAT
Sagittaria guyanensis	Alismataceae	Broadleaf aquatic	32.50	13.23
Sphenoclea zeylanica	Sphenocleaceae	Broadleaf	19.32	13.45
Oxalis europea	Oxalaceae	Broadleaf	8.77	10.35
Enhydra fluctuans	Compositae	Broadleaf aquatic	5.89	7.66
Alternanthera sessilis	Amaranthaceae	Broadleaf aquatic	5.02	10.21
Echinochloa cruss-galli	Gramineae	Grass	0.00	2.29
Echinochloa colona	Gramineae	Grass	8.90	9.87
Digitaria sanguinalis	Gramineae	Grass	5.65	7.22
Fimbristylis miliacea	Cyperaceae	Sedge	2.33	1.50
Monochoria vaginalis	Pontederiaceae	Broadleaf aquatic	1.23	6.76
Leersia hexandra	Gramineae	Grass	0.00	2.32
Scirpus juncoides	Cyperaceae	Aquatic sedge	3.51	6.56
Cyperus iria	Cyperaceae	Sedge	1.09	1.02
Polygonum hydropiper	Polygonaceae	Broadleaf	0.00	1.88
Pistila stratiotes	Araceae	Broadleaf aquatic	2.35	4.66
Cynodon dactylon	Gramineae	Grass	3.44	1.02

Table 2: Weed dry matter and weed control efficiency as affected by different weed control methods

	Weed dry matter (g m^{-2})		Weed control efficiency (%)	
Treatment	35 DAT	60 DAT	35 DAT	60 DAT
W_1	15.21 a	35.43 a	-	-
W_2	9.31 b	17.54 b	38.79 d	50.49 d
W_3	4.33 c	9.65 c	71.53 c	72.76 c
W_4	3.11 d	6.11 e	79.55 b	82.75 ab
W_5	2.56 d	5.99 e	83.17 b	83.09 ab
W_6	4.22 c	7.12 d	72.26 c	79.90 b
W_7	1.23 e	6.78 e	91.91 a	85.44 a
$LSD_{0.05}$	0.98	1.02	4.53	3.44

Means separation in columns followed by the same letter(s) are not significantly different at P=0.05.

[W_1 = Control (no weeding); W_2 = 1 hand weeding at 25 DAT; W_3 = 2 hand weeding at 25 and 50 DAT; W_4 = Topstar® 400 SP @ 190 ml ha^{-1}; W_5 = Sunrice 13.75 WG @ 100 g ha^{-1}; W_6 = Topstar 80 WP @ 75 g ha^{-1}; W_7 = Topstar® 400 SP @ 190 ml ha^{-1} + 1 hand weeding at 50 DAT]

Leersia hexandra and *Polygonum hydropiper* were emerged at 60 DAT observations which might be due to their seasonal preferences and favourable condition of growth. However, relative weed density was highest for *Sphenoclea zeylanica* (13.45%). Relative weed species of many several weeds decreased at later stages (60 DAT) due to their completion of life cycle. In this study it was also observed that grasses and sedges were less dominating weed species.

Weed Control: Weed density was however significantly affected by different weeding treatments (Fig. 1). At 34 and 60 DAT weed density was highest in unweeded control plots. Weeding treatments significantly reduced weed population. Among the treatments W_7 reduced the weed population most effectively at every growth stages. At 35 DAT the treatment W_7 reduced the of weed population to 3.44 per square meter where in unweeded plots it was 128.4 per square meter. Similar trend were observed at 60 DAT. At 30 DAT W_2 and W_3 showed similar result because the second weeding was applied after the count (at 50 DAT). Herbicide application drastically reduced the weed population but different preemergence herbicides showed identical result in relation to weed density at 60 DAT. Al-Kothayri and Hasan [8] reported that all herbicidal treatments reduced weed population significantly compared with weedy check. Similar result also observed by Hasanuzzaman *et al.* [9].

Significant differences in weed dry weight were observed due to different weeding treatments (Table 2). Among the treatments W_7 produced the lowest amount of weed dry matter (1.23 g m^{-2}) at 35 DAT which statistically different from others. At 60 DAT W_4 produced the lowest dry matter (6.11 g m^{-2}) but it was identical with W_5 and W_7. It reveals that use of preemergence herbicides along

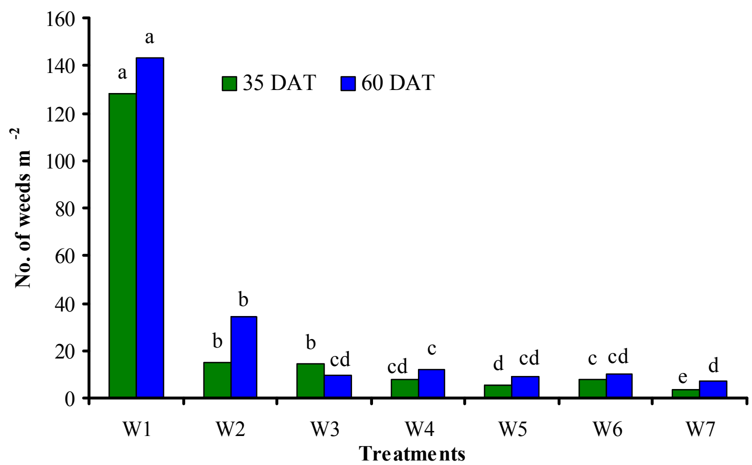

Fig. 1: Weed density in rice field as affected by different weed control methods

Table 3: Plant characters and yield components of Transplanted *aus* rice as affected by weed control methods

Treatment	Plant height (cm)	No. of total tillers hill^{-1}	No. of effective tillers hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	1000-grain weight (g)
W_1	86.78 b	11.81 e	5.90 e	17.55 d	71.25 d	20.23
W_2	88.99 a	13.32 d	8.33 d	19.87 c	87.87 c	21.22
W_3	91.43 a	17.01 b	10.98 c	21.34 ab	95.65 b	21.99
W_4	88.98 a	14.33 d	10.65 c	19.38 c	87.65 c	20.23
W_5	89.98 a	16.22 bc	11.56 b	20.56 bc	90.12 c	21.55
W_6	88.11 a	15.34 cd	11.01 bc	20.01 c	88.73 c	20.67
W_7	90.03 a	18.78 a	12.76 a	22.34 a	101.30 a	23.01
$LSD_{0.05}$	3.54	1.12	0.56	1.30	4.21	NS

Means separation in columns followed by the same letter(s) are not significantly different at P=0.05.

[W_1 = Control (no weeding); W_2 = 1 hand weeding at 25 DAT; W_3 = 2 hand weeding at 25 and 50 DAT; W_4 = Topstar® 400 SP @ 190 ml ha^{-1}; W_5 = Sunrice 13.75 WG @ 100 g ha^{-1}; W_6 = Topstar 80 WP @ 75 g ha^{-1}; W_7 = Topstar® 400 SP @ 190 ml ha^{-1} + 1 hand weeding at 50 DAT]

with one hand weeding effectively reduce the weed biomass. The differences were more prominent at earlier growth stage (35 DAT). However, the highest dry weight of weeds was observed in unweeded plots (W_1) at every stages of crop cycle. In this study Topstar® 400 SP and Sunrice did not show any significant differences. Alam *et al.* [10] and Singh *et al.* [11] also found similar results.

In case of weed control efficiency, the treatment W7 showed the best result both at 35 DAT and 60 DAT. At 35 DAT weed control efficiency of W7 was 91.91% where it reduced to 85.44% at 60 DAT (Table 2). At later stage the treatments showed lower efficiency which might be due to emergence of some new weed species at later stages. The treatment W_4 and W_5 produced identical results at every stage. The lowest weed control efficiency was shown by W_2 (one hand weeding at 25 DAT) because it only controlled a portion of weed population at earlier growth stage (35 DAT) only. This result was partially supported by Hasanuzzaman *et al.* [12].

Crop Characters and Yield Components: Except the grain weight all the crop characters and yield components were significantly influenced by different treatments used in this experiment (Table 3). Among weed weeding methods W_7 produced the tallest plants (90.03 cm) but it was statistically similar with other weeding treatments. Unweeded control plots showed the lowest plant height. Lower plant height with poor weed management or unweeded control might be due to the inter plant completion for longer period which inhibited the plants to become taller. Uremis *et al.* [13] also found that the duration of weed infestation significantly affected the plant height. Total tillers hill^{-1} was significantly affected by different weeding treatments. Highest number of tillers was produced by W_7 (18.78) where unweeded control plots produced the lowest number of tillers (Table 3). These results conform to those of Bajpai and Singh [14]. Fertility of tillers was also greatly affected by weed control methods. In this study the number of effective tillers per hill was highest with W_7. The second highest

Table 4: Yield and harvest index of transplanted *aus* rice as affected by different weed control methods

Treatment	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
W_1	2.45 c	5.02 b	32.80
W_2	3.45 b	6.05 b	36.32
W_3	4.72 a	8.52 a	33.64
W_4	3.04 b	5.59 b	35.23
W_5	3.31 b	5.95 b	35.75
W_6	3.16 b	5.52 b	36.41
W_7	5.02 a	8.60 a	36.86
$LSD_{0.05}$	0.46	2.01	NS

Means separation in columns followed by the same letter(s) are not significantly different at P=0.05.

[W_1 = Control (no weeding); W_2 = 1 hand weeding at 25 DAT; W_3 = 2 hand weeding at 25 and 50 DAT; W_4 = Topstar® 400 SP @ 190 ml ha^{-1}; W_5 = Sunrice 13.75 WG @ 100 g ha^{-1}; W_6 = Topstar 80 WP @ 75 g ha^{-1}; W_7 = Topstar® 400 SP @ 190 ml ha^{-1} + 1 hand weeding at 50 DAT]

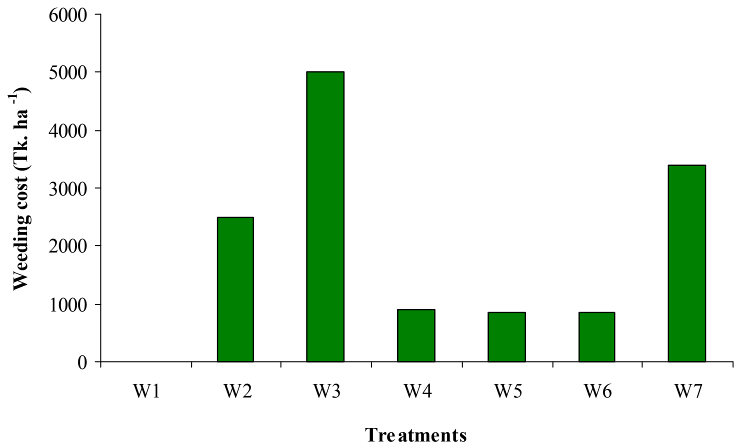

Fig. 2: Cost of weed control for different weed control methods
$1.00= Tk. 69.3
[W_1 = Control (no weeding); W_2 = 1 hand weeding at 25 DAT; W_3 = 2 hand weeding at 25 and 50 DAT; W_4 = Topstar® 400 SP @ 190 ml ha^{-1}; W_5 = Sunrice 13.75 WG @ 100 g ha^{-1}; W_6 = Topstar 80 WP @ 75 g ha^{-1}; W_7 = Topstar® 400 SP @ 190 ml ha^{-1} + 1 hand weeding at 50 DAT]

number of effective tillers was observed with W_5. Proper control of weeds reduced the weed density which facilitates the crop plants to have sufficient space, light, nutrient and moisture and thus the effective tillers increased. The treatment W_7 also produced highest length of panicle (22.34 cm) which was statistically at per with W_3. Weeds always compete with crop for resources like light, water, nutrient which are needed for crop plant to produce more grains [15]. In this study, greater weed infestation in the unweeded plots (W_1) resulted in the lowest number of grain panicle^{-1} (71.25). The treatment W_7 produced the maximum number of grain panicle^{-1} (101.30) which was statistically superior to any other treatment (Table 3) mainly due to weed-free conditions in this treatment. Single application of any preemergence herbicides produced identical numbers of grains per panicle. These results corroborated with the results of Ahmed *et al*. [5] and Hasanuzzaman *et al.* [12]. In this study 1000-grain weight was not significantly affected by weeding treatments. However, the highest grain weight was observed with W_7 and the lowest with W_1. It is also reported by many workers that control of weeds promoted the yield and yield attributes including productive tillers m^{-2}, number of filled grains per panicle and 1000- grain weight in rice [16].

Yield and Harvest Index: As the treatment W_7 showed the maximum control of weed, the ultimate reflection of this treatment was appeared as the highest grain yield (5.02 t ha^{-1}) of transplanted *aus* rice in this experiment (Table 4). It was statistically similar with W_3 (two hand weeding). It might be the resultant effects of highest tillers hill^{-1} and grains panicle^{-1} with those treatments (Table 3). W_7 (Topstar® 400 SP @ 190 ml ha^{-1} + 1 hand weeding at 25 DAT) and W_3 (2 hand weeding at 25 and 50 DAT) produced 104.90% and 92.65% higher yield than unwedded control. This result was supported by Hasanuzzaman *et al.* [9]. Straw yield also significantly affected by weeding treatments (Table 4). The highest straw yield (8.60 t ha^{-1}) was observed with W_7 which was statistically identical with W4 (8.52 t ha^{-1}). In this study herbicide application did not show any extra benefit to produce higher straw yield. Numerically the control treatment showed the lowest straw yield. In this study different treatment effects were non-significant in terms of harvest indices. However, the highest harvest index was observed from W_7 where the lowest harvest index was observed in unweeded control plots. Ahmed *et al*. [5] also found similar results.

Weed Control Cost: Different weed control methods involved different amounts of cost which affect the total cost of cultivation of *aus* rice (Fig. 2). The hand wedding is laborious and generally more expensive. From the computation of weed control cost it was observed that the maximum cost of weed control (5000 Tk. ha^{-1}) was required for the treatment W_3 (2 hand weeding) which was due to maximum labour requirement. The treatment W_7 needed the second highest weed control cost (3400 Tk. ha^{-1}) where it produced the highest yield. Three different preemergence herbicides required identical weed control costs. It revealed application of premergence herbicide along with one hand weeding is the most economic method for weed control in transplanted rice. On the other hand application of preemerenge herbicides alone showed much better economic benefits compared to one hand weeding in terms of weed control in *aus* rice. Similar results on the weed control costs were as also observed by Hasanuzzaman *et al.* [12].

REFERENCES

1. IRRI (International Rice Research Institute), 2006. *World Rice Statistics*. Intl. Rice Res. Inst. http://www.irri.org/science/wrs. Accessed on July, 2006.
2. Julfiquare, A.W., M.M. Haque, A.K.G.M. Enamul Haque and M.A. Rashid, 1998. Current status of hybrid rice research and future programme in Bangladesh. A country report presented in the workshop on use and development of hybrid rice in Bangladesh. Held at BARC on 18-19 may, 1998.
3. BRRI (Bangladesh Rice Research Institute), 2006. Weed identification and management in rice. Bangladesh Rice Research Institute, Joydebpur, Gazipur, Bangladesh.
4. Mamun, A.A., 1990. Weeds and their control: A review of weed research in Bangladesh. Agricultural and Rural Development in Bangladesh. Japan Intl. Co-operation Agency, Dhaka, Bangladesh. JSARD. 19: 45-72.
5. Ahmed, G.J.U., M.K.A. Bhuiyan, C.R. Riches, M. Mortimer and D. Jhonson, 2005. Farmer's participatory studies of integrated weed management system for intensified lowland. Proceeding of the 8th Biennial Agronomy Convention, Bangladesh Agron. Soc., Dhaka.
6. Gomez, K.A. and A.A. Gomez, 1984. Statistical Procedures for Agriculture Research. Int. Rice Res. Inst. Jhon Wiley and Sons. New York, pp: 139-240.
7. CoStat, 2008. CoStat - Statistics Software version 6.400. CoHort Software, 798 Lighthouse Ave. PMB 320, Monterey, CA, 93940, USA.
8. Al-Kothayri, G.R. and A.A. Hasan, 1990. Chemical control of annual weeds in irrigated onion Hadhramount valley. Arab J. Plant Protec. (Lebanon), 8(1): 49-54.
9. Hasanuzzaman, M., M.O. Islam and M.S. Bapari, 2008. Efficacy of different herbicides over manual weeding in controlling weeds in transplanted rice. Aus. J. Crop Sci., 2(1): 18-24.
10. Alam, M.S., M.N. Islam, A.K.M. Zaman, B.K. Biswas and M.K. Saha, 1996. Relative efficiency and economics of different cultural methods and herbicides for weed control in transplanted *Aus* rice. Bangladesh J. Agric. Sci., 23: 67-73.
11. Singh, S.S., S.J. Singh and S.S. Mishra, 1992. Weed management in transplanted rice (*Oryza sativa*). Under mid-land calcareous ecosystem. Indian J. Agron., 37: 173-176.
12. Hasanuzzaman, M., Kamrun Nahar and M.R. Karim, 2007. Effectiveness of different weed control methods on the performance of transplanted rice. Pakistan J. Weed Sci. Res., 13(1-2): 17-25.
13. Uremis, I., M. Arslan and A. Uludag, 2005. Effect of weed duration on seed yield and yield components of double-cropped soybean. Asian J. Plant Sci., 4(4): 370-373.
14. Bajpai, R.P. and V.K. Singh, 1992. Weed management in direct seeded upland rice (*Oryza sativa*). Indian J. Agron., 37: 705-709.
15. Antigua, G., C. Colon and M. Perez, 1988. Weed competition capacity in upland rice 'IR 1529', utilizing different row distances, hand weeding, herbicide application or without weed control. Ciencia y Tecnica en la Agricultura Arroz., 11(1): 35-42.
16. Raju, A., B.J. Pandian, P. Thukkaiyannan and N. Thavaprakash, 2002. Effect of weed management practices on the yield attributes and yields of wet-seeded rice. Acta Agron. Hungarica, 51: 461-464.