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Effect of a single weeding on growth and yield of two *Brassica species*

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Abstract

An experiment was conducted at the Crop Botany Field Laboratory, Bangladesh Agricultural University, Mymensingh, from November 2010 to February 2011 to assess the effect of a single weeding on crop growth and yield of two mustard species, *Brassica napus* and *Brassica campestris*. The experiment comprised four treatments from the combination of those two species along with one hand weeding on 40 days after sowing (DAS) or without weeding (i.e. control). The experiment was laid out following a Randomized Complete Block Design with three replications. Weeding and species interaction had significant effect on most of the growth characters and yield. One hand weeding on 40 DAS remarkably suppressed the weed growth for the subsequent stages. The results indicated that both species gave higher yield due to the operation of a single weeding as compared to without weeding. The highest seed yield, 1.48 t ha^{-1} was obtained from the crop treated with one hand weeding whereas the lowest yield 1.08 t ha^{-1} was observed in un-weeded control treatment. In context of species, the higher seed yield 1.31 t ha^{-1} was found in *Brassica campestris* and that of lower seed yield 1.25 t ha^{-1} was found from *Brassica napus*.

Keywords

Brassica campestris, Brassica napus, Crop Growth, Mustard, Species, Weeding

1. Introduction

Weed infestations cause serious problems in mustard as in other crops. The most noxious weed species which attack mustard and oilseed rape crops include *Sinapis arvensis*, *Avena fatua*, *Setaria viridis*, *Cyperus rotundus, Cynodon dactylon, Parthenium hysterophorus, Amaranthus viridis, Digera arvensis, Euphorbia hirta, Cleome viscosq, Portulaca oleracea, Trichoalesma indicum, Melilotus indica* etc (Madhabilatha *et al.*, 1997; Yadav *et al*., 1999; Ghadiri *et al*., 2008). These weed species are act as earlier competitors to the crop during establishment period, and may decrease subsequent crop growth (Ghadiri and Naderi, 2008; Bagherani and Shimi, 2001). Therefore, weed control is necessary to achieve higher yield as weeds compete for land, water and nutrients and then natural resources like light, gases, space etc. with crops, causing significant yield reduction (Bijanzadeh and Ghadiri, 2006; Abdollahi and Ghadiri, 2004). Bowerman (1990) also reported that significant yield increase could be achieved mainly where the level of weed control is high.

The taller plant, greater number of branches per plant, number of seeds per siliqua, number of siliqua per plant, 1000-seed weight, and crop yield were recorded for the weed-free control condition, followed by hand weeding at 30 and 45 days after sowing (DAS) (Sharma and Jain, 2002). Most workers informed about a single weeding from 20 to 40 DAS through which yield loss of mustard can be minimized (Yadav *et al*., 1999). It is found that vegetative phase is the critical competitive period of weed growth and Sangakkara *et al*. (1995) also observed that the adverse effect of weeds was greatest on vegetative growth of mustard.

Most farmers of Bangladesh do not adopt weed control in mustard field due to its short life span, although weeding is

essential for achieving a higher yield of mustard. Therefore, the present investigation was conducted to find out the effect of a single weeding on the growth and yield of two common species of mustard like *Brassica napus* and *Brassica campestris* under the prevailing climatic conditions of Bangladesh.

2. Materials and Methods

A field experiment was conducted in the Crop Botany Filed Laboratory, Bangladesh Agricultural University, Mymensingh (24° 25″ N latitude and 90° 50″ E longitude at the elevation of 18m above the sea level) during the period extended from November 2011 to February 2012 to study the effect of a single weeding on the growth and yield of two species of mustard. The site belongs to sub-tropical climate with rainy monsoon during June to October and rainless dry period for rest of the year. The experimental field was medium high land belonging to the Sonatola Soil Series of grey flood plain soil under the Agro-Ecological Zone-9 of Old Brahmaputra Flood Plain. The soil is silt loam with imperfectly to poorly drained permeability. The average air temperature during the experimental period was 16.5 to 24.2 degree Celsius. The average relative humidity was 74 to 84 percent and the total sunshine period ranged from 133 to 204 hours/month from November to February.

The experiment comprised 4 treatments from the combination of two weeding regimes viz. weeding and without weeding conditions with two species of mustard viz. *Brassica napus* and *Brassica campestris*, represented by the cultivars BINAsarisha-5 and BINAsarisha-6, respectively (Table 1). The experiment was laid out in a Randomized Complete Block Design with three replications. The size of unit plot was 4m×3m. Distance between plot to plot was 50 cm. The row to row and plant to plant distances within a row were 30 and 10 cm, respectively. The manure as rotten cow dung and fertilizers as urea, triple super phosphate and muriate of potash, gypsum, and borax were applied to the soil @ 1000, 200, 150, 120, 100 and 5 kg ha^{-1}, respectively. Half the amount of urea, and entire amount of other manures and fertilizers were mixed to the soil at the time of final land preparation. The remaining amount of urea was top dressed on 30 DAS. Mustard seeds of said species were sown manually in line in each plot uniformly maintaining the fixed spacing on 11 November 2010. After sowing, the seeds were covered with the loose soil by hand. Thinning, pest control and other crop managements were conducted to optimize the growth and development of the crops. Weed was controlled once manually on 40 DAS from selected plots and the remaining plots were kept un-weeded throughout the crop season as per experimental design.

All weeds of 50×50 cm^2 area from each plot were uprooted from 40 DAS till final harvest of crop with 15 days interval and dried with an electric oven for 72 hours maintaining a constant temperature of 80±2°C. After drying, weight was taken and converted to per unit of land area basis i.e. gm^{-2}. From each experimental plot five plants were randomly harvested destructively and the data on crop growth parameters like plant height, number of branches/plant, leaf area index, crop and weed dry matter accumulation etc were recorded from 40 DAS till final harvest with 15 days interval. Yield and yield components were recorded during final harvest i.e. physiological maturity of crops. Based on maturity, the *Brassica napus* was harvested on 10 February 2011 and *Brassica campestris* was harvested on 16 February 2011 when 70 percent siliqua became straw colored. The harvested crop of 1 m^2 from each plot was bundled separately with proper tags and brought to the clean threshing floor. The bundles were dried in open sunshine for three days, and then threshing, cleaning, winnowing and drying of seeds were done carefully. Straw was also dried properly in the sunshine. Then dry weight of seed and straw were recorded after keeping them in an oven for 72 hours at 80±2 degree Celsius. Harvest index was calculated as economic (seed) yield to biological yield (total dry weight). The collected data on different parameters were statistically analyzed to obtain the level of significance using MSTAT-C Package Programme. The mean differences were compared with Duncan's Multiple Range Test.

3. Results and Discussion

3.1. Plant Height

Plant height increased gradually with the progress of season. The tallest plant was obtained from weeding condition along with the species *Brassica campestris* whereas the shortest plant was found in interaction with or without weeding along with *Brassica napus* (Table 2). The taller plant was obtained from weeded plots than that at non-weeded plots throughout the growing period. Similar results were also found by Sharma and Jain (2002) who reported that plant height was found to be taller in weeding condition in mustard crop. The species *Brassica campestris* produced the taller plant as compared to *Brassica napus* throughout the growing season. The results are in agreement with the result of Mondal *et al*. (2003) who found that plant height differed significantly among the varieties of *Brassica napus*. The results of the present study are also supported by the results of Islam (2006) in *Brassica napus* cvs. MM 02-02rb, MM 09-02rb and MM 03-05, and *Brassica campestris* cvs. Agrani, Safal and Sonali.

3.2. Branch Formation

The number of branches per plant increased gradually with time. The interaction effect of weeding and species was found significant but the trend was irregular. However, the highest number of branches was obtained at weeding treatment plants with *Brassica napus* and the lowest number from no weeding along with *Brassica campestris* (Table 3). Weeding gave the higher number of branches as compared to no weeding treatment. Similar results were reported by Singh and Sinsinwar (2002) who observed that hand weeding twice gave the greatest number of branches per plant in mustard.

The *Brassica napus* produced the higher number of branches than that at *Brassica campestris* throughout the growing stages. The results are in consistent with Khaton (2004) who reported that number of branches per plant differed significantly among the different genotypes of *Brassica campestris* cvs. Agrani and Safal, *Brassica napus* cvs. MM 49-3-98 and MM 06-02rb, and *Brassica juncea* cvs. MM 04-04, RAI 5 etc.

3.3. Leaf Area Development

Development of leaf area was assessed in terms of leaf area index (LAI) which was recorded at 15 days interval from 40 to 85 DAS. There was no leaf during physiological maturity of crop. Leaf area index quickly increased to attain a peak on 55 DAS followed by a decrease with growth progress (Table 4). The larger LAI was obtained at weeding condition along with *Brassica napus* and the smaller LAI from no weeding along with *Brassica campestris* throughout the growth period. The other interactions ranked intermediate. The higher LAI was obtained from weeded plots and that of smaller LAI from without weeding condition throughout the growth period. The results obtained from the present study were consistent with the results of Sharma and Jain (2002) in mustard. They reported that plant growth characters like plant height, number of branches, number of leaves etc. were higher in weeding treatment as compared to un-weeded condition which has resulted larger LAI. The species *Brassica napus* produced the higher LAI and *Brassica campestris* gave the lower LAI throughout the crop growth. The results are in agreement with the result of Prakash *et al*. (1987) who stated that leaf area differed significantly among the varieties like Vaibhav and Urwashi of *Brassica juncea*.

3.4. Accumulation of Crop Dry Matter

Total dry matter (TDM) is the sum of dry weight of roots, stem, leaves, branches, and fruits (siliqua). Initial low accumulation of TDM increased rapidly till 85 DAS followed by a slower increase. Table 5 showed that the higher TDM obtained from the weeding condition along with species *Brassica campestris* whereas the smaller TDM was found in no weeding condition for both the species throughout the growing period. A single weeding had significant effect on TDM accumulation. Irrespective of the species higher TDM was obtained from weeding condition than that of no weeding condition. Similar results were found by Hamzei *et al.* (2007) who reported that TDM was larger in weed free condition as compared to un-weedy situation. *Brassica campestris* produced the larger TDM as compared to *Brassica napus* across the growth phases. Similar results were found by Mondal *et al*. (2003) and Islam (2006) who observed a wide range of variability in TDM production in mustard species- *Brassica napus* cvs. MM 02-02rb, MM 09-02rb and MM 03-05 and *Brassica campestris* cvs. Agrani, Safal and Sonali.

3.5. Growth of Weed Population

Initially the dry weight of weed population was smaller which gradually increased along with the advancement of crop growth (Table 6). Highest weed growth was recorded in un-weeded plots along with *Brassica napus* whereas lowest weed dry weight was obtained from weeded plots along with *Brassica campestris*. A single hand weeding on 40 DAS had significant control of weed in the subsequent growth stages. Weed growth was suppressed about 2-3 folds in a single weeded treatment as compared to un-weeded condition. A larger weed dry matter was obtained from no weeding plot than that at weeding treatment throughout the growth stages. The findings are supported by the results of Tekale *et al*. (2005) who stated that one hand weeding in mustard field at 25 DAS gave the lowest weed count, weed dry weight and weed growth rate. The species effect on weed growth was found insignificant which is a very common phenomenon in weed ecology.

3.6. Yield Components

The interaction effect between weeding and species on yield components of mustard like number of siliqua plant^{-1}, seed siliqua^{-1}, seed weight plant^{-1} and 1000-seed weight was significant (Table 7). The highest value of those components was obtained from weeding condition along with *Brassica campestris* and the lowest value was found from without weeding condition along with the *Brassica napus* species.

The effect of weeding on the said yield components was significant except number of seed siliqua^{-1} where the higher values were obtained from weeding condition and that of lower values from without weeding condition. Similar result was reported by Bowerman (1990), Singh and Singh (2001) and Omprakash (2002) who observed that the weeding gave the greater number of siliqua per plant in mustard. The weed-free management through timely manual weeding like hand weeding was also found as the most effective treatment in improving the growth and yield attributes with maximum seed yields in mustard (Tekale *et al*., 2005).

The effect of species on the said yield components was also found significant; the *Brassica campestris* shown the higher values as compared to *Brassica napus*. The results obtained from the present study are in consistent with the results of Khaton (2004) who reported that yield components differed significantly among the species/varieties of mustard like *Brassica campestris* cvs. Agrani and Safal, *Brassica napus* cvs. MM 49-3-98 and MM 06-02rb, and *Brassica juncea* cvs. MM 04-04 and RAI 5 etc. Prakash *et al*. (1987), Singh *et al*. (1991), Omprakash (2002), Mondal *et al*. (2003) and Islam (2006) also found the similar results.

3.7. Yield

The highest seed yield and biological yield were obtained at weeding condition along with the *Brassica campestris* and the lowest seed yield was found in interaction from without weeding condition along with the *Brassica napus*. The higher seed yield and biological yield were obtained from weeding

condition as compared to non-weeding one (Table 7). The findings are also supported by the results of Sharma *et al.* (2005) and Singh *et al.* (2009) who observed that the mustard seed yield was found highest in weed free condition. The species *Brassica campestris* produced the higher seed yield and biological yield as compared to *Brassica napus*. Khaton (2004) also observed a wide variation of seed yield among the species like *Brassica napus* cvs. MM 49-3-98, MM 48-19 and MM 04-04, and *Brassica campestris* cvs. Agrani, Safal and Sonali. Singh *et al*. (1999) conducted a field study on Indian mustard (*Brassica juncea*) during the rabi season of 1996-97 and 1997-98 in Rajasthan, India and reported that *Chenopodium album* and *Chenopodium murale* made up 82% of the weed flora. One weeding at 30 DAS was effective and resulted the largest reduction of weed population and dry weight of weeds. The higher seed yields (18.41 and 17.68 q ha^{-1}) were also obtained from weeded treatment compared to the un-weeded control.

Table 1. *Some important characters of Brassica napus and Brassica campestris species*

Species characters	***Brassica napus* (cv. BINAsarisha-5)**	***Brassica campestris* (cv. BINAsarisha-6)**
Plant height (cm)	80-90	110-130
Seed colour	Reddish-brown	Light yellow
Oil content of seed (%)	42-43	42-44
Life duration (days)	85-90	90-95
Highest yield (t/ha)	2.10	2.20
Average yield (t/ha)	1.40	1.30

Source: BINA (2008).

Table 2. *Plant height of Brassica napus and Brassica campestris with and without weeding*

Treatment	**Plant height (cm) at different DAS**				
	40	**55**	**70**	**85**	**Final harvest**
(a) Main effect (Weeding × Species)					
W × Sp_1	13.64 b	46.82 c	81.00 b	93.54 c	94.06 c
WW × Sp_1	11.82 c	37.55 d	61.54 c	78.95 d	85.03 d
W × Sp_2	17.39 a	62.55 a	91.64 a	132.49 a	137.53 a
WW × Sp_2	17.02 a	53.74 b	80.45 b	120.00 b	120.82 b
S $\bar{x}$	1.21	1.88	4.74	1.90	1.61
(b) Weeding effect					
Weeding (W)	15.51 a	54.69 a	86.32 a	113.01 a	115.80 a
Without Weeding (WW)	14.42 b	45.64 b	71.00 b	99.48 b	102.93 b
S $\bar{x}$	0.85	1.33	3.35	1.35	1.14
(c) Species effect					
Brassica napus (Sp_1)	12.73 b	42.18 b	71.27 b	86.25 b	89.55 b
Brassica campestris (Sp_2)	17.20 a	58.15 a	86.05 a	126.24 a	129.18 a
S $\bar{x}$	0.86	1.33	3.35	1.35	1.14

In a column, figures followed by similar letters do not differ significantly (P<0.01).

Table 3. *Number of branches per plant of Brassica napus and Brassica campestris with and without weeding*

Treatment	**Number of branches per plant at different DAS**			
	40	**55**	**70**	**85**
(a) Main effect (Weeding × Species)				
W × Sp_1	2.02 b	5.68 b	11.07 a	11.07 a
WW × Sp_1	1.27 d	3.40 d	8.00 c	8.00 c
W × Sp_2	2.52 a	6.31 a	9.57 b	9.57 b
WW × Sp_2	1.81 c	4.58 c	6.40 d	6.40 d
S $\bar{x}$	0.26	0.50	0.76	0.76
(b) Weeding effect				
Weeding (W)	2.27 a	5.99 a	10.32 a	10.32 a
Without Weeding (WW)	1.54 b	3.99 b	7.20 b	7.20 b
S $\bar{x}$	0.18	0.35	0.53	0.53
(c) Species effect				
Brassica napus (Sp_1)	1.65 b	4.54 b	9.53 a	9.53 a
Brassica campestris (Sp_2)	2.16 a	5.44 a	7.98 b	7.98 b
S $\bar{x}$	0.18	0.35	0.53	0.53

In a column, figures followed by similar letters do not differ significantly (P<0.01).

Table 4. *Leaf area index (LAI) of Brassica napus and Brassica campestris with and without weeding*

Treatment	Leaf area index (LAI) at different DAS			
	40	55	70	85
(a) Main effect (Weeding × Species)				
W × Sp_1	0.97 a	2.17 a	1.39 a	0.59 a
WW × Sp_1	0.57 b	1.88 b	0.97 b	0.41 b
W × Sp_2	0.51 b	1.58 c	0.94 c	0.35 c
WW × Sp_2	0.31 c	1.04 d	0.49 d	0.16 d
$S\bar{x}$	0.03	0.05	0.11	0.03
(b) Weeding effect				
Weeding (W)	0.74 a	1.88 a	1.17 a	0.45 a
Without Weeding (WW)	0.44 b	1.46 b	0.73 b	0.28 b
$S\bar{x}$	0.02	0.03	0.08	0.02
(c) Species effect				
Brassica napus (Sp_1)	0.77 a	2.02 a	1.18 a	0.48 a
Brassica campestris (Sp_2)	0.41 b	1.31 b	0.72 b	0.26 b
$S\bar{x}$	0.02	0.03	0.08	0.02

In a column, figures followed by similar letters do not differ significantly (P<0.01).

Table 5. *Total dry weight accumulation per unit area of Brassica napus and Brassica campestris with and without weeding*

Treatment	Crop dry matter (gm^{-2}) at different DAS				
	40	55	70	85	Final harvest
(a) Main effect (Weeding × Species)					
W × Sp_1	10.08 c	75.25 b	298.67 b	390.45 b	422.25 b
WW × Sp_1	9.49 c	52.24 d	270.25 d	335.25 d	375.45 d
W × Sp_2	13.99 a	88.05 a	340.05 a	418.85 a	484.42 a
WW × Sp_2	11.26 b	58.97 c	283.37 c	372.28 c	396.67 c
$S\bar{x}$	1.51	0.35	2.74	6.92	3.14
(b) Weeding effect					
Weeding (W)	12.04 a	81.65 a	319.36 a	404.65 a	453.34 a
Without Weeding (WW)	10.38 b	55.61 b	276.81 b	353.77 b	386.06 b
$S\bar{x}$	1.07	7.32	6.08	9.03	6.36
(c) Species effect					
Brassica napus (Sp_1)	9.79 b	63.75 b	284.46 b	362.85 b	398.85 b
Brassica campestris (Sp_2)	12.63 a	73.51 a	311.71 a	395.57 a	440.55 a
$S\bar{x}$	1.07	7.32	6.08	9.03	6.36^{*}

In a column, figures followed by similar letters do not differ significantly (P<0.01) ($^{*}P$< 0.05).

Table 6. *Weed growth under Brassica napus and Brassica campestris crops subjected to with and without weeding*

Treatment	Weed dry matter (g m^{-2}) at different DAS				
	40	55	70	85	Final harvest
(a) Main effect (Weeding × Species)					
W × Sp_1	-	2.55 b	8.40 b	17.53 b	24.54 c
WW × Sp_1	5.97 a	10.21 a	33.10 a	48.62 a	57.80 a
W × Sp_2	-	2.23 b	8.55 b	16.56 c	23.79 d
WW × Sp_2	5.41 b	10.20 a	29.58 b	48.05 a	56.88 b
$S\bar{x}$	0.39	0.29	0.72	1.28	2.28
(b) Weeding effect					
Weeding (W)	-	2.42 b	8.48 b	17.05 b	24.16 b
Without Weeding (WW)	5.69	10.21 a	31.34 a	48.34 a	57.34 a
$S\bar{x}$	0.28	0.21	0.51	0.91	1.61
(c) Species effect					
Brassica napus (Sp_1)	2.98	6.38	20.75	33.08	41.17
Brassica campestris (Sp_2)	2.71	6.18	19.07	32.31	40.34
$S\bar{x}$	0.28^{NS}	0.21^{NS}	0.51^{NS}	0.91^{NS}	1.61^{NS}

In a column, figures followed by similar letters do not differ significantly (P<0.01).
NS= not-significant

Table 7. *Yield components and yield of Brassica napus and Brassica campestris subjected to weeding and without weeding*

Treatment	No. of siliqua plant^{-1}	No. of seed siliqua^{-1}	Seed weight plant^{-1} (g)	1000-seed weight (g)	Seed yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
(a) Main effect (Weeding × Species)							
W × Sp_1	71.99 b	20.48 b	4.37 b	2.98 a	1.43 b	4.22 b	33.88 a
WW × Sp_1	62.42 c	18.92 c	3.20 c	2.70 b	1.06 c	3.75 d	28.27 c
W × Sp_2	82.53 a	21.04 a	4.57 a	2.62 b	1.52 a	4.84 a	31.38 b
WW × Sp_2	71.55 b	18.31 d	3.29 c	2.52 c	1.10c	3.97 c	27.81 d
S $\bar{x}$	0.8678	0.4136	0.0988	0.036	0.0363	0.2689	1.0154
(b) Weeding effect							
Weeding (W)	77.26 a	20.76 a	4.47 a	2.80 a	1.48 a	4.53 a	32.63 a
Without weeding (WW)	66.98 b	18.61 b	3.25 b	2.61 b	1.08 b	3.86 b	28.04 b
S $\bar{x}$	0.6137	0.2925	0.0699	0.0254	0.0256	0.1901	0.718
(c) Species effect							
Brassica napus (Sp_1)	67.21 b	19.70	3.78 b	2.84 a	1.25 b	3.99 b	31.08 a
Brassica campestris (Sp_2)	77.04 a	19.67	3.93 a	2.57 b	1.31 a	4.41 a	29.60 b
S $\bar{x}$	0.61	0.29 ^{NS}	0.07	0.03	0.03	0.19	0.72

In a column, figures followed by similar letters do not differ significantly (P<0.01).
NS= not-significant

3.8. Harvest Index

Highest harvest index was found at weeding treatment along with species *Brassica napus* and the lowest in without weeding condition and *Brassica campestris* (Table 7). Higher harvest index was obtained from weeding condition as compared to without weeding. Similar result was found by Singh *et al.* (2000) who reported that harvest index was higher in weed free condition than un-weeded control. The species *Brassica napus* showed higher harvest index than the *Brassica campestris*. Similar result was found by Singh *et al.* (1991) in mustard which supported our results. Moderately high genotypic variation for harvest index in mustard was reported by them for the mustard cultivars like CAR2, CAR6, BC2 and RH30 of *Brassica carinata* species.

4. Conclusion

It can be concluded that a single hand weeding at early growth stage of mustard crop may promote the beneficial effects to form higher yield, and the species *Brassica campestris* showed higher yield as compared to *Brassica napus*.

References

[1] Abdollahi, F. and H. Ghadiri, 2004. Effect of separate and combined applications of herbicides on weed control and yield of sugar beet. Weed Technol., 18: 968-976.

[2] Bagherani, N. and P. Shimi, 2001. Evaluation of some herbicides for weed control in oil rapeseed (*Brassica napus* L.). J. Agric. Sci. Natur. Res., 8: 157-163.

[3] Bijanzadeh, E. and H. Ghadiri, 2006. Effect of separate and combined treatments of herbicides on weed control and corn (*Zea mays* L.) yield. Weed Technol., 20: 640- 645.

[4] BINA, 2008. Booklet. Bangladesh Institute of Nuclear Agriculture (BINA), Mymensigh.

[5] Bowerman, P., 1990. Weed control in winter oilseed rape review of ADAS trials. Weed Abs., 39(12): 482.

[6] Ghadiri, H., M. Ebrahimi and E. Zand, 2008. Effect of wild oat (*Avena fatua* L.) densities and nitrogen on morphophysiological traits of several Iranian wheat (*Triticum aestivum* L.) cultivars. Vancouver, Canada. p. 75-78.

[7] Ghadiri, H. and R. Naderi, 2008. Competition of wild mustard (*Sinapis arvense* L.) densities with rapeseed (*Brassica napus* L.) under different levels of nitrogen fertilizer.Vancouver, Canada. p. 185.

[8] Hamzei, J., A.D.M. Nasab, F.R. Khoie, A. Javanshir, and M. Moghaddam, 2007. Critical period of weed control in three winter oilseed rape (*Brassica napus* L.) cultivars. Turkish J. Agric. For., 31(2): 83-90.

[9] Islam, A., 2006. Study of some morphological characters and reproductive efficiency in mustard. M.S. Thesis. Dept. Crop Bot., Bangladesh Agril. Univ., Mymensingh.

[10] Khaton, M., 2004. Study of canopy structure and flower production in mustard. M. S. Thesis. Dept. Crop Botany, Bangladesh Agricultural Univ., Mymensingh.

[11] Madhabilatha, A., V. Satyanarayana, B.V. Kumar, and P.C. Rao, 1997. Integrated weed management in mustard. J. Oilseeds Res., 14(1): 100-101.

[12] Mondal, M.M.A., M.L. Das, M.A. Malek, and M.I. Khalil, 2003. Performance of advanced generation rapeseed mutants under high and low input conditions. Bangladesh J. Agric. Sci., 30: 115-118.

[13] Omprakash, 2002. Weed management in Indian mustard (*Brassica juncea*) on Terraced ravine alluvial soils. Ann. Agric. Res., 23(2): 280-283.

[14] Prakash, N., Y.S. Chauhan, and K. Kumar, 1987. Genetics of harvest index, seed and biological yield in Indian mustard. Narendra Deva J. Agric. Res., 2: 198-201.

[15] Sangakkara, U.R., B. Meylemans, and P. Damme, 1995. Impact of different weed types on growth and yield of mustard. J. Agron. Crop Sci., 175(1): 1-5.

[16] Sharma, O.L. and N.K. Jain, 2002. Effect of herbicides on weed dynamics and seed yield of Indian mustard (*Brassica juncea*). Indian J. Agric. Sci., 72 (6): 322-324.

[17] Sharma, S.K., V. Singh and K.S. Panwar, 2005. Weed management in Indian mustard *(Brassica juncea)* under dryland conditions. Indian J. Agric. Sci., 75(5): 288-289.

[18] Singh, S.K., N.K. Jain, and B.L. Poonia, 2000. Integrated weed management in Indian mustard (*Brassica juncea*). Indian J. Agric Sci., 70(12): 850-852.

[19] Singh, P., M.K. Khera, and K.P. Gupta, 1991. Variability and correlation studies for oil seed rape in Rabi season. Crop Improve., 18: 99-102.

[20] Singh, R., B. Singh, and K.N.K. Chauhan, 1999. Productivity and economics of Indian mustard (*Brassica juncea*) as influenced by varieties and weed control treatments. Indian J. Weed Sci., 31(3/4): 138-141.

[21] Singh, H. and B.P. Singh, 2001. Effect of weed management on nutrient uptake in *Brassica* species. Ann. Agric. Res., 22(3): 417-419.

[22] Singh, R.K., R.P. Singh, and D. Mukherjee, 2009. Effect of fertilizer placement and weed management practice on weed dynamics and yield of rain fed mustard (*Brassica juncea* L.). Environ. Ecol., 27(4B): 1932-1938

[23] Singh, F. and B.S. Sinsinwar, 2002. Effect of cultural and chemical methods of weed control in Indian mustard *(Brassica juncea).* Ann. Agric. Res., 23(2): 346-348.

[24] Tekale, K.U., V.D. Khanpara, M.S. Deshmukh, and A.M. Bonde, 2005. Effect of weed management practices on growth and yield contributing parameters of Indian mustard and their correlation with yield. J. Soils and Crops, 15(1): 183-186.

[25] Yadav, R.P., U.K. Shrivastava, and S.C. Dwivedi, 1999. Weed control in Indian mustard (*Brassica juncea*). Indian J. Agron., 44(3): 613-616.