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Research Article

THE EFFECT OF NITROGEN AND PLANT DENSITY ON COMPETITIVE ABILITY OF SWEET CORN AGAINST WEEDS

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ABSTRACT
This study was carried out to evaluate the effect of different levels of nitrogen and plant density on sweet corn growth and yield and weeds biomass and population. Treatments were arranged in a split-split plot based on randomized complete block design (RCBD) with three replicates. The treatments were the amount of urea fertilizer at five levels (75, 150, 225 and 300 kg/ha) and plant density at three levels (40000, 50000 and 62500 plants/ha). The results of this study showed that the application of fertilizer treatments significantly increased the number of grains per ear, grain weight per plant and grain yield. The weight of ear with 225 and 300 kg/ha of nitrogen fertilizer in within-row plant space of 15 and 20 cm, was less than 25 cm spacing. Also, Grain weight per plant at levels of 225 and 300 kg/ha nitrogen fertilizer and 15 cm spacing, was less amount than 25 cm spacing. The greatest weight of ear (45 percent higher than control) was recorded when corn plants were planted in 25 cm spacing with 300 kg/ha nitrogen fertilizer. Maximum grain yield (398 gr/m^2 belonged to 150 kg/ha) that was 123 percent higher than control. Grain yield in 15 and 20 cm spacing was 19.1 and 26.3 percent more than 25 cm spacing. In this study, the increasing density had a significantly reduced the number of pigweed per square meter. 15 cm spacing had less number of pigweed compared to 25 cm spacing. Also, the treatment of 150, 225 and 300 kg/ha nitrogen fertilizer were 20, 18.8 and 27.4 percent higher than control, respectively. The weight of pigweed was obtained 105 g/m^2 in 15 cm spacing that was 18.6 percent lower than 25 cm spacing. Also, the weight of pigweed at 15 cm spacing was 19.1 percent lower than 20 and 25 cm spacing, respectively.

***Keywords*:** *Corn, Weeds, Nitrogen Fertilizer, Amount of Fertilizer, Herbicide Dose*

INTRODUCTION
The increasing of maize production is one of global objective to meet the needs of humans and animals. Based on the cultivation and production rate, maize is the third most important cereal after wheat and rice in the word (Ghazal *et al*., 2013). In terms of grain yield per unit area, however, corn has the first grade (Asim *et al*., 2012). Sweet corn is one of the world's major food sources which are used to boiled, cooked or in salad, pizza and etc. Although sweet corn is grown in a small surface, has the high economic importance for farmers. The weeds are also serious constraint in all crops such as sweet corn that interferes with plant yield and decreased it up to 85 percent. The greatest reduction is when the weeds interfere with corn in early growth stages. Because of the weakness canopy of sweet corn caused a poor competitor with weeds. Even low weed density in sweet corn will result yield reduction. So that have been shown a plant of *Ambrosra trifida* in surface of 25 m^2 lead to a reduction (5 percent) on grain yield where as 10.5 corn plant led to same reduction. Both of narrow and broad leaf of weeds in sweet corn will result reduced yield (Simik *et al*., 2012). Other researchers reported that weeds reduce 10 percent of crop yield in worldwide (Bakhsh *et al*., 2013). The presence of weeds in corn field will be severely reduced yield in vegetative growth stage (Malicurjuna *et al*., 2013; Shaibani and Ghadiri, 2012). The fertilizer management is the most important factor in increasing crop yield. Since the fertilizer inputs are expensive, so determining the appropriate amount of fertilizer that is increased yield and economy and don't have negative effect on environment (Avan *et al*., 2011). Other researchers have also reported that in recent decades, the using of nitrogen fertilizer has been increased worldwide. However, there was not changing in corn yield. At present, the average nitrogen use efficiency is nearly 33 percent in the world.

Therefore, the application of proper amount of nitrogen is very important to maintain the yield and reduce the environmental risks (Lou *et al*., 2012). Nitrogen use efficiency in developed and developing countries is 42 and 29 percent, respectively (Valsh *et al*., 2012). Some researchers suggested that corn varieties with higher nitrogen use efficiency could be reduced competition with weeds (Kanas *et al*., 2012). The researchers have reported that the levels of nutrients for crop competition with weeds are essential, so the management of fertilizer application in time and place could be important in weeds control. Most of weeds in using of nutrients are more effectively than crops. So sometimes adding the fertilizer can reduce crop yield, because it can increased weed competition. On the other hand, in some conditions the crop plants can absorb more fertilizer than weeds as a result the increasing of nitrogen application can lead to increased weed biomass and prevent grain yield losses of corn (Kritenson *et al*., 2008). The corn yield is severely reduced by weed competition. Researchers have reported that the effective management of fertilizer can improve weeds interference with crops (Najafi and Ghadiri, 2012).
Accordingly, this study aimed to evaluate the effects of nitrogen fertilizer and plant density on the growth and yield of sweet corn under weed competitions.

MATERIALS AND METHODS

The experiment was conducted at experimental farm of Islamic Azad University, Tabriz Branch, Iran (38˚5'N; 46˚17'E; elev. 1360 m). Experiment was split-split plot based on randomized complete block design (RCBD) with three replicates. Plot size was 18×4 m and consists of 3 rows with 3 m length. Row spacing between and within rows were 60 and 20 cm, respectively. The treatments consisted of two factors, included the amount of urea fertilizer at five levels of nitrogen fertilizers (0: as control, 75, 150, 225 and 300 kg/ha) and plant density at three levels (40000, 50000 and 62500 plants/ha). After the physiological maturity, five samples were taken from the middle row and measured their characteristics. Weeds were harvested by 1×60 cm quadrate and some growth parameters were determined. Before statistical analysis, the normality test of data was performed. Data analyzed using MSTATC software. Mean comparisons done by Duncan's multiple range tests at the 5 percent level.

RESULTS AND DISCUSSION

Plant Height: Plant height significantly increased in all of levels of nitrogen fertilizer compared to control. The maximum plant height (194 cm) was obtained when 225 or 300 kg/ha nitrogen was applied. The application of 150, 225 and 300 kg/ha nitrogen increased plant height 9.6, 17.5 and 14.5 percent compared to control, respectively. Application of 75 kg/ha nitrogen, however, did not a significant effect on plant height (Figure 1). In the previous research, Eyvazi and Habibi (2013) have been investigated the effect of different nitrogen levels (0, 110 and 193 kg/ha) on growth and yield of corn varieties and reported that the nitrogen increased the plant height.
Biomass: The results of this study showed that planting density had no significant effect on biomass. Only in the 225 and 300 kg/ha nitrogen fertilizer and plant spacing of 15 cm caused less biomass than other plant densities. According to the results of the two levels of fertilizer and plant spacing of 15 cm, biomass decrease 23.3 and 21.5 percent compared to 25 cm spacing. The maximum of biomass per plant at 25 cm spacing and 225 kg/ha nitrogen fertilizer was obtained 130 gr/m^2. The other treatments were also caused a significant increase in spacing of 25 cm. plant spacing of 25 cm and levels (75, 150, 225 and 300 kg/ha nitrogen), increased biomass (32, 56, 66 and 50 percent) compared to control, respectively. Also, the maximum biomass in plant spacing of 20 cm and levels (150, 220 kg/ha nitrogen) increased 50 and 48 percent compared to control, respectively. The biomass in fertilizer levels (75, 300 kg/ha) and plant spacing of 20 cm increased 34 and 32 percent, respectively. The maximum biomass per plant was obtained in 15 cm spacing and 150 kg/ha nitrogen, which was no significant difference between 75 and 225 kg/ha nitrogen, respectively. In this density, the lowest increasing of biomass was obtained in 300 kg/ha nitrogen. It seems that the lowest amount of biomass was obtained with increasing of density in all of fertilizer levels. It seems that with increasing density, the highest biomass of plant will obtain in less fertilizer. Also the effect of nitrogen fertilizer on yield is more prominent with increasing density and in

high levels of nitrogen fertilizer; biomass per plant can be significantly reduced with increasing of density. The 15 cm spacing and levels (75, 150, 225 and 300 kg/ha nitrogen), lead to increasing of (28, 32, 23, 14 percent) of biomass compared to control (figure 2). So, according to this study, corn biomass was significantly increased by application of nitrogen fertilizer. Researchers have reported that nitrogen fertilizer led to increased grain and biomass yield of corn 43- 68 and 25-42 percent, respectively.

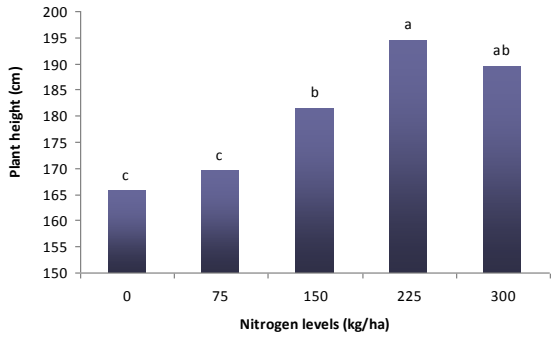

Figure 1: Effect of nitrogen levels on sweet corn height

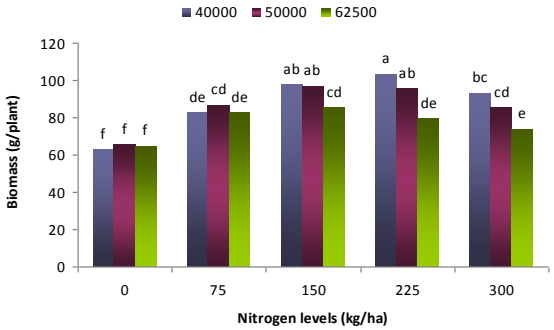

Figure 2: Effect of nitrogen levels and plant density on sweet corn biomass

Leaf Area: According to the results obtained from the comparison of leaf area affected by different levels of nitrogen fertilizer and different plant densities, in none of fertilizer, except level of 300 kg/ha was not significant difference in leaf area. Leaf area at the level of 300 kg/ha nitrogen and plant spacing of 15 cm was 28 and 40 percent lower than of 25 and 20 cm spacing, respectively. The highest of leaf area was obtained 499 and 465 cm^2 in 300 kg/ha nitrogen fertilizer with 25 cm spacing and 150 kg/ha nitrogen with 20 cm spacing, respectively. While the level of 75 kg/ha nitrogen had no significant effect on leaf area. The 25 cm spacing at levels (150, 225 and 300 kg/ha nitrogen) caused 65, 74 and 95 percent increasing of leaf area, but no significant difference in leaf area between three levels. Also, there was no significant difference between the three levels of fertilizer in 20 cm spacing. In three treatments, leaf area was increased 90, 65 and 68 percent than control, respectively. Only the 150 k/ha fertilizer in 15 cm spacing, lead to a significant increase 50 percent of leaf area compared to control (Figure 3). Eyvazi and Habibi (2013) investigated the effect of different nitrogen levels (control, 110 and 193 kg/ha) on growth and yield of maize varieties. According to the results of researchers, flag leaf was increased by application of nitrogen fertilizer. Also, the researchers commented, nitrogen increases protoplasm content and thus leads to an increase in cell size, leaf area and the photosynthetic activity. Bhat (2012) investigated the effect of plant densities (66666, 80000, 100000 plants/ha) and nitrogen levels (120, 160, 200 and 240 kg/ hectare) on sweet corn. Based on these results of researchers, growth indices increased such as leaf area index and dry matter accumulation by increasing nitrogen levels.

Ear Weight: In this study, the highest ear weight was obtained 483 and 482 kg/ha at 225 and 300 kg/ha nitrogen fertilizer with 25 cm spacing which were 45 and 44 percent higher than control, respectively. At 25 cm spacing, fertilizer levels of 75 and 150 kg/ha also resulted an increase 22 and 29 percent on ear weight compared to control. Ear weight increased 26, 20 and 20 percent at 20 cm spacing with application of 75, 150 and 225 kg/ha nitrogen compared to control. But the treatment of 300 kg/ha nitrogen and 25 cm spacing had no significant effect on ear weight. At 15 cm spacing, fertilizer application had no significant effect on this trait, so according to this study, the effect of nitrogen fertilizer would be greater in low density. Because of the high density, plants compete for water and other environmental factors such as light, plants would not be able to make effective use of nitrogen fertilizer. According to the results of this study, only fertilizer levels of 225 and 300 Kg/ha nitrogen was observed significantly different between density treatments. The amount of 300 kg/ha nitrogen and 20 and 15 cm plant spacing caused a reduction 23.8 and 27.1percent in ear weight compared to 25 cm spacing, respectively. Therefore, with

increasing levels of nitrogen, the effect of plant density was higher on this trait (figure 4). Bhat (2012) was investigated effect of plant densities (66666, 80000, 100000 plants/ha) and nitrogen (120, 160, 200 and 240 kg/ha) on sweet corn. The highest amount of yield components such as ear length, ear weight, and grain number per ear and grain weight belonged to 240 kg/ha nitrogen fertilizer. The highest grain yield (18090 kg/ha) was obtained at 80000 plants/m^2 with 240 kg/ha nitrogen application.

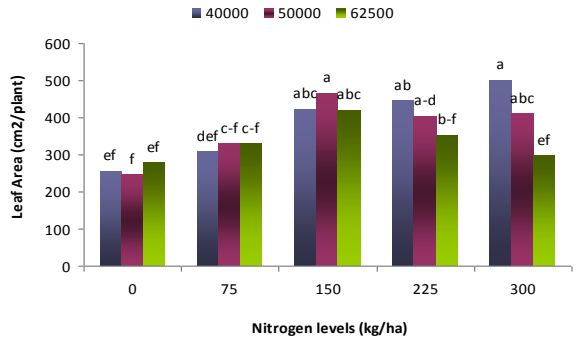

Figure 3: Effect of nitrogen levels and plant density on sweet corn leaf area

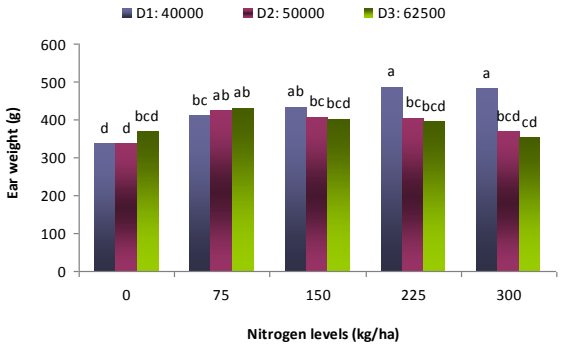

Figure 4: Effect of nitrogen levels and plant density on sweet corn ear weight

Grain Number per Ear: Grain number per ear was affected by nitrogen fertilizer application, fertilizer caused a significant increase in grain number per ear, but the amount of fertilizer had no significant effect on grain number. The grain number per ear at 75, 150, 225 and 300 kg/ha nitrogen was 529, 569, 568 and 528 numbers, respectively, that were 7.9, 56.44 and 45.4 percent higher than control, respectively (Figure 5). Other researchers have reported that the application of nitrogen lead to increasing of grain number (Spidkar, 2013). Nemati *et al.*, (2012) investigated the effect of different levels of nitrogen (0, 75, 150, 225 kg/ha) in different times on growth and yield of corn. Results showed that the highest grain number per ear, grain number per ear and grain yield were obtained the maximum amount of nitrogen application at time, respectively. Grain number was not affected by amount and time of nitrogen application.

Grain Weight per Plant: The greatest grain weight per plant at 75 and 150 kg/ha nitrogen was obtained 381 and 384 g. that was 121 and 123 percent higher than control, respectively. Grain weight at levels of 225 and 300 kg/ha nitrogen increased less amount than 75 and 150 kg/ha nitrogen, respectively. Also, grain weight was increased 79 and 44.7 percent at levels of 225 and 300 kg/ha nitrogen fertilizer (Figure 6). It can be observed that grain weight per plant reduced by increasing the amount of 150 kg/ha of fertilizer. The investigation shows that with increasing levels of nitrogen, increased vegetative growth and reduced grain production. Ali *et al.*, (2012) reported that the application of nitrogen leads to delay in formation of tassel, production of silk and physiological maturity of corn. Researchers have reported that coarse grains such as corn in during the grain filling depend on nitrogen. High amounts of nitrogen required, especially under conditions of nitrogen deficiency, the effect of Leaf senescence will be provided with transferring of nitrogen from old leaves. Therefore, in order to maximize the amount of yield, onset and speed of leaf senescence will be important. Maintaining of leaf area photosynthetic is delayed onset of leaf senescence, and thus can increase yield by increasing the amount of assimilate (Donison *et al*., 2006).

Grain yield: The mean comparison of grain yield under different levels of nitrogen fertilizer showed the highest grain yield (398 g/m^2) belonged to 150 kg/ha nitrogen fertilizer that had no significant difference with 225 kg/ha nitrogen. Grain yield was increased 80, 123, 109 and 82 percent at levels of 75, 150, 225 and 300 kg/ha nitrogen compared to control, respectively (Figure 7). Lu *et al.*, (2010) also reported the application of nitrogen resulted increased plant yield. Also, the application of 150 kg/ha nitrogen produced highest grain and biological yield (Akmal *et al*., 2010). Regarding the results, the use of excessive nitrogen fertilizer will reduce yield. Asgar *et al.*, (2010) also reported that excessive use of nitrogen decrease yield. According to the results of this study, grain yield and plant spacing of 20 and 15

cm were greater than 25 cm spacing, but there were no significant differences between 20 and 15 cm plant spacing. At 20 and 15 cm plant spacing, grain yield were 330 and 350 g/m^2, respectively, that were19.1 and 26.3 percent more than plant spacing of 25 cm, respectively (Figure 8). Ariannia *et al.*, (2013) examined the response of grain yield and yield component of corn hybrids and different densities (6, 7.5, 9 plants /m^2). According to these results, yield was affected by plant density. The highest yield was obtained at density of 9 plants/m^2 (Almtvaly *et al*., 2012).

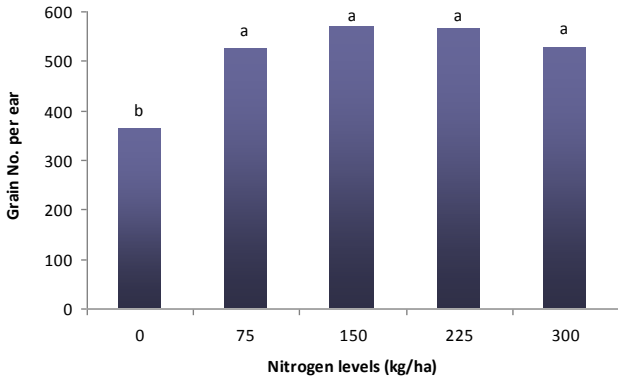

Figure 5: Effect of nitrogen levels on sweet corn grain number per ear

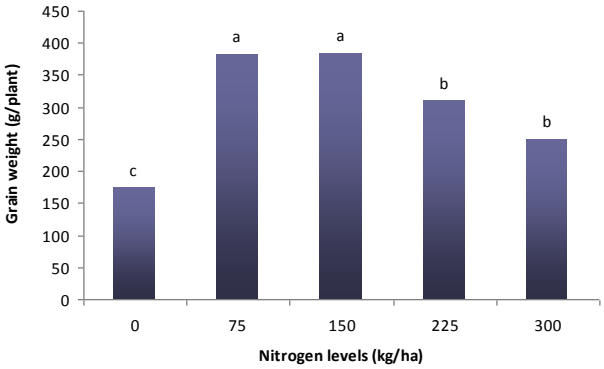

Figure 6: Effect of nitrogen levels on sweet corn grain weight

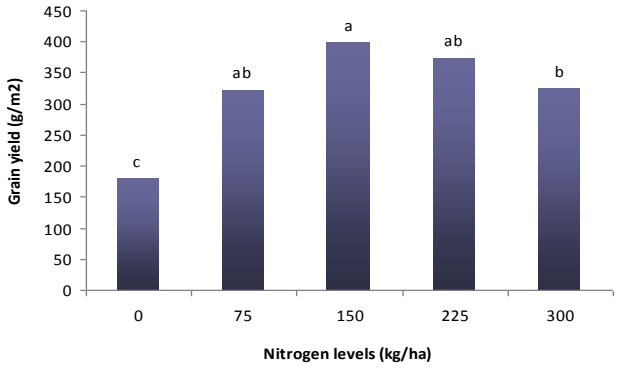

Figure 7: Effect of nitrogen levels on sweet corn grain yield

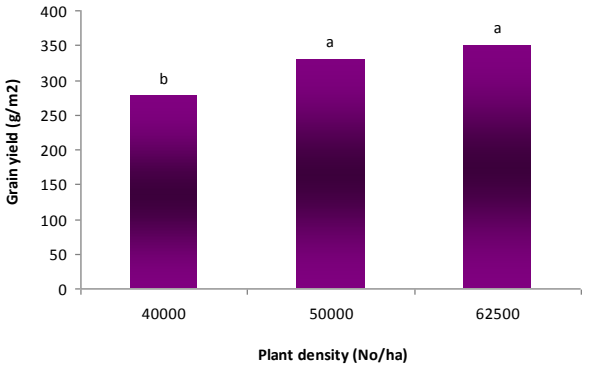

Figure 8: Effect of plant density on sweet corn grain yield

Redroot Pigweed (*Amaranthus retroflexus*) Population and Dry Weight: The mean number of redroot pigweed was affected by planting density so that, increasing plant density caused a significant decreased pigweed population. Minimum number of redroot pigweed belonged to 15 cm spacing that was 56 percent lower than 25 spacing.

The number of redroot pigweed at plant spacing of 20 cm reduced about 17 percent compared to 25 cm spacing (Figure 9).

Also researchers have reported that the planting pattern and between plants spacing is important to reduce interference with weeds. Particular, planting pattern may provide a suitable space for vegetative growth.

Adjust between row and within row spacing is the most important agricultural practice to reduce competition with weeds (Husain *et al.*, 2005). Smyk *et al.*, (2012) investigated the effect of plant densities (40,000, 50,000, 60,000, 70,000 plants/ha) on weed infested and yield of sweet corn cultivars.

According the results of this study, the weeds population decreased by increasing of plant density.

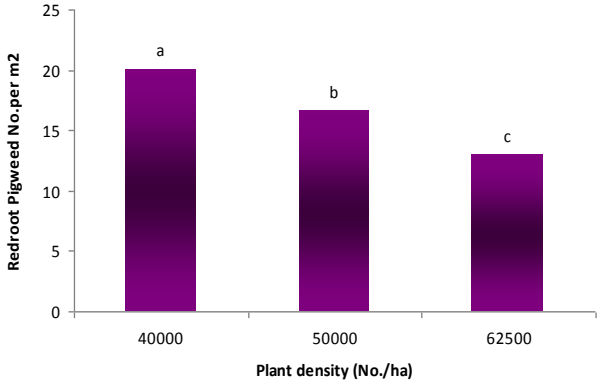

Figure 9: Effect of sweet corn density on redroot pigweed population

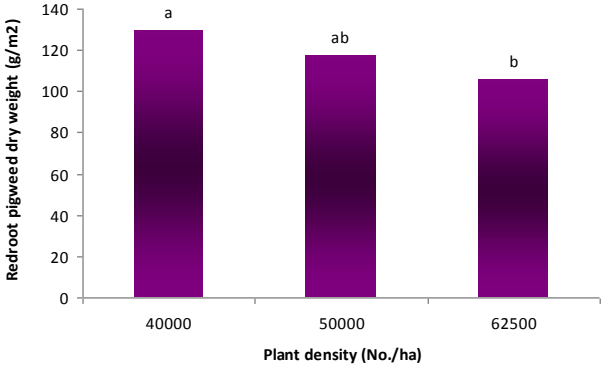

Figure 10: Effect of sweet corn density on redroot pigweed dry weight

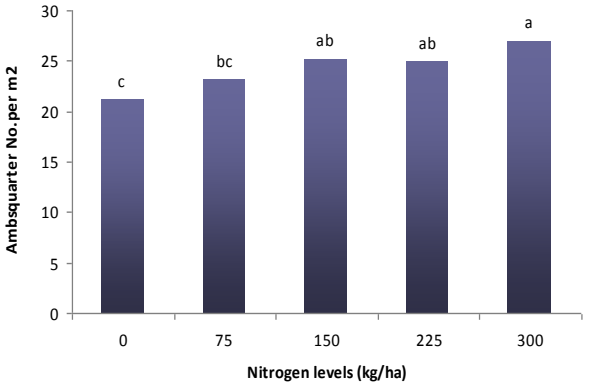

Figure 11: Effect of nitrogen levels on ambsquarter population

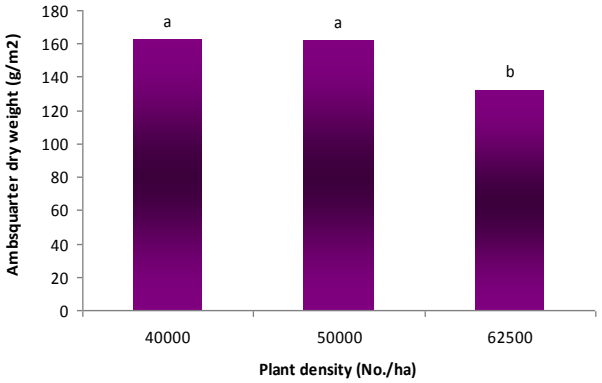

Figure 12: Effect of sweet corn density on ambsquarter dry weight

Redroot pigweed weight was affected by sweet corn density so that pigweed weight at 15 cm plant spacing (105 g/m^2) was obtained 18.6% lower than 25 cm spacing (Figure 10). Yield and yield component was examined by plant density of corn hybrids (6, 7, 9 plant/m^2) and weed population (0, 50, 100 percent removal of weeds) (Aryannia *et al*., 2013). According to this results, high plant density reduced grain yield compared to weeds. Earlier canopy closure and increasing of shading on weeds increased competitive ability of corn and reduced weeds growth (Almtvaly *et al*., 2012).

Ambsquarter (*Chenopodium album*) Population and Dry Weight: The mean number of lambsquarter affected by nitrogen levels showed the lowest number of lambsquarter (10.5 plants/m^2) was obtained in without nitrogen application. The application of 75 kg/ha nitrogen had no significant effect on yield, but increasing the amount of nitrogen was increased lambsquarter population. So that the treatment of 150, 225 and 300 kg/ha were higher 20, 18.8 and 27.4 percent than control, respectively (Figure 11).

There was no significant differences on weed weight at 25 and 20 cm spacing, but, weed weight (131 g/m^2) at 15 cm spacing was lower (19.1%) compared to 25 and 20 cm spacing, respectively (Figure 12). In this study, nitrogen fertilizer had no significant effect on weed weight.

Najafi and Ghadiri (2012) reported that weed biomass was increased by high levels of nitrogen application. But the researchers have suggested that the addition of nitrogen increases competitive ability of sweet corn against weeds. Weed control in early stages of corn growth, will not significantly reduced on corn yield.

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