Research Paper

Influence of Humic Acid, Plant Density on Yield and Fatty acid Composition of some Rapeseeds Cultivars during Two years

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ABSTRACT

A field experiment was designed to study the different plant densities and humic acid (HA) applications on some rapeseeds cultivars. The experiment was designed as a factorial split plot based on a Complete Block Design (CBD) with three plots including three plant densities (40, 60 and 80 plants/m²), two HA applications (+HA and –HA) as main plots and six rapeseeds varieties as sub-plots including Ahamadi, Opera, Okapi, L72, Karaj1 and Sw102 with three replications. The analysis variance showed that HA, varieties, plant density and interaction effect of plant density and varieties had significant effect on the studied traits. Applications of HA increased seed yield and seed oil in comparison with non-HA applications. All studied traits (except oleic acid) were different between varieties. Erucic and linolenic acids were the highest at 80 plants/m² whereas oleic, linoleic and palmitic acids, seed oil and seed yield were the highest at the lowest plant density (40 plants/m²). Interaction effect of plant density and varieties showed that all studied index (except linolenic and erucic acids) were decreased by increasing plant density (60 and 80 plants/m²). The highest palmitic acid, seed yield and seed oil were observed at L72 and SW102 with 40 plants/m². Linolenic and erucic acids showed an increment by increasing plant density (80 plants/m²) in rapeseeds cv.L72. Finally, it can be concluded that cv.L72 in the lowest density (40 plants/m²) had the highest yield in this region.

Key words: Fatty acid, rapeseed, organic compound, plant density.

INTRODUCTION

Rapeseed is the second edible oil resource in the world with high seed oil and lowest saturated fatty acid among oil seed crops (Raymer, 2002). Rapeseed oil has higher nutrient value than other oil seeds due to its high unsaturated fatty acid (Naseri et al., 2012).

Using suitable cultivars matchable with climate conditions and also choosing ideal plant density with minimum competition among plants are ways to increasing seed yield. Previous studies showed that plant density have an important role in rapeseed yield and a uniform distribution is required for yield stability (Diepenbrock, 2000). Plant density had significant effect on number of pods, secondary branch and seeds per plant (Salehian et al., 2002). The same researcher reported that the maximum number of pods and seeds per plant were observed at 50 plants/m².

In addition, Naseri et al. (2012) in their study showed that the highest canola seed yield (3636.6 kg/h), oil seed yield (1603.4 kg/h) was from Hyola 401 and in 60 plants/m². Ozer (2003) suggested that seed yield was affected by spacing between rows. Leach et al. (1999) also reported that plant density had no influence on seed oil, whereas at the highest plant density, it produced more branches and a fewer pod-bearing branches per plants. Similarly, Al-Barzinjy et al. (1999) concluded that seed weight and pods per plant decreased with increasing
plants density. Prasad and Shakda (1991) found that highest seed yield could be achieved by increasing plant density and nitrogen levels.

On the other hand, humic acid (HA) is a dark colored organic substance and a natural resource used as an alternative for fertilizer to increase crop production. Humic acid have been reported to enhance nutrient absorption, plant growth, physiology and metabolism (Ahmad et al., 2016). Rajpar et al. (2012) reported that the rapeseed cv. S-9 responded better to humic acid application than P-78 and AH-2001. Also, the results of Nikbakht et al. (2011) showed that HA application reduced oil content of Silybum marianum and Cucurbita pepo convar. pepo var. styriaca seeds.

Optimum densities for each crop and environment should be studied. Hence, the objective of this present study is to investigate the effect of different plant densities, usage of humic acid on the seed yield and fatty acid composition of some rapeseeds cultivars in two years.

**MATERIALS AND METHODS**

This outdoor experiment was conducted in 2014 and repeated under the same condition in 2015 at the field of seed and plant improvement institute (35.59°N, 51.6°E; 300 m). The present study was designed as a factorial split plot experiment based on a Complete Block Design (CBD) to evaluate the effect of humic acid (HA) applications in combination with different plant densities on six rapeseed varieties. Treatments were three plant densities (40, 60 and 80 plants/m²), two HA applications (+HA and −HA) as main plots and six rapeseed varieties as sub-plots including Ahamadi, Opera, Okapi, L72, Karaj1 and Sw102 with three replications.

Each plot consisted of four (4) lines (5 m) and an area of 6 m². The soil texture was clay-loam, while Electrical conductivity (EC), pH, Organic carbon (OC%), total Nitrogen (N), Phosphorus (P), Iron (Fe), Zinc (Zn) and Copper (Cu) are 2.22, 7.24, 0.58%, 0.06, 12.6, 5.02, 0.32 and 1.47, respectively. Seeds were obtained from the Department of Oil Seed Research, Seed and Plant Improvement Institute (Karaj, Iran) and planted manually by applying urea (350 kg/h) thrice, (1/3 planting time, 2/3 before flowering) and triple superphosphate applied (50 kg/h). Irrigation was performed regularly and at the end of plant maturity plants were harvested and seed yield, seed oil and fatty acid composition measured.

Seed oil was extracted using the Soxhlet extraction apparatus and petroleum ether (40 to 60°C) was used as a solvent. As 20 g of oil was needed for further analysis, 60 g of pumpkin seeds and 100 g of milk thistle seeds were taken for oil extraction. The extracted oil was separated from the organic solvent using a rotary vacuum evaporator. To avoid changes in the chemical composition of samples, they were frozen immediately after extraction and stored under a nitrogen atmosphere at -18°C. Fatty acids composition was determined using Gas Liquid Chromatography (GLC).

The study was arranged in a factorial split plot experiment based on a complete block design with three replications per treatment. The data set was analyzed using SAS. All data were subjected to two-way ANOVA and the means compared for significance using Duncan’s least significant difference (LSD) test at p < 0.05.

**RESULTS AND DISCUSSION**

Analysis variance of data showed that year had significant effect on seed yield and seed oil yield at p<0.1% and palmitic, linolenic and erucic acids at p=0.5% (Table 1). Erucic acid was the highest at first year while linoleic acid, palmitic acid, oil seed yield and seed yield were the highest at the second year (Table 2). Plant density had significant effect (p<0.1%) on fatty acid composition, seed yield and oil seed yield. The results showed that erucic acid and linolenic acid were the highest at 80 m, while oleic, linoleic and palmitic acids were the highest at 40 m. Seed oil yield and seed yield increased at 40 m in comparison with other densities (Table 2). Table 1 shows that the application of humic acid had no significant effect on fatty acid composition. Seeds were significantly increased by the application of humic acid in comparison with non-HA application (Table 2).

Fatty acid composition (except oleic acid), seed yield and seed oil yield were influenced by varieties at p<0.1%. Table 2 shows that the highest erucic acid was at Opera (0.33) and Karaj1 (0.33) and the lowest at Ahmadi (0.28). The result showed that there was no significant difference in oleic acid concentration in all the studied varieties. The highest linoleic acid was achieved at Ahmadi (19.62) and the lowest at Opera (18.57) and Karaj1 (63.08). Linolenic acid was the highest at Okapi, Opera and Karaj1. Palmitic acid increased in Ahmadi and decreased in Okapi, Opera and Karaj1. Seed yield and seed oil yield was the highest at Ahmadi and the lowest at Karaj1 (Table 2).

Figure 1 shows that the interaction effect of plant density and varieties on seed yield was significantly reduced by increasing plant density in both 60 and 80 in comparison with 40. The highest seed yield was at L72 and SW102 at the lowest plant density (40). Also, seed oil yield was sharply decreased by increasing plant density and the lowest oil seed yield was at L72 × 80 and the highest at L72 × 40 (Figure 2).

A sharp decrease in palmitic acid was observed in variety L72 when grown at the highest plant density (80). The highest palmitic acid was at this variety at the lowest density. Palmitic acid at all varieties decreased at both 60 and 80 m² density (Figure 3). Linolenic and erucic acids
significantly increased with increasing plant densities. The highest linolenic and erucic acids was achieved at L72 in

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<th>Table 1: Analysis variance of traits under different densities and humic acid application of rapeseed varieties in two years.</th>
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Ns, * and ** showed non-significant, significant in 1 and 5%, respectively. Y, D, HA and V showed year, density, humic acid and varieties, respectively.

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<th>Table 2: Main effect of year, humic acid, plant density and variety on some yield compound traits.</th>
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The mean values with different letters across treatments are significantly different at p<0.05.
plants grown at the highest density (Figure 4a and b).

In our study, humic acid applications caused an increase in seed yield and seed oil yield in comparison with plants grown without humic acid applications. These results are in line with the report of Rajpar et al. (2011) which showed that applications of humic acid and varieties had significant effect on seed yield; but interaction effect of humic acid and varieties was non-significant. Also, they
found that all applications of humic acid increased seed oil content in S-9 more than other varieties (P-78 and AH-2001). Similarly, folic and soil application of humic acid improved seed yield and oil content of mustard (Chris et al., 2005).

Fatty acid compound included palmitic, linoleic and erucic acids; linolenic and oleic acids were not affected by HA addition. Contrary to our results, Nikbakht et al. (2011) reported that two unsaturated fatty acids (oleic and linoleic acids) increased by HA applications while palmitic acid decreased in milk thistle and pumpkin seeds and explained that HA was probably only effective on synthesis fatty acid cycle.

Naseri et al. (2012) studied seed yield and seed oil of rapeseed in different varieties and observed that highest seed yield was at 401 Hyola hybrid than other cultivars (Hyola 308, Zarfam and Sarigol) and explained that seed yield difference may be due to their genetic properties. Seed oil content of rapeseed cv. Lirawell was found higher than cv. Tower (Ozer, 2003). In the present study, Ahmadi had the highest seed yield and oil seed yield, while Opera and Karaj1 had the lowest yield. Low seed yield can contribute to low pod per plant or 1000 seed weights (Naseri et al., 2012).

In our study, mean seed yield in 40, 60 and 80 plants/m² were 6377, 4233 and 2741 respectively. It showed that seed yield significantly decreased with increasing plant densities (about 33 and 57% in 60 and 80 plants/m² in comparison with 40 plants/m²). Similar results were also found by Larry et al. (2002) in soybean. Chen et al. (2008) concluded that the highest rapeseed yield was observed at 32 plants/m². Similarly, Naseri et al. (2012) reported on the difference in seed yield by changing plants densities and concluded that the thicker densities (80 plants/m²) reduced sunlight absorption into canopy and then decreased photosynthetic matter and transformed them to seeds by increasing competition among plants. Increasing plant densities resulted in an increase of plant elongation and competition and reduced seed yield (Sadeghi et al., 2009). Besides, in appropriate density, plant utilization increased environmental factors, while the highest assimilation and yield was achieved.

The highest palmamic acid and linoleic acid in Amaranthus was observed at 5000 plants/h and no significant difference was observed between 5000 and 75000 plants/h in the amount of oleic acid (Ardal, 2014). Our results showed that the highest erucic, linolenic acids were observed at 80 plants/m² while oleic, linoleic, palmitic acids were the highest at 40 plants/m².

Interaction effect of plant densities and varieties were significant, hence, the highest seed yield was at L72 and SW102 in the thinner densities (40 plants/m²). A similar report by Naseri et al. (2012) showed that the highest seed yield was at 401 Hyola hybrid in 60 plants/m², while Zarfam had the lowest seed yield in 40 plants/m². Champiri and Bagheri (2013) studied two cultivars of

Figure 3: Interaction effect of plant density and some canola cultivars on palmitic acid. The mean values with different letters across treatments are significantly different at p<0.05.
rapeseed (Hyola 60 and Sarigol) in three row spacing (15, 25 and 35). They reported that Hyola 60 with planting distance (15 cm) produced higher seed yield. This may be due to leaves falling quickly in high densities as a result of competing for absorption of light and this may lead to decreasing seed yield (Fathi, 2008).

Highest seed oil was observed at the lowest densities (40 plants/ m²) and it was 35 and 59% higher than 60 and 80 plants/ m². High oil yield in 40 plants/m² could be due to high seed yield at this plant density. Eikaaee and Emam (2003) explained that thin densities leads to an increase in pod per plant and also reduced seed size and this may in turn lead to increasing oil content in thin densities. Ozoni and Davaji (2007) reported that genetic

**Figure 4:** Interaction effects of plant density and some canola cultivars on (A) Linolenic acid and (B) Erucic acid. The mean values with different letters across treatments are significantly different at p<0.05.
and environmental factors affected canola oil content.

Oil content (oleic, palmitic and linoleic acids) of Industrial hemp (Cannabis sativa L.) was not affected by different plant densities (Townshend and Boleyn, 2008). The highest oil yield was at L72 in 40 plants/m² and the lowest at L72 in 40 plants/m²; this is due to the fact that sunlight penetrates better than other densities.

Conclusion

The results of this study indicated that applications of humic acid had beneficial effect on seed and seed oil yield. On the other hand, there was a significant difference between the studied cultivars. The highest seed, seed oil yield, linoleic acid and palmitic acid was at Ahmadi. Opera and Karaj1 had the highest erucic acid, while Okapi, Opera and Karaj1 had the highest linolenic acid than other varieties. Interaction effect of varieties and plant densities showed that the lowest densities had significant effect on all the studied varieties. Based on the results obtained, rapeseed cv. L72 and 40 plants/m² is suitable in the Karaj region (Iran).

REFERENCES


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