Research Article

Study and Determination of the Best Plant Density and Planting Patterns of Silage Corn (*Zea mays* L.), H.S.C. 704 Cultivar

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Abstract

To examine the effect of plant densities and sowing patterns on yield and agronomical characteristics of corn (hybrid S.C.704), a field experiment was conducted at agricultural research station of Gorgan. This experiment was laid out in a randomized complete block design arranged in a factorial with four replications. Forage corn experiment had four levels of plant densities (D1=65000, D2=75000, D3=85000, D4=95000) and with two planting arrangements (p1=single row and p2=double row 15 cm space apart). The results showed; there was significant difference between planting arrangement for total dry matter, number of kernel per ear, kernel per row, ear length and double row produced higher amount for all above characters. In addition, plant density had a significant effect on total dry weight, number of kernel per ear, number of row per year, total fresh weight, ear length at 0.01 probability level and with an increase in plant density amount of biomass increased. The highest forage yield was produced by 95000 plant density and 15-centimeter double row at 5% significant (93.31-ton ha-1). It might be concluded that by using double row planting pattern the inter plant competition could be decreased and higher yield might be produced.

Introduction

With the increase in world population, demand for food consequently will grow. It is expected that human population will increase to over 8 billion by the year 2020 and this will worsen the current scenario of food security. Improved crop productivity over the past 50 years has resulted in increasing world food supplies up to 20% per person and reducing proportion of food-insecure peoples living in developing countries from 57% to 27% of total population [1]. It is predicted that at least 10 million people will be hungry and malnourished in the world by the end of this century [1]. Thus, to reduce the food insecurity, crop production will have to be doubled, and produced in more environmentally sustainable ways [2]. This can be achieved by expanding the area of crop production, increasing per hectare yield and improving crop quality. Furthermore, during the second half of the past century, rise in per hectare crop productivity was due to improved or high

yield potential [3].

The relationship between growth of corn under different planting pattern and plant density is not well understood. Many changes take place in plants to enable them to compete and maintain photosynthetic activity. A consideration of the adaptation mechanisms by which density affects photosynthesis would aid the improvement of growth conditions and crop yield and would provide useful tools for future genetic engineering. Works in the late 1980s demonstrated that yields can be raised two to three-fold by using available improved varieties and appropriate agronomic techniques. But, these findings need to be refined, improved and tested for local climatic, soil and crop conditions [4].

These include in the aspects of to what extent of planting pattern and plant density affect the yield and morpho-physiological parameters of corn. In addition, no comprehensive database is available on corn under combination of pattern and density at north of Iran. Thus, studies are still needed to improve understanding of the effects of pattern and density for corn. Hence, the present study

was to design with the following objectives

Objectives:

1. To determine the performance of corn at different levels of plant density.

2. To study the effect of planting arrangement on yield and morphological parameters of corn.

3. To identify how interaction of planting pattern and plant density affect yield and yield components of corn.

Materials and Methods

In order to the development and management for corn in summer season, the current study was conducted to finding the effects of different planting pattern and plant density on yield and yield components of corn was investigated.

A field experiment was conducted in 2006 at Gorgan agricultural research station, Northern Iran (36°N 54.00′ 54°E 25.00′, 51m altitude). The experiment was laid out in a randomized complete block design and replicated four times. The experiment consisted of 8 treatments outlined as follows:

Forage corn experiment had four levels of plant densities (D1=65000, D2=75000, D3=85000, D4=95000) and with two planting arrangements (p1=single row and p2=double row 15 cm space apart). Fix distance of maize was 75 cm and the space among bushes on the furrow double row arrangement was 15 cm. Those totally were including 32 plots. Each treatment with six reasbed and 6 meters length is planting, and in doughing - milking stage for forage harvested.

All observations on dates of recording were in accordance with related statistical design, independently and complex.

Sufficient numbers of plants were sown for each treatment to facilitate destructive sampling for determining relative growth rates at the various growth stages. The selected field was under wheat cultivated, after harvesting wheat on 15 June of 2006. The considered land plowed in deep of 20-25 cm, then with cross of desk made ready for planting. At the end the analysis of variance (ANOVA) of data was performed using the software of SAS (2004) [5] by the proc. GLM procedure and significant of means between the treatments were obtained using Duncan Multiple Range Test at $P<0.05$.

Results

The results of comparing agronomic parameters of corn at four plant densities (Tables 1 & 4) showed, that most of the corn studied characters included; total fresh weight, total dry yield, stem dry weight, leaf dry weight, husk dry weight, ear seed row, ear diameter, stem diameter and plant height were statistically significant at 5% probability level. In addition, above yield and yield components parameters with an increase in plant density increased, i.e. the highest total fresh weight, total dry yield, stem dry weight, leaf dry weight, husk dry weight with 87.40, 14.55, 5.83, 3.14 and 2.86 t/ha respectively obtained from plant density of 95000 plant/ha. While morphological parameters got from medium plant density (75000 plant/ha), in contrast plant height increased at low and high plant density.

As shown at (Tables 2 & 5), the main effect investigation of planting arrangement could not change significantly number of above treats, just increased ear dry weight 14% (from 2.72 to 3.16 t/ ha), it means the benefit of planting pattern would be appear if arrange with suitable plant density.

Interaction of planting pattern and plant density become significant at most corn studied characters. Combination treatment of planting patterns and plant density; showed: high plant density (95000 plant/ ha) in double row pattern produced the most total fresh weight (93.31 t/ ha), total dry weight (15.36 t/ ha), dry stem (6.04 t/ ha) and dry leaf (3.38 t/ ha) and number of leaf (11.91). The highest plant height (214.5 cm), ear height (113.9 cm) and stem diameter (17.76 mm) obtained from plant density of 85000 plant/ ha in single row pattern, while production of dry corn at double row pattern (at the same plant densities) showed better performance. Other morphological parameters and yield components such as, ear length, ear seed row, seed in row and number of seed per ear were the best at low plant density (Table 1).

Treats/ Treatment	Ear length (mm)	Total fresh weight (kg/h)	Total ear weight (kg/h)	Ear Seed Row	Seed in ear	Number of seed in ear	Total dry weight (kg/h)	Diameter Ear (mm)
Density								
D1	19.68	77.42	20.46	14.51	25.67	432.1	12.45	40.63
D2	19.53	80.75	21.32	14.61	26.06	439.7	13.28	42.47
D3	18.41	85.68	21.46	13.8	23.44	385	13.22	41.06
D4	18.41	87.4	21.1	14.22	24.18	399.1	14.55	41.07
LSD (%)	2.24	7.238	2.537	0.763	4.391	56.05	1.058	1.418
Means within columns followed by same letters are not significantly different at 5% level (Duncan Test) D= Density; D1= 65000 plant ha^{-1} D21= 75000 plant ha^{-1}, D3= 85000 plant ha^{-1}, D4= 95000 plant ha^{-1}								

Table 1: Mean comparison of yield and some agronomic characteristics of silage corn on deferent plant density (2 years results).

Treats/ Treatment	Ear length (mm)	Total fresh weight (kg/h)	Total ear weight (kg/h)	Ear seed row	Seed in ear	Number of seed in ear	Total dry weight (kg/h)	Diameter Ear (mm)
Planting pattern								
Single row	19.84	78.55	19.81	14.6	26.57	442.3	12.71	41.82
Double row	18.18	87.08	22.36	13.97	23.1	485.7	14.04	40.79
LSD (%)	1.162	9.156	4.43	2.062	1.727	41.89	1.611	3.847

Table 2: Mean comparison of yield and some agronomic characteristics of silage corn on deferent planting pattern (2 years results).

Treats/ Treatment	Ear length (mm)	Total fresh weight (kg/h)	Total ear weight (kg/h)	Ear Seed Row	Seed in ear	Number of seed in ear	Total dry weight (kg/h)	Diameter Ear (mm)
Pattern×Density								
P1 * D1	20.19 ab	76.88 cd	19.98cd	14.63a	27.63a	460.7a	12.16 c	47.94 ab
P1 * D2	20.53 a	75.37 d	19.60 a	15.25a	27.14a	465.7a	12.41 bc	44.26 a
P1 * D3	18.86 cd	80.46 bcd	20.02a	14.07a	24.66b	403.9ab	12.51 bc	43.54 ab
P1 * D4	19.76 abc	81.48 bcd	19.64 a	14.44a	26.86a	438.9ab	13.75 abc	43.50 ab
P2 * D1	19.76 bcd	77.97cd	20.94a	14.39a	23.71bc	403.6ab	12.73 bc	38.37 c
P2 * D2	18.53 cd	86.13abc	23.04a	13.98a	24.97b	413.7ab	14.15 ab	40.67 bc
P2 * D3	17.96 de	90.90 ab	22.90a	13.92a	22.22cd	466.1a	13.93 ab	38.59 c
P2 * D4	17.05 e	93.31a	22.56 a	14.00a	22.50d	459.4b	15.36 a	38.64 c
LSD (%)	1.266	10.46	4.827	2.248	1.877	79.67	1.755	2.639
Means within columns followed by same letters are not significantly different at 5% level (Duncan Test) P= Planting pattern; P1= Single row, P2= Double row D= Density; D1= 65000 plant ha^{-1} D21= 75000 plant ha^{-1}, D3= 85000 plant ha^{-1}, D4= 95000 plant ha^{-1}								

Table 3: Mean comparison of yield and some agronomic characteristics of silage corn on deferent planting pattern and plant density (2 years results).

Treats/ Treatment	Husk dry weight(Ton/ha)	Ear dry weight(Ton/ha)	Cob dry weight(Ton/ha)	Stem dry weight(Ton/ha)	Leaf dry weight(Ton/ha)	Stem diameter (mm)	Plant height (cm)	Ear height (cm)	Number of leaf
Density									
D1	1.898 b	2.613 a	1.178 a	5.037 b	2.668 b	16.09 a	191.3 b	99.12 a	11.46 a

D2	1.971 ab	3.111a	1.198 a	5.386 ab	2.804 b	16.26 a	198.9 ab	101.8 a	11.80 a
D3	2.046 a	3.040 a	1.146 a	5.285 ab	2.842 b	15.77 a	213.2 a	111.4 a	11.85 a
D4	2.076 a	3.016 a	1.121 a	5.836 a	3.147a	15.72 a	207.2 ab	109.2 a	11.84 a
LSD (%)	0.1283	0.633	0.289 a	0.559	0.174	2.26	17.75	15.31	1.185
P= Planting pattern; P1= Single row, P2= Double row D= Density; D1= 65000 plant/ha D21= 75000 plant/ha, D3= 85000 plant/ha, D4= 95000 plant/ha									

Table 4: Mean comparison of yield and some agronomic characteristics of silage corn on deferent plant density (2 years results).

Discussion

The results showed with changing planting arrangement from single row to double row plant density would be increase 15% without negative effect on yield and yield components parameters. It means at minimum and medium plant density specially on one double - row pattern, the bushes can grow better and produce a good ear [6-8]. Increasing the yield at high plant density due to double row pattern, may is because of closing to square planting arrangement. The yield at low plant density due to lacking number of plant per surface and at high plant density because of competition for absorption growth elements and interference of male and female's flowers become limited [9-11].

Treats/Treatment	Husk dry weight(Ton/ha)	Ear dry weight(Ton/ha)	Cob dry weight(Ton/ha)	Stem dry weight(Ton/ha)	Leaf dry weight(Ton/ha)	Stem diameter (mm)	Plant height(cm)	Ear height(cm)	Number of leaf
Planting pattern									
Single row	2.032	2.726	1.122	5.177	2.582	16.27	203.3	107.6	11.69
Double row	1.196	3.164	1.199	5.595	3.138	15.65	202	103.2	11.78
LSD (%)	0.3646	0.394	0.6353	0.561	0.1778	1.797	7.823	3.261	0.261

Table 5: Mean comparison of yield and some agronomic characteristics of silage corn on deferent planting pattern (2 years results).

Treats/Treatment	Husk dry weight(Ton/ha)	Ear dry weight(Ton/ha)	Cob dry weight(Ton/ha)	Stem dry weight(Ton/ha)	Leaf dry weight(Ton/ha)	Stem diameter(mm)	Plant height(cm)	Ear height(cm)	Number of leaf
Density× Pattern									
P1 * D1	1.865	2.46	1.119	4.991	2.431	16.38	187.6	99.94	11.48
P1 * D2	2.056	2.823	1.164	5.088	2.422	17.18	201.1	105.5	11.69
P1 * D3	2.095	2.85	1.114	4.99	2.566	17.76	214.5	113.9	11.84
P1 * D4	2.112	2.773	1.094	5.631	2.91	15.76	210.1	110.9	11.77
P2 * D1	1.931	2.776	1.236	5.082	2.905	15.8	195	98.3	11.44
P2 * D2	1.886	3.938	1.322	5.685	3.185	15.34	196.8	98.09	11.91
P2 * D3	1.996	3.231	1.178	5.572	3.118	15.77	211.9	108.9	11.86
P2 * D4	2.06	3.259	1.149	6.04	3.384	15.68	204.3	107.5	11.91
LSD (%)	0.729	0.787	0.213	0.792	0.194	1.959	15.65	3.533	0.284
P= Planting pattern; P1= Single row, P2= Double row D= Density; D1= 65000 plant/ha, D21= 75000 plant/ha, D3= 85000 plant/ha, D4= 95000 plant/ha									

Table 6: Mean comparison of yield and some agronomic characteristics of silage corn on deferent planting pattern and plant density (2 years results).

Conclusion

With considering double row planting arrangement, plant density would be increase 15% without negative effect on yield component and the yield could be increase 20%. The highest forage yield was produced by 95000 plant density and 15centimeter double

row at 5% significant (93.31 t/ha). It might be concluded that by using double row planting pattern the inter plant competition could be decreased and higher yield might be produced.

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