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# Effect of Plant Density on Yield and Yield Components of Rice

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**Abstract:** for study of plant density on yield and yield components of rice variety Hashemi, an experiment in factorial format based on randomized complete block design with 3 replications, at a paddy field in Lahijan Township (north of Iran) in 2009 was conduced. Factors of Experiment was consist of three levels of plant spacing ($a_1$: 15×15, $a_2$: 20×20 and $a_3$: 25×25 cm) and three levels of number of seedling per hill ($b_1$: 1, $b_2$: 3 and $b_3$: 5 seedlings per hill). Results showed that, the effect of plant spacing and also number of seedling per hill on all studied traits was significant in 1% probability level. Highest grain yield among plant spacing levels was found from 15×15 cm treatment with 3415 kg/ha. Also, between number of seedling per hill, $b_2$ treatment with 3526 kg/ha grain yield was recorded the highest amount of this trait. Interaction effect of plant spacing and number of seedling per hill on grain yield, straw yield and harvest index was significant in 1% and on biological yield in 5% probability level. Also, on other traits was non significant. The interaction level of $a_2b_2$ with 3612 kg/ha was recorded the highest grain yield.

**Key words:** Rice · Plant Spacing · Number of Seedling per hill · Yield · Yield components

## INTRODUCTION

Rice (Oryza sativa L.) plays an important role as a staple food in Asia and other parts of the world, including Mediterranean Europe [1]. The plants largely depend on temperature, solar radiation, moisture and soil fertility for their growth and nutrition requirements. A dense population of crops may have limitations in the maximum availability of these factors. It is, therefore, necessary to determine the optimum density of plants population per area unit for obtaining maximum yields [2]. Optimum plant spacing ensures plants to grow properly both in their aerial and underground parts through different utilization of solar radiation and nutrients. The optimum plant density depends on different factors that most importance of this factors include: plant characteristics, growth period duration, planting time and methods, soil fertility, plant size, available moisture, sun shin, planting pattern and situation of weeds [3]. Plant spacing is an important production factor in transplanted rice [4]. Mohapatra *et al*. were reported that plant spacing of 20× 20 cm was better than those of 15 × 15 or 15 × 20 cm under normal soil for rice productivity [5]. Maske *et al*. reported that plant height, leaf area index, yield and yield components of rice with plant spacing of 15×10 cm were higher than of 15×15 cm or 15×20 cm [6]. Patel. observed that hill spacing of 20 × 20 cm in compared with 20 × 15 cm and 20 × 10 cm of hill spacings recorded perceptible increase in number of panicles per $m^2$, yield and straw yield. Also, Number of grains per panicle and 100-grain weight was not affected by hill spacings [7]. Number of seedling per hill is another important factor that it can play important roles in boosting yield of rice. Because it influences the tiller formation, solar radiation interception, total sunshine reception, nutrient uptake, rate of photosynthesis and other physiological phenomena and ultimately affects the growth and development of rice plant. In densely populated rice field the inter-specific competition between the plants is high in which sometimes results in gradual shading and lodging and thus increase production of straw instead of grain. It is, therefore, necessary to determine the optimum plant spacing and number of seedling per hill for high yield [8, 9]. Faruk *et al*. reported that the highest grain yield was recorded from two seedlings per hill and the lowest one was recorded from single seedling per hill [10]. mohammadian roshan *et al*. with Study of yield and yield components of rice variety Ali Kazemi in different Plant Spacings and Number of Seedlings per Hill was reported that The highest grain yield was obtained from plant spacing of 20×20 cm with

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5582 kg/ha. Also The 7 seedling per hill with 5188 kg/ha was recorded the maximum grain yield [11]. The current study aim was to investigate the influence of different plant spacings and number of seedlings per hill on yield and yield components of rice variety Hashemi in order to select the optimum planting pattern for cultivation of this variety.

## MATERIALS AND METHODS

For study effect of plant spacing and number of seedling per hill on rice cultivation, an experiment in factorial format based on randomized complete block design with 3 replication on a paddy field in Lahijan Township bested on Guilan province (north of Iran), with 37°11' N latitude and 50°0' E longitude and 20 m above sea level in 2009 was conducted. The climate of the area is mild and Mediterranean. Soil analysis results show that (Table 1), the soil texture was Silty Loam and pH 7.1. The factors of experiment included three levels of plant spacing ($a_1$: 15×15, $a_2$: 20×20 and $a_3$: 25×25 cm) and three levels of number of seedling per hill ($b_1$: 1, $b_2$: 3 and $b_3$: 5 seedlings per hill) The operations of preparing land include first plough in winter and secondary plough along with giving phosphorus and potash was done. The area of plots was 15 $m^2$. Sowing in nursery was done April 15 and transplanted to main field May 22. According to soil analysis amount of fertilizers N, K and P were implemented. During growth period, cultivate cares were done ordinarily. In maturity time, Grain yield, straw yield, biological yield, harvest index, plant height, panicle length, number of grain per panicle, number of tillers per $m^2$ and percentage of unfilled grain were measured. The yield and yield components were analyzed by using MSTAT-C software. The Duncan's multiple range tests was used to compare the means at%5 of significant.

## RESULTS AND DISCUSSION

**Effect of Plant Spacing:** Results of variance analysis show that (Table 2), the effect of plant spacing on all measured traits was significant in 1% probability level. Comparison of mean between plant spacing treatments show that (Table 3), the highest grain yield, biological yield and harvest index was obtained from plant spacing of 20×20 cm ($a_2$) respectively with 3415 kg/ha, 8033 kg/ha and 42.43%. The lowest grain yield with 3242 kg/ha and harvest index with 40.87% was recorded from plant spacing of 15×15 cm ($a_1$). Also, the minimum amount of biological yield with 7867 kg/ha was obtained from plant spacing of 25×25 cm ($a_3$). The plant spacing of 20×20 cm with 42.13% harvest index statistically was placed on same level with 20×20 cm treatment. The highest straw yield, plant height and unfilled grain percentage was found from plant spacing of 15×15 cm respectively with 4696 kg/ha, 133.2 cm and 11%. The lowest amount of straw yield with 4547 kg/ha and plant height with 127 cm was recorded from plant spacing of 25×25 cm. minimum unfilled grain percentage was found from 20×20 cm treatment ($a_2$) with 9.31%. The maximum amount of panicle length with 26.99 cm, number of grain per panicle with 87 and number of tillers per $m^2$ with 325.3 was found from plant spacing of 25×25 cm ($a_3$). Minimum amount of panicle length, number of grain per panicle and number of tillers per $m^2$ respectively with 25.70 cm, 79.11 and 197.1 was obtained from 15×15 cm treatment ($a_1$). Similar results were recorded from Mohammadian Roshan *et al*. [11], Erfani [12] and Hasanuzzaman *et al*. [13].

Table1: Soil analysis results of the experimental sites

| Depth (cm) | 0-30 | Texture | Silty loam |
|---|---|---|---|
| Organic matter % | 7.1 | PH | 7.1 |
| Clay % | 18.35 | N% | 0.18 |
| Sand % | 20.42 | P ppm | 36.8 |
| Silt % | 61.23 | K ppm | 28.2 |

Table 2: Analysis of variance on studied traits of rice variety under different levels of plant spacing and number of seedling per hill

| Source of variance | df | Grain yield (kg/ha) | Straw yield (kg/ha) | Biological yield (kg/ha) | Harvest index (%) | Plant height (cm) | Panicle length (cm) | No.of grain per panicle | No.of Tillers ($m^2$) | Unfilled grain (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MS | | | | | |
| Factor A | 2 | 66828.926$^{**}$ | 47818.111$^{**}$ | 62462.704$^{**}$ | 6.223$^{**}$ | 84.041$^{**}$ | 3.768$^{**}$ | 146.778$^{**}$ | 40880.111$^{**}$ | 6.614$^{**}$ |
| Factor B | 2 | 362605.815$^{**}$ | 413769.333$^{**}$ | 1146098.926$^{**}$ | 15.730$^{**}$ | 36.403$^{**}$ | 2.354$^{**}$ | 117.444$^{**}$ | 8018.111$^{**}$ | 13.339$^{**}$ |
| A×B | 4 | 15599.426$^{**}$ | 27974.444$^{**}$ | 20125.870$^{*}$ | 2.298$^{**}$ | 1.254$^{ns}$ | 0.149$^{ns}$ | 5.722$^{ns}$ | 154.889$^{ns}$ | 0.161$^{ns}$ |
| Error | 16 | 1446.481 | 3863.194 | 5513.412 | 0.180 | 1.925 | 0.070 | 12.528 | 58.50 | 0.091 |
| C.V% | | 1.14 | 1.35 | 0.93 | 1.01 | 1.07 | 1 | 4.24 | 3.07 | 2.94 |

Ns,** and * respectively non significant, significant in 1% and 5% area

Table 3: comparison of Mean Effect of plant spacing and number of seedling per hill

| Treatment | Grain yield (kg/ha) | Straw yield (kg/ha) | Biological yield (kg/ha) | Harvest index (%) | Plant height (cm) | Panicle length (cm) | No.of grain per panicle | No.of Tillers ($m^2$) | Unfilled grain (%) |
|---|---|---|---|---|---|---|---|---|---|
| Plant spacing (A) | | | | | | | | | |
| 15×15 | 3242c | 4692a | 7935b | 40.87b | 133.2a | 25.70c | 79.11b | 197.1c | 11a |
| 20×20 | 3415a | 4619b | 8033a | 42.43a | 130b | 26.44b | 84.56a | 225.2b | 9.31c |
| 25×25 | 3321b | 4547c | 7867b | 42.13a | 127c | 26.99a | 87a | 325.3a | 10.41b |
| No.of seedling $hill^{-1}$ | | | | | | | | | |
| 1 | 3125c | 4408c | 7533b | 41.44b | 132.2a | 26.90a | 80.89b | 217.4c | 11.32a |
| 3 | 3526a | 4612b | 8139a | 43.28a | 129.8b | 26.36b | 87.67a | 253.6b | 8.92c |
| 5 | 3326b | 4837a | 8163a | 40.71c | 128.2c | 25.88c | 82.11b | 276.7a | 10.48b |

Within each column, means followed by the same letter do not differ significantly at P<0.05

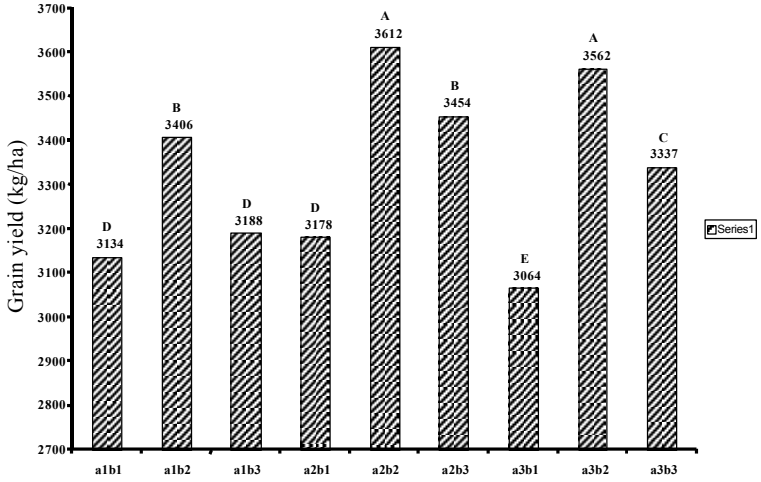


Fig. 1: Interaction effect of plant spacing and number of tillers per hill on grain yield.

**Effect of Number of Seedling per Hill:** All the studied traits significantly (In 1% probability level) were affected by number of seedling per hill (Table2). Comparison of mean between number of seedlings per hill show that (Table 2), the highest grain yield, harvest index and number of grain per panicle respectively with 3526 kg/ha, 43.28% and 87.67 was recorded from 3 seedlings per hill. The lowest grain yield with 3125 kg/ha and number of grain per panicle with 80.89 grains per panicle was found from 1 seedling per hill. The maximum amount of straw yield, biological yield and number of tillers per $m^2$ was recorded from 5 seedlings per hill respectively with 4837 kg/ha, 8163 kg/ha and 276.7. Minimum values of this traits respectively with 4408 kg/ha, 7533 kg/ha and 217.4 was recorder from 1 seedling per hill. The highest plant height with 132.2 cm, panicle length with 26.90 cm and unfilled grain percentage with 11.32% was obtained from 1 seedling per hill. The lowest plant height and panicle length respectively with 128.2 cm and 25.88 cm was found from 5 seedlings per hill. Minimum unfilled grain percentage with 8.92 was recorded from 3 seedlings per hill. Similar results were obtained by Mohseni and Tabari. [14] and Faruk *et al*. [10].

**Interaction Effects:** Results of variation analysis show that (Table 1), the interaction of plant spacing and number of seedling per hill on grain yield, straw yield and harvest index had significant differences in 1% probability level and on biological yield in 5% probability level. Also, on other measured traits was non significant. The highest grain yield, biological yield and harvest index respectively with 3612 kg/ha, 8248 kg/ha and 43.73% was obtained from plant spacing of 20×20 cm along with 3 seedlings per hill ($a_2b_2$). On the other hand the lowest grain yield with 3064 kg/ha and biological yield with 7431 kg/ha was found from plant spacing of 25×25 cm along with 1 seedling per hill. The minimum amount of harvest index with 38.73% was obtained from plant spacing of 15×15 cm along with 5 seedlings per hill (figure 1, 3, 4). The highest straw yield with 5039 kg/ha was recorded from plant spacing of 15×15 cm along with 5 seedlings per hill. The lowest straw yield was found from plant spacing of 25×25 cm along with 1 seedling per hill with 4367 kg/ha. Similar results were obtained by Mohammadian Roshan *et al*. [11], Muhammad *et al*. [15] and Salem. [16].

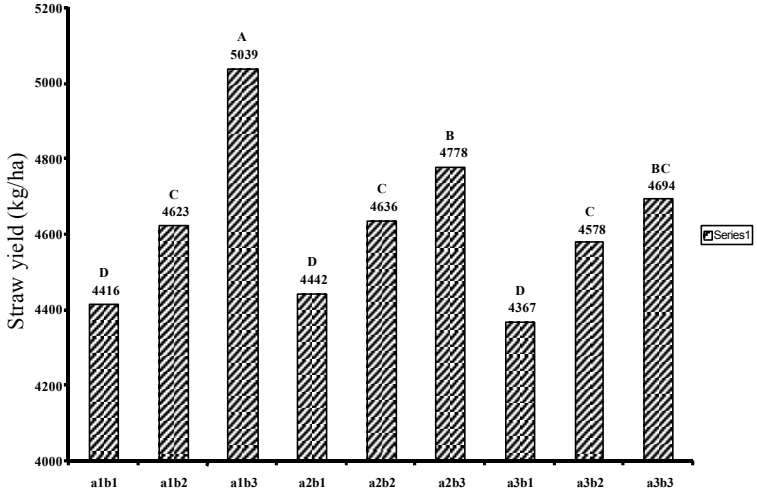


Fig. 2: Interaction effect of plant spacing and seedling per hill on straw yield.

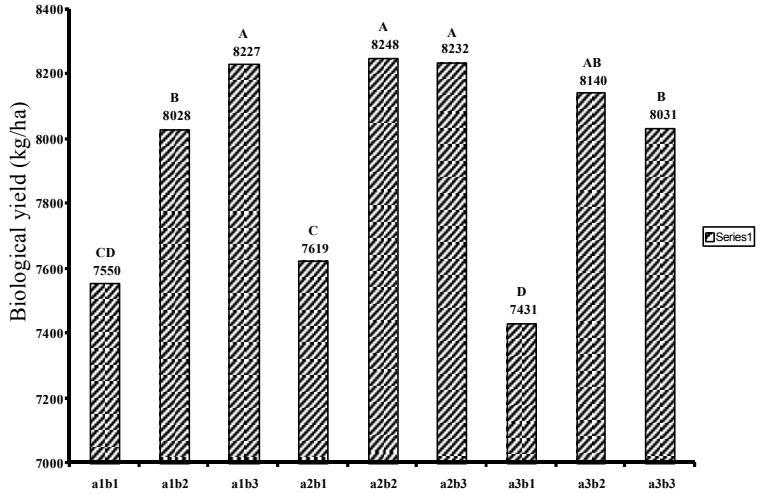


Fig. 3: Interaction effect of plant spacing and seedling per hill on biological yield.

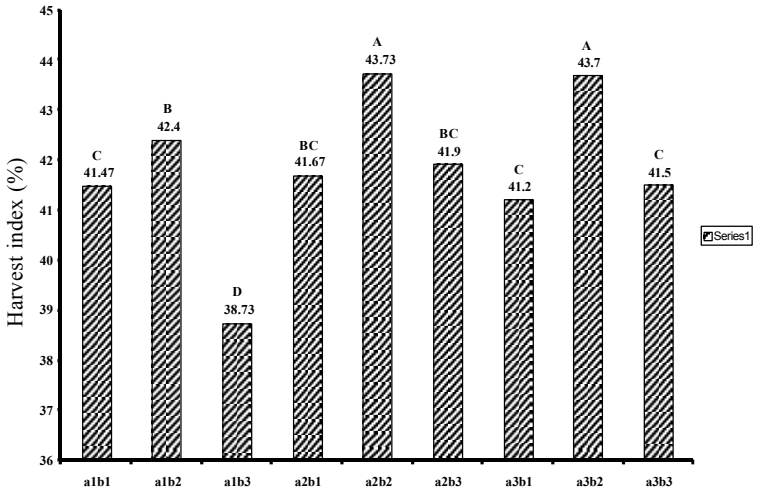


Fig. 4: Interaction effect of plant spacing and seedling per hill on Harvest index.

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