Effects of conduct to weeds and row spacing on weeds traits and agronomical parameters of rice (*Oryza sativa* L.) at the north of Iran

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Abstracts: In order to investigate effects of conduct to weeds and row spacing on weeds traits and agronomical parameters of rice (*Oryza sativa* L.) var. Tarom Mahalli, an experiment was carried out at split-plot in randomized complete block design with four replications at Sari region in 2010. Main factor was conduct to weed in two levels including (non weed control and with weed control) and sub factor was between row spacing in five levels including (10, 15, 20, 25 and 30 cm). Results showed lowest and highest of weeds number per m^2, weed height and weed dry weight were obtained at 10 cm and 30 cm between rows spacing, respectively. With control of weed increased of the plant height, panicle length, total tiller number per hill, fertile tiller number per hill, and panicle number per m^2, spikelet number per panicle, grain yield, and biological yield and due to harvest index. The most of panicle length, panicle number per m^2, spikelet number per panicle, fertile spikelet percent, grain yield, biological yield and harvest index were obtained in between row spacing of 15 cm and the least of panicle length, panicle number per m^2, fertile spikelet percent, grain yield, biological yield and harvest index were produced in between row spacing of 30 cm. The most of spikelet number per panicle and harvest index were produced at interaction of weed control × row space of 15 cm. Therefore, weed control treatment due to an increase of almost all the traits and the row space of 15 cm due to increased panicle length, panicle number per m^2, spikelet number per panicle, fertile spikelet percent, grain yield, biological yield and harvest index as the best studied factors introduced applied.
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Introduction:

Early weeding isn't necessary because there is no competition between weeds and rice (Hall *et al.,* 1992). With progress of the growing season weeds make maximum damage to the plant (Wilson and Cole, 1966). All weeds remove before seedling transplanting, so there is no competition between weeds and rice in transplanting stage because there are few weeds and abundance of nutritional resources (Radosevich, 1987). In tillering time crop growth is impaired with increasing of weeds and despite its not significant decrease of yield but if weeds don't control it can significantly decrease yield (Rejmanek *et al.,* 1989). Weed interference with plant is important in tillering time and a good management Gives priority to weeding and weeds control (Van-Acker *et al.,* 1993). Rice yield strongly decrease with delay in weeds control 15 to 25 days after transplanting in rice field and decrease of rice yield are 30 to 40 % in transplanting seedling and 70 to 80 % in directly sowing because of weeds competition (Balasubramaniyam and Palaniappans, 2002). Estorninos *et al*. (2005) found that number of tiller decreased from 20 to 48 % with increase of weeds density from 25 to 51 plants per m^2. Nitrogen is important factor of growth limitation and lack of that caused decrease yield in each stage (Haefel *et al.,* 2006). Farmer grow the cultivars had high quality also, they had long height and sensitive to lodging and including 50% plant density area in Iran. Weather condition especially wind and rain in during full heading to ripening stages result in yield loss because increasing lodging and disease as a result decrease in grain yield. Baloch et al., (2002) found that the reason of rice grain yield enhancement under high plant density was due to the increase of the panicles per m². But at the same time the number of tillers and effective tiller in bush showed significant reduction. Therefore, with increasing of planting-density, in spite of the reduction of total number of tiller and effective tiller per bush, because of the increasing of the stem per square meter; consequently, number of panicle per m² and grain yield were increased. Also plant height in various genotypes of rice decreased by the increasing plant density (Mobasser et al., 2007). The purpose of this experiment was investigate effects of conduct to weeds and row spacing on weeds traits and agronomical parameters of rice (*Oryza sativa* L.) var. Tarom Mahalli at the north of Iran.

Materials and Method:

In order to investigate effects of conduct to weeds and row spacing on weeds traits and agronomical parameters of rice (*Oryza sativa* L.) var. Tarom Mahalli, an experiment was carried out at Sari city geographically situated at 36°, 37' N latitude and 53°, 11' E longitude at an altitude of 13.5 m above mean sea level in 2010. The soils of fields were clay-loam. The results of soil analyses are shown in table 1 and the weather condition in growth season is shown in table 2.

Table 1. Physical and chemical properties of soil before planting at Sari area in 2010.

Soil texture	K (ppm)	P (ppm)	N (%)	OM (%)	pH	EC (µmohs/cm)	Depth (cm)
Clay loam	185	22.8	0.50	2.2	7.1	0.24	0-30

Table 2. Weather conditions in rice growing period at Sari in 2010.

Variable	April	September	August	July	June	May
Minimum tem.	7.5	14	18.8	23.1	23.7	20.2
Maximum tem.	16.4	24	27.8	32.6	32.6	28.8
Minimum evaporation	60.4	55.6	56.5	49.6	54	58.2
Maximum evaporation	91.9	91.8	89.3	85.9	84.9	91.2
Precipitation	124.9	26.9	29.4	8.1	11.9	68.5

The experimental work was started in April 2010. Seeds of rice var. Tarom Mahalli were procured from Rice Research Institute, Amol, Mazandaran, Iran. This experiment was done as split plot in randomized complete blocks design based 3 replications. Weeds treatment was chosen as main factor (control and without control) and row spacing as sub-factor (10, 15, 20, 25 and 30 cm). The field was ploughed with tractor drawn disc plough followed by a through harrowing to break the clods. The field was properly levelled and 5 × 2 m size plots were earmarked with raised bunds all around to minimize the moment of watering and nitrogen. Channels were laid to facilitate irrigation to plots individually and each replication had 10 plots. 150 kg/ha Urea was supplemented as a source of urea to the main plant in three times (in time of transplantation, in time of initiative panicle, and in time of complete panicle). Also Phosphoric fertilizer in form of triple super-phosphate and potassium fertilizer in form of Sulphate-potassium was used about 110 and 100 kg/ha respectively. When rice seedlings were of 20 to 25 cm in height and 4 weeks old; they were uprooted and transplanted to experimental plots with treatment arrangement. Seedling transplanting and weeds control were done by design map. All operations like plant illnesses controlling and pests controlling were done during the growth process with chemical components. During the growth time, following characteristics was measured randomly from each plot. Plant height and stem length were measured from 12 hills in middle of each plot. Panicle length and flag leaf length were measured in the middle of each plot. Grain yield was harvested from 4 M^2 from the middle of the plot with 14 % humidity. Data analyzed by MSTAT-C statistical software and Averages comparison were calculated by Duncan's multiple range tests in a 5% probability level.

Results:

Weeds were indentified in rice field, the most important and main weeds were barnyard grass (*Echinochloa crus-galli* L.) and Rice flat sedge (*Cyperus iria* L.) because those were higher and more than the others and occupied widely ecological nich. Barnyard grass is so important between rice weeds because of similarity in genetically, morphological and phenotype (Gibson *et al*., 2003). Also barnyard grass had C4 Photosynthetic pathway and more carbon exchanging capacity compare to rice (C3), so it had more efficient in water absorption and nitrogen (Alberto *et al.,* 1996). Weeds height had significant effect under row spacing in 1 % probability level (Table 3). Weeds height by 25 and 30 cm row spacing (62.53 and 61.33 cm) was the most and minimum weed height (10.1 cm) was observed in 10 cm treatment (Table 4). Weeds number per m^2 had significant effect under row spacing in 1 % probability level (Table 3). Maximum 49.25 plant per m^2) and minimum (9.25 plant per m^2) of weeds number were noted for 30 and 10 cm row spacing treatment, respectively and in 15, 20 and 25 cm was 22.45, 34.25 and 40.35 plants per m^2, respectively (Table 4). Weeds dry matter per m^2 had significant effect under row spacing in 1 % probability level (Table 3). Maximum weeds dry matter (193.7 g/m^2) was observed for 30 cm treatment and minimum of that (45.23 g/m^2) was for 10 cm row spacing (Table 4).

Table 3. Mean squares effects of weed traits in row spacing of rice.

S.O.V.	DF	Weed density	Weed height	Weed dry weight
Replication	3	32.574^{ns}	67.612**	334.260**
Treatment	4	875.943**	2086.470**	13262.418**
Error	12	17.920	9.718	28.796
C.V. (%)	-	13.97	7.71	4.78

ns, *, ** = non significant, significant at 0.05 and 0.01 level of probability respectively.

Table 4. Mean comparison effects of weed traits in row spacing of rice.

Treatment	Weed density (plant per m^2)	Weed height (cm)	Weed dry weight (g.m^2)
Row spacing			
10 cm	9.25^d	10.10^d	45.23^e
15 cm	22.45^c	28.83^c	67.55^d
20 cm	34.25^b	46.33^b	122.00^c
25 cm	40.35^b	62.53^a	143.10^b
30 cm	49.25^a	61.33^a	193.70^a

*; means with similar letters in each column are not significant difference at the %5 level of probability according to DMRT.

Plant height had significant effect under weeds treatment in 5% probability level and row spacing in 1% probability level (Table 5). Plant height increased 2.53 % by weeds control and plant height was obtained (157.8 and 161.8 cm) for weeds without control treatment and control treatment respectively. Also plant height increased by increasing row spacing, so minimum plant height (140.3 cm) was observed for 10 cm and maximum of that (181.9 cm) was observed for 30 cm treatment (Table 6).

According to table 5, panicle length had significant effect under weeds treatment in 5% probability level and row spacing in 1% probability level (Table 5). Panicle length (26.2 and 30.7 cm) was for weeds without control treatment and weeds control treatment, respectively and panicle length increased 17.17 % by weeds control treatment. Minimum panicle length (21.4 cm) was observed for 30 cm row spacing and maximum of that (33.3 and 33.1 cm) was produced for 10 and 15 cm treatments (Table 6).

Tiller number per hill had significant effect under weeds treatment and row spacing in 1 % probability level (Table 5). Tiller number per hill (13.9 and 16.9 tiller) was for weeds without control treatment and weeds control treatment, respectively. Minimum tiller number (10.4 tillers) was observed for 10 cm row spacing and maximum of that (20.1 tillers) was obtained for 30 cm treatment (Table 6).

Fertile tiller number per hill had significant effect under weeds treatment and row spacing in 5 % probability level (Table 5). Fertile tiller number increased 41.1 % by weeds control treatment that they were 9 and 12.7 tillers for without weeds control and weeds control treatments, respectively. Also fertile tiller per hill increased by decreased plant density that the most fertile tiller equivalent to 13.8 tillers was observed for 30 cm row spacing and the least fertile tiller number (7.7 tillers) was observed in 10 cm treatment (Table 6).

Panicle number per m^2 had significant effect under weeds treatment in 5% probability level and row spacing in 1% probability level (Table 5). Panicle number was 331 and 381 panicles for without weeds control and weeds control treatments, respectively. The maximum panicle number equivalent to 416.5 panicles was performed in 15 cm row spacing and minimum panicle number (294.8 panicles) produced for 30 cm treatment (Table 6).

Spikelet number per panicle had significant effect under weed control and interaction weeds × row spacing in 5 % probability level and row spacing treatment in 1 % probability level (Table 7). The most spikelet number was observed for 15 cm treatment (167.6 numbers) and minimum of that (122.3 numbers) was obtained in 10 cm treatment (Table 8). Maximum spikelet number (168.5 and 166.8 spikelets) was noted for interaction weeds control and non control with 15 cm row spacing and minimum of that (115.5 spikelet's) was for interaction weeds without control with 10 cm row spacing (Table 9).

Filled spikelet percentage had significant effect under row spacing in 1 % probability level (Table 5). Filled spikelet percentage was the most in 15 and 20 cm (96.4 and 94.4 %) and minimum of that (86.7 and 85.5 %) was performed for 10 and 30 cm treatment (Table 6).

1000 grain weight had significant effect under row spacing in 1 % probability level (Table 5). the most 1000 grain weight (26.9 g) was observed in 25 cm row spacing and minimum of that 20.7 g was obtained in 10 cm treatment in 15 and 20 cm (96.4 and 94.4 %) and minimum of that (86.7 and 85.5 %) was performed for 10 and 30 cm treatment (Table 6).

Table 5. Mean squares effects of conduct to weed and row spacing on agronomical traits of rice.

S.O.V.	DF	Plant height	Tiller number per hill	Fertile tiller per hill	Panicle number per m^2	Panicle length	Spikelet number per panicle	Filled spikelet percentage	1000 grain weight
Replication	3	199.37^{ns}	21.63^{**}	1.84^{ns}	11.83^{ns}	26.47^{ns}	105.29^{ns}	3.18^{ns}	1.64^{ns}
Weed (A)	1	155.24^{*}	87.03^{**}	132.50^{**}	24950.03^{*}	202.50^{*}	585.23^{*}	0.97^{ns}	0.03^{ns}
Error	3	32.87	0.03	2.79	48.76	6.97	22.96	5.84	0.76
Row spacing (B)	4	1984.65^{**}	114.81^{**}	46.91^{**}	19409.53^{**}	214.96^{**}	2259.98^{**}	180.07^{**}	53.61^{**}
AB	4	58.85^{ns}	1.81^{ns}	0.26^{ns}	208.03^{ns}	16.06^{ns}	73.98^{*}	12.29^{ns}	1.78^{ns}
Error	24	31.51	1.18	1.06	127.46	9.36	26.71	6.45	0.90
C.V. (%)	-	3.51	7.03	9.48	3.17	10.77	3.59	2.79	3.86

ns, *, ** = non significant, significant at 0.05 and 0.01 level of probability respectively.

Table 6. Mean comparison effects of conduct to weed and row spacing on agronomical traits of rice.

Treatment	Plant height (cm)	Tiller number per hill	Fertile tiller per hill	Panicle number per m^2	Panicle length (cm)	Spikelet number per panicle	Filled spikelet percentage	1000 grain weight(g)
Conduct to weeds								
Non control	157.8^{b}	13.9^{b}	9.0^{b}	331.0b	26.2^{b}	140.1^{b}	90.7^{a}	24.5^{a}
Control	161.8^{a}	16.9^{a}	12.7^{a}	381.0^{a}	30.7^{a}	147.8^{a}	91.0^{a}	24.6^{a}
Row spacing								
10 cm	140.3^{e}	10.4e	7.7^{e}	345.0^{c}	33.3^{a}	122.3^{d}	86.7^{c}	20.7^{d}
15 cm	151.1^{d}	13.1^{d}	9.4^{d}	416.5^{a}	33.1^{a}	167.6^{a}	96.4^{a}	23.2^{c}
20 cm	159.0^{c}	15.8^{c}	10.9^{c}	394.3^{b}	29.3^{b}	137.5^{c}	94.4^{a}	26.4^{ab}
25 cm	166.6^{b}	17.6^{b}	12.5^{b}	329.4^{d}	25.0^{c}	141.3^{c}	91.4^{b}	26.9^{a}
30 cm	181.9^{a}	20.1^{a}	13.8^{a}	294.8^{e}	21.4^{d}	151.0^{b}	85.5^{c}	25.6^{b}

*; means with similar letters in each column are not significant difference at the %5 level of probability according to DMRT.

Grain yield had significant effect under weeds treatment and row spacing in 1 % probability level (Table 7). Grain yield by weeds control treatment (568.5 g/m^2) increased 19.26 % because of panicle length, panicle number per m^2 and spikelet per panicle increase compare to weeds without control (476.7 g/m^2). Minimum grain yield (451.5 g/m^2) was noted for 30 cm row spacing because of reduce in panicle length and panicle number per m^2. Maximum grain yield (590.5 g/m^2) was produced for 15 cm treatment, because increased panicle length, panicle number and spikelet number per panicle (Table 8).

Biological yield had significant effect under weed control and row spacing in 5 % probability level interaction weeds × row spacing in 1 % probability level (Table 7). The most biological yield was observed for weed control (1366 g/m^2) and minimum of that was note in non weed control (1315 g/m^2). The most biological yield (1413 g/m^2) was produced in 15 cm treatment and minimum of that (1269 and 1227 g/m^2) was obtained in 25 and 30 cm treatment (Table 8). Maximum biological yield (1473 g/m^2) was noted for interaction weeds control and non control with 10 cm row spacing and minimum of that (1178 g/m^2) was observed for interaction weeds without control with 30 cm row spacing (Table 9).

Harvest index had significant effect under weed control and interaction weeds × row spacing in 5 % probability level and row spacing in 1 % probability level (Table 7). The maximum harvest index was observed for weed control (41.6 %) and minimum of that was note in non weed control (35.9 %). The most harvest index (41.9 %) was produced in 15 cm treatment and minimum of that (36.4 and 36.7 %) was obtained in 10 and 30 cm treatment (Table 8). The most harvest index (45.9 %) was noted for interaction weeds control with 15 cm row spacing and minimum of that (32.7 %) was observed for interaction weeds without control with 10 cm row spacing (Table 9).

Table 7. Mean squares effects of conduct to weed and row space on yield and harvest index of rice.

S.O.V.	DF	Grain yield	Biological yield	Harvest index
Replication	3	6728.025^{ns}	25770.233^{ns}	18.663^{ns}
Conduct to weed (A)	1	91872.225**	25100.100*	320.073*
Error	3	2072.492	18283.567	11.586
Row spacing (B)	4	22467.538**	68336.100*	42.607**
AB	4	1215.288^{ns}	4008.600**	9.608*
Error	24	1031.279	4111.650	2.986
C.V. (%)	-	6.17	4.78	4.46

ns, *, ** = non significant, significant at 0.05 and 0.01 level of probability respectively.

Table 8. Mean comparison effects of conduct to weed and row space on yield and harvest index of rice.

Treatment	Grain yield (g.m^2)	Biological yield (g.m^2)	Harvest index (%)
Conduct to weeds			
Non control	476.7^b	1315.9^b	35.9^b
Control	568.5^a	1366.0^a	41.6^a
Row spacing			
10 cm	526.6^b	1383.0^{ab}	36.4^c
15 cm	590.5^a	1413.0^a	41.9^a
20 cm	544.6^b	1353.0^b	40.2^{ab}
25 cm	489.6^c	1269.0^c	38.6^b
30 cm	451.5^d	1227.0^c	36.7^c

*; means with similar letters in each column are not significant difference at the %5 level of probability according to DMRT.

Table 9. Mean comparison interaction effects of conduct to weed and row space on agronomical traits of rice.

Interaction	Spikelet number per panicle	Biological yield (g.m^2)	Harvest index (%)
W_1D_1	115.5^f	1415^{ab}	32.7^f
W_1D_2	168.5^a	1425^{ab}	37.9^{cd}
W_1D_3	133.0^{de}	1323^{bcd}	37.2^{de}
W_1D_4	138.5^{cd}	1240de	37.0^{de}
W_1D_5	145.0^c	1178^e	35.0^{ef}
W_2D_1	129.0^e	1473^a	40.2^c
W_2D_2	166.8^a	1401^{ab}	45.9^a
W_2D_3	142.0^c	1383^{abc}	43.2^b
W_2D_4	144.0^c	1299^{cd}	40.2^c
W_2D_5	157.0^b	1276de	38.5^{cd}

*; means with similar letters in each column are not significant difference at the %5 level of probability according to DMRT.

Discussion:

Weeds had the most damage in crops when it reached to sources limitation time (Wilson and Cole, 1996). Natural process of rice growth was disturbed by increase of weeds seed germination and occupied within the row space (Rejmanek *et al.,* 1989). There is no competition between rice and weeds in early growth stage and weeding is not necessary (Hall *et al*., 1992). Islam *et al*. (2003) have seen plant height was 76.5 cm when there was no competition between rice and weeds but in 112 plants per m^2 barnyard grass decreased 42.9 % plant height and this results were supported by Holm *et al.* (1997). Asghari (2002) stated that plant height increased by weeds control and less nutritional competition. Sadati and Fallah (1995) stated that plant height had significant different in tillering time by nitrogen contributing in 1 % probability level. Panicle length (17.21 %) increased by weeds control (Malek *et al.,* 2011). Panicle length in transplanting rice and direct sowing rice effects in grain yield by more transfer of photosynthetic material (Dobermann *et al*., 2002). Malek *et al.* (2011) stated that flag leaf length increased by weeds control compare to weeds without control. Mohammadi *et al*. (2011) found flag leaf length increased by weeds control and nitrogen application. Rice grain yield decreased with barnyard grass competition because it reduced fertile tiller number, spikelet number per panicle and 1000-seed weight (Holm *et al.,* 1977). Grain yield decreased 25 % by weeds competition (Lindquist and Kropff, 1996). Reduce of dry matter gathering was for competition between rice and weeds for nutrition sources and light (Aminpanah *et al*., 2007). Researchers reported reduce of dry matter gathering by competition conditions

(Heafele *et al*., 2004; Holm *et al.,* 1977 and Zhao *et al.,* 2006). Grain yield strongly decreased by delay in weeds control in rice filed and reduce of grain yield was 30 to 40 % for transplanting rice and 70 to 80 % in seedling direct planting (Balasubramaniyam and Palaniappans, 2002). According to the research results, as the total number of tiller and effective tiller per bush reduces by plant density deduction, but the number of panicle per m² has had a significantly increasing. Also, length of panicle and flag leaf by increasing of plant density had deduction, but the total number of spikelet, hollow spikelet per panicle, weight of 1000-seed and straw yield under the plant density effects have not shown significant differences (Yadi et al., 2012).

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