Effect of Plant Density on Silage Yield and Quality of some Maize (*Zea mays* L.) Hybrids

Mahmud A. A. Rahouma[1]

ABSTRACT

This experiment was conducted at Grower Farm in Al-Maamorah district, El-Ghafara, Tripoli, Libya, during 2020 summer season to study effect of four maize hybrids (SC 10, SC 176, TC 310 and TC 360)as main plots and three maize plant densities, i.e. 166667, 83333 and 55555 plants/ ha as sub plots in a split plot design with three replicates on silage yield and quality. Results showed that SC 10 had the tallest plants (183.03 and 210.93 cm) and stalk diameters (21.08 and 24.46 mm) at 55 and 90 DAS, leaf/ stem ratio (59.06%), number of ears/ plant (1.21) and total dry forage yield (17.059 t/ ha) at 90 DAS. However, single crosses studied were significantly surpassed in leaf area index, number of leaves/ plant and total dry forage yield at 55 DAS, besides protein yield.

The highest plant density (166667 plants/ ha) produced maximum plant height and total dry forage yield at 55 and 90 DAS, maximum L.A.I. at 55 DAS. Conversely, the lowest plant density (55555 plants/ ha) produced thicker stalks and highest plant dry weight at 55 and 90 DAS and highest leaf/ stem ratio, protein yield and number of ears/ plant. Interaction between the two factors studied pointed out that sowing SC 10 at 166667 plants/ ha produced the tallest plants and highest total dry forage yield at 55 and 90 DAS, and LAI at 55 DAS. However, sowing the same hybrid at the lowest plant density showed thicker stalks at 55 and 90 DAS, number of leaves and ears/ plant.

Keywords: maize, plant density, hybrids, silage, yield, quality.

INTRODUCTION

Corn (*Zea may* L.) is a very important cereal crop in the world and Egypt. It is used as food, feed and industrial crop. Nowadays, it becomes a major source for silage for feeding cattle during the summer season in Egypt, because maize produced high green yield and dry matter per unit area, high energy content and quality of its biomass for animal production (Roth and Undersander, 1995 and Mandic *et al*., 2015).

Deinum and Struik (1989) reported that digestion of silage transformed to volatile fatty acids, that considered essential for milk production. Maize breeders aimed to increase fresh and dry matter of silage maize that contain higher percentage of ears and good quality (stalks quality and ability for digestion).

Besides the best maize genotypes, cultural practices as plant density is considered for maximizing corn production per unit area. High plant density of hybrid corn significantly increased silage yield without decreasing of its nutritional value (Ferreira *et al.*, 2014 and Al-Naggar *et al.*, 2016). On the other hand, Hunter (1986) and Cox (1997) concluded that the suitable plant density of silage plants is 10- 20 % higher than cultivated corn for grain yield. The objective of this study is evaluation of productivity and quality of silage resulted from cultivation some maize hybrids under different plant density.

MATERIALS AND METHODS

A field experiment in 2020 summer season was carried out at Grower Farm located in Al-Maamorah district, El-Ghafara, Tripoli, Libya, in split plot design with three replications to study plant density effect on silage yield and quality of some maize (*Zea mays* L.) hybrids. The main plots occupied by four maize hybrids, i.e. white and yellow single crosses (SC 10 and SC 176) and white and yellow triple crosses (TC 310 and TS 360), respectively. However, three plant densities, i.e. D_1 (166667), D_2 (83333) and D_3 (55555) plants/ ha, were randomly assigned as sub plots. Sowing date was 15 July. Sub-plot area was 9 m^2 (five ridges each 3 m length and 0.6 m width). Manually planting was done on one side of the ridge with two kernels/ hill. Distances between hills were 10, 20 and 30 cm (166667, 83333 and 55555 plants/ ha) for D_1 and D_2 and D_3 densities, respectively. At 21 days (DAS), plants were thinned to one plant/ hill. Nitrogen fertilization was applied at the rate of (140 kg N/ ha) as ammonium nitrate (33.3% N). Other cultural practices for maize production were carried out as recommended.

Plant samples were harvested from a one meter length from the third ridge in each sub-plot by cutting 10 cm above the soil surface at 55 and 90 DAS to determine plant height (cm), stalk diameter (mm), leaf area index (L.A.I), plant dry weight (g) and total dry forage yield (t/ ha) which calculated by multiplying plant dry weight by plant density. At harvest (90 DAS) number of leaves/ plant, leaf/ stem ratio (%) and protein yield (t/ ha) were determined. Protein yield (t/ ha) calculated by multiplying total dry forage yield (t/ ha) by crude protein content (%), where crude protein

DOI: 10.21608/asejaiqjsae.2021.151909
[1] Higher and Moderate Institute of Agricultural Technology, Algheran, Libya
Received January 10, 2021 , Accepted February 25, 2021

content (%) was determined by multiplying nitrogen content (%) × 6.25 according to (A.O.A.C., 1990).

Data were subjected and statically analyzed according Steel and Torrie (1980) and comparisons between means were carried out using least significant difference method (L.S.D) at 0.05 level of probability.

RESULTS AND DISCUSSION

I- Hybrids effect:

Plant characters and total dry forage and protein yields of maize as affected by maize hybrids, plant density and their interactions are presented in (Tables 1 and 2). Results in Table (1) showed that the studied traits were significantly affected by the studied four maize hybrids, except leaf area index (LAI) at 55 days after sowing (DAS) and plant dry weight at 55 and 90 DAS; plant density, except LAI at 90 (DAS) Interaction between maize hybrids × plant density, also had significant effect on all the characters under study, except (LAI) at 55 DAS and protein yield.

Concerning the differences between the four maize hybrids studied, obtained results showed that single crosses, especially SC 10 generally produced the highest values for the studied traits. That could be due to higher hybrid vigor (heterosis) in the first generation (F_1) in single crosses than triple crosses of maize.

Regarding the studied traits, SC 10 had the tallest maize plants (183.03 cm) at 55 DAS, highest stalk diameters (21.08 and 24.46 mm) at 55 and 90 DAS, respectively. Single cross 10, also surpassed the other maize genotypes studied for leaf/ stem ratio (59.06 %), number of ears/ plant (1.21) and total dry forage yield at 90 DAS (17.059 ton/ ha). On the other hand, single crosses (SC 10 and SC 176) had taller plants (210.93 and 209.72 cm) at 90 DAS, higher number of leaves/ plant (15.59 and 15.31), highest LAI (6.39 and 6.28) at 90 DAS, total dry forage yield (13.708 and 13.508 ton/ ha) at 55 DAS and protein yield (1.14 and 1.17 ton/ ha), respectively. These findings are in consistent with those reported by El-Metwally *et al.* (2011), El-Shahed *et al.* (2013) and Hegab *et al.* (2019) for plant height, El-Shahed *et al*. (2013) for stalk diameter, Awadalla and Morsy (2016), El-Hosary *et al*. (2019) and Hegab *et al*. (2019) for number of leaves/ plant, El-Metwally *et al*. (2011), El-Shahed *et al.* (2013) and Hegab *et al.* (2019) for leaf area index. The same trend of plant characters have been reported by Nazli *et al.* (2019) for leaf/ stem ratio and El-Metwally *et al.* (2011) for number of ears/ plant. On the other hand, Gaile (2008), Lynch *et al.* (2012) and El-Hosary *et al.* (2019) reported that maize hybrids showed significant differences in total dry forage yield and protein yield.

II- Plant density effect:

Considering plant density effect, results presented in Table (1) indicated that the highest maize plant density (166667 plants/ ha) produced the tallest plants (184.54 and 212.40 cm), total dry forage yield (13.927 and 17.448 t/ ha) at 55 and 90 DAS and leaf area index (3.65) at 55 DAS. Conversely, the lowest plant density (55555 plants/ ha) produced thicker stalk diameter (21.12 and 24.34 mm), heaviest plant dry weight (224.10 and 272.34 g) at 55 and 90 DAS, highest number of leaves/ plant (15.83), highest leaf/ stem ratio (60.62 %), highest number of ears/ plant (1.22) and highest protein yield (1.22 t/ ha). Higher competition between maize plants in higher plant density on light could be accelerated plant height and consequently increased plant height as a result of increase internode length and that led to decrease number of leaves/ plant, stalk diameter, plant dry weight, leaf/ stem ratio, number of ears/ plant and protein yield. However, increasing number of plants per unit area (high plant density) increased leaf area index and total dry forage yield. These results are in line with those obtained by El-Hosary *et al.* (2019), Fromme *et al.* (2019) and Li *et al.* (2019) for plant height, Mandic *et al.* (2015) and Fromme *et al.* (2019) for stalk diameter, Kumar *et al.* (2016) and El-Hosary *et al.* (2019) for number of leaves/ plant, El-Sobky and Al-Naggar (2016) and Rahouma (2018) for number of ears/ plant, Karasahin (2014) for plant dry weight, El-Shahed *et al.* (2013), Rahuma (2018) and El-Hosary *et al.* (2019) for leaf area index, Ferreira *et al.* (2014), Haddadi and Mohseni (2016) and Opoku (2017) for total forage yield and El-Hosary *et al.* (2019) for protein yield.

III- Hybrid × plant density interactions effect:

Results presented in Table (2) revealed that interactions between the studied maize hybrids and plant density had significant effects on all studied traits, except leaf area index at (55 DAS) and protein yield per hectare. That means the four maize hybrids were differently responded to plant densities studied. With respect plant height trait at 55 and 90 DAS, decreasing plant density significantly decreased plant height in all the studied hybrids and SC 10 produced the tallest plants (190.51 and 220.62 cm) at 55 and 90 DAS, respectively, under the highest plant density (166667 plants/ ha). The same trend obtained for leaf area index at 90 (DAS), where SC 10 realized the highest LAI (7.22), total dry forage yield, also took similar trend, where lax plant population, generally produced the lowest total dry forage yield, however SC 10 produced the highest total dry forage yield (15.10 and 18.97 t/ ha) at 55 and 90 (DAS) when sown at 166667 plants/ ha, also sowing SC 176 at 166667 plants/ ha produced

Table 1. Means of maize plant characters, total dry forage and protein yields as affected by hybrids, plant density and their interactions in 2020 season

Treatment	Plant height (cm)		Stalk diameter (mm)		Number of leaves/ plant	L.A.I.		Plant dry weight (g)		Leaf/ stem ratio	Number of ears/ plant	Total dry forage yield (t/ ha)		Protein yield (t/ ha)
	55 DAS	90 DAS	55 DAS	90 DAS		55 DAS	90 DAS	55 DAS	90 DAS			55 DAS	90 DAS	
Hybrid														
SC 10	183.03 ^{a}	210.93 ^{a}	21.08 ^{a}	24.46 ^{a}	15.59 ^{a}	3.39 ^{a}	6.39 ^{a}	160.62 ^{a}	201.09 ^{a}	59.06 ^{a}	1.21 ^{a}	13.708 ^{a}	17.059 ^{a}	1.14 ^{a}
SC 176	179.96 ^{ab}	209.72 ^{a}	20.65 ^{ab}	22.55 ^{b}	15.31 ^{a}	3.55 ^{a}	6.28 ^{a}	160.94 ^{a}	185.94 ^{a}	58.52 ^{ab}	1.13 ^{ab}	13.508 ^{a}	16.053 ^{b}	1.17 ^{a}
TC 310	168.35 ^{b}	196.54 ^{ab}	19.64 ^{b}	21.56 ^{b}	13.66 ^{b}	3.31 ^{a}	4.81 ^{b}	152.05 ^{a}	196.29 ^{a}	54.54 ^{b}	1.05 ^{ab}	12.874 ^{b}	15.698 ^{b}	1.03 ^{ab}
TC 360	166.25 ^{b}	182.60 ^{b}	18.74 ^{b}	22.23 ^{b}	13.30 ^{b}	3.00 ^{a}	4.42 ^{b}	147.65 ^{a}	183.53 ^{a}	51.53 ^{b}	0.96 ^{b}	12.482 ^{b}	15.514 ^{b}	0.94 ^{b}
L.S.D$_{0.05}$	13.81	21.26	1.23	1.89	0.94	n.s	1.08	n.s	n.s	4.34	0.22	0.621	0.987	0.16
Plant density														
D_1	184.54 ^{a}	212.40 ^{a}	19.09 ^{b}	21.17 ^{c}	13.35 ^{c}	3.65 ^{a}	5.88 ^{a}	83.94 ^{c}	106.04 ^{c}	51.25 ^{c}	0.95 ^{c}	13.927 ^{a}	17.448 ^{a}	0.88 ^{b}
D_2	173.45 ^{ab}	198.79 ^{ab}	19.88 ^{b}	22.59 ^{b}	14.21 ^{b}	3.38 ^{ab}	5.45 ^{a}	157.92 ^{b}	189.27 ^{b}	55.88 ^{b}	1.09 ^{b}	13.066 ^{b}	15.709 ^{b}	1.11 ^{a}
D_3	165.20 ^{b}	188.65 ^{b}	21.12 ^{a}	24.34 ^{a}	15.83 ^{a}	2.92 ^{b}	5.10 ^{a}	224.10 ^{a}	272.34 ^{a}	60.62 ^{a}	1.22 ^{a}	12.436 ^{c}	15.085 ^{b}	1.22 ^{a}
L.S.D$_{0.05}$	11.34	16.70	0.95	1.08	0.67	0.52	n.s	24.74	35.61	3.08	0.12	0.334	0.744	0.21
Interactions	*	**	*	**	*	n.s	*	**	*	*	*	*	**	n.s

D_1: 166667D_2: 83333D_3: 55555 plants/ ha

*, ** Significant at 0.05 and 0.01 levels of probability, respectively.

Table 2. Means of maize plant characters, total dry forage and protein yields as affected by interaction between hybrids and plant density in 2020 season

Maize hybrid	Plant density	Plant height (cm)		Stalk diameter (mm)		Number of leaves/ plant	L.A.I.		Plant dry weight (g)		Leaf/ stem ratio	Number of ears/ plant	Total dry forage yield (t/ ha)		Protein yield (t/ ha)
		55 DAS	90 DAS	55 DAS	90 DAS		55 DAS	90 DAS	55 DAS	90 DAS			55 DAS	90 DAS	
SC 10	D_1	190.51^{a}	220.62^{a}	20.12^{ab}	22.98^{ab}	14.65^{bc}	3.92^{a}	7.22^{a}	90.20^{c}	118.37^{c}	52.63^{cd}	0.84^{c}	15.100^{a}	18.970^{a}	1.772^{a}
	D_2	182.17^{ab}	210.86^{ab}	20.98^{ab}	24.27^{ab}	15.10^{bc}	3.40^{a}	6.02^{ab}	166.32^{b}	195.84^{b}	60.40^{ab}	1.17^{b}	13.520^{bc}	16.208^{bc}	1.801^{a}
	D_3	176.43^{ab}	201.31^{b}	22.14^{a}	26.15^{a}	17.03^{a}	2.86^{a}	5.94^{ab}	225.36^{a}	289.08^{a}	64.17^{a}	1.42^{a}	12.506^{c}	16.000^{bc}	1.885^{a}
SC 176	D_1	184.96^{ab}	220.17^{ab}	19.89^{ab}	20.16^{b}	14.39^{c}	3.67^{a}	6.83^{ab}	84.00^{c}	109.87^{c}	53.77^{cd}	0.98^{bc}	13.869^{b}	18.251^{a}	1.833^{a}
	D_2	180.35^{ab}	208.49^{ab}	20.61^{ab}	22.67^{b}	15.56^{b}	3.90^{a}	6.24^{ab}	162.84^{b}	181.20^{b}	58.65^{b}	1.22^{ab}	13.554^{bc}	15.093^{c}	1.855^{a}
	D_3	174.59^{b}	200.50^{b}	21.47^{ab}	24.84^{ab}	16.00^{ab}	3.10 a	5.79^{b}	235.98^{a}	266.76^{a}	63.14^{ab}	1.31^{ab}	13.102^{bc}	14.815^{c}	1.869^{a}
TC 310	D_1	180.62^{ab}	208.34^{ab}	18.44^{b}	20.17^{b}	12.11^{d}	3.67^{a}	4.88^{bc}	82.91^{c}	98.33^{c}	49.86^{d}	0.88^{c}	13.668^{b}	16.342^{b}	1.694^{a}
	D_2	165.11^{bc}	199.10^{b}	19.63^{b}	21.20^{b}	13.23^{d}	3.23^{a}	5.00^{bc}	152.76^{b}	190.56^{b}	54.11^{c}	1.08^{bc}	12.723^{c}	15.854^{bc}	1.768^{a}
	D_3	159.34^{c}	182.18^{bc}	20.87^{ab}	23.31^{ab}	15.64^{b}	3.05^{a}	4.57^{bc}	220.50^{a}	270.00^{a}	59.69^{b}	1.13^{b}	12.233^{c}	14.899^{c}	1.789^{a}
TC 360	D_1	182.09^{ab}	200.49^{b}	17.92^{b}	21.37^{b}	12.28^{d}	3.34^{a}	4.62^{bc}	78.65^{c}	97.61^{c}	48.74^{d}	0.82^{c}	13.071^{bc}	16.230^{bc}	1.783^{a}
	D_2	166.20^{bc}	176.71^{c}	18.32^{b}	22.25^{b}	12.97^{d}	3.00^{a}	4.55^{bc}	149.76^{b}	189.48^{b}	50.38^{cd}	0.99^{bc}	12.470^{c}	15.684^{bc}	1.806^{a}
	D_3	150.46^{c}	170.62^{c}	20.00^{ab}	23.08^{ab}	14.65^{bc}	2.68^{a}	4.10^{c}	214.56^{a}	263.52^{a}	55.49^{bc}	1.03^{bc}	11.905^{c}	14.628^{c}	1.828^{a}
L.S.D$_{0.05}$		14.83	19.21	2.34	3.42	1.13	n.s	1.32	31.40	46.13	4.23	0.21	0.872	1.153	n.s

D_1: 166667D_2: 83333D_3: 55555 plants/ ha

Means in the same column followed by the same letters(s) are not significant according to L.S.D$_{0.05}$ values.

maximum total dry forage yield (18.251 t/ ha) at 90 (DAS).

On the contrary, decreasing plant density from (166667 to 55555 plants/ ha) significantly increased stalk diameter at 55 and 90 (DAS), number of leaves/ plant, leaf stem ratio at 90 (DAS), number of ears/ plant and plant dry weight at 55 and 90 (DAS), where sowing SC 10 at 55555 plants/ ha produced the thickest stalk (22.14 and 26.15 mm) at 55 and 90 DAS, highest number of leaves and ears/ plant (17.03 and 1.42), respectively, highest leaf/ stem ratio (64.17 %) at 90 (DAS), while the four maize hybrids studied produced the heaviest plant dry weight under the lowest plant density.

From the aforementioned results, it could be conclude that SC 10 white grain maize was significantly surpassed other maize crosses studied under the three plant densities in Al-Maamorah district, El-Ghafara, Tripoli, Libya.

REFERENCE

A.O.A.C. 1990. Association of Official Analysis Chemists. 13th ed., Washington, D.C., USA.

Al-Naggar, A.M.M., M.M. Atta, M. Ahmed and A. Younis.2016. Maximizing corn (*Zea mays* L.) crop yield via matching the appropriate genotype with the optimum plant density. J. Appl. Life Sci. Int., 5 (4): 1- 18.

Awadalla, A. and A. Morsy. 2016. Response of some yellow maize crosses to N-fertilizer rates and plant densities at Toshka Region. Egypt. J. Agron., 38 (3): 337- 354.

Cox, W.J. 1997. Corn silage and grain yield response to plant densities. J. Prod. Agric., 10 (3): 405- 410.

Deinum, B. and P.C. Struik. 1989. Genetic variation in digestability of forage maize (*Zea mays* L.) and its estimation by near infrafred reflectance spectroscopy (NIRS). An analysis Euphytica, 42 (1-2): 89- 98.

El-Hosary, A.A., G.Y. Hammam, E.M.M. El-Gedwy and M.E. Sidi. 2019. Response of white maize hybrids to plant densities and nitrogen fertilizer rates. Annals Agric. Sci., Moshtohor, 57 (2): 333-350.

El-Metwally, E.A., A. El-Met, A. El-Deeb, S.A. Safina and B.G. Rabbani. 2011. Agricultural studies on some corn hybrids cultivated with different plant densities. J. Plant Prod., Mansoura Univ., 2 (3): 479- 490.

El-Shahed, H.M., M.E. Sahel, S.A. Mowafy and M.M.A. Osman. 2013. Effect of planting density and plant skipping irrigation at certain growth stages on yield potentiality of some maize hybrids. Zagazig J. Agric. Res., 40 (4): 617- 646.

El-Sobky, E.E.A. and N.Z.A. Al-Naggar.2016. Effect of weed control treatments and plant density in maize (*Zea mays* L.). Egypt J. Agron., 38 (1): 55- 77.

Ferreria, G., M. Alfanso, S. Depino and E. Alessandri. 2014. Effect of planting density on nutritional quality of green-chopped corn for silage. J. Dairy Sci., 97 (9): 5918- 5921.

Fromme, D.D., T.A. Spivey and W.J. Grichar.2019. Agronomic response of corn (*Zea mays* L.) hybrids to plant populations. Int. J. Agron., Doi:https://doi.org/10.1155/2019/3589768.

Gaile, Z. 2008. Harvest time effect on yield and quality of maize (*Zea mays* L.) grown for silage. Latvian J. Agron., 10: 104- 111.

Haddadi, M. and M. Mohseni.2016. Plant density effect on silage yield of maize cultivars. J. Agric. Sci., 8 (4): 186-191.

Hegab, A.S.A., M.T.B. Fayed, M. Hamada and M.A.A. Abdrabbo.2019. Growth parameters, irrigation requirements and productivity of maize in relation to sowing dates under north-delta of Egypt conditions. Arab Univ. J. Agric. Sci., 27 (1): 289-298.

Hunter, R.B. 1986. Selecting hybrids for silage corn production: a Canadian experience. Page 140-146. In O. Dolstra and P. Miedema (eds). Breeding of silage maize. 13th Congress of maize and sorghum section, EUCARPIA, Wageningen, Netherlands, 9-12 Sept. 1985.

Karasahin, M. 2014. Effect of different irrigation methods and plant density on silage yield and yield components of PR 31Y43 hybrid corn cultivar. Turk. J. Agric. Forst., 38 (2): 159- 168.

Kumar, R., M. Singh, S.K. Tomar, B.S. Meena and D.K. Lathore. 2016. Productivity and nutritive parameters of fodder maize under varying plant density and fertility levels for improved animal productivity. Indian J. Animal Res., 50 (2): 199- 202.

Li, Q., F. Kong, W. Long, Y. Wu, Q. Cheng, P. Dou and X. Guo. 2019. Effects of planting density and cropping pattern on the dry matter accumulation and yield of maize (*Zea mays* L.) in Southeast China. J. Animal Plant Sci., 29 (1): 182- 193.

Lynch, J.P., P.O'Kiely and E.M. Doyle. 2012. Yield, quality and silage characteristics of whole-crop maize and off the cob and stover components: 1- Harvest date and hybrid effects. Grass and Forage Sci., 67 (4): 472- 487.

Mandic, V., V. Krnjaja, Z. Bijelic, Z. Tomic, A. Simic, A. Stanojkovic and V. Caro-Petrovio. 2015. The effect of crop density on yield of forage maize. Biotech. Animal Husb., 31 (4): 567- 575.

Nazli, M.H., R.A. Halim, A.M. Abdullah, G. Hussin and A.A. Samsudin. 2019. Potential of four corn varieties at different harvest stages for silage production in Malaysia. Asia-Aust. J. Animal Sci., 32 (2): 224-232.

Opoku, E. 2017. Effect of row width and plant population density on yield and quality of maize (*Zea mays* L.) silage. Ph.D. dissertation, Lincoln Univ., New Zealand.

Rahouma, M.A.A. 2018. Response of maize (*Zea mays* L.) to plant population density and nitrogen fertilizer levels. Alex. Sci. Exch. J., 39: 379- 386.

Roth, G.W. and D. Undersander. 1995. Corn silage Production and Feeding. NCR Publicate. 574, Am. Soc. Agron., Mandison, WI, USA.

Steel, R.G.D. and I.N. Torrie.1980. Principles and Procedures of Statistics. 2nd ed., Mc.Grow Hill Co., New York, USA.

الملخص العربي

تأثير الكثافة النباتية على محصول وجودة السيلاج الناتج من بعض هجن الذرة الشامية

محمود أبو عجيلة على رحومة

أجريت هذه الدراسة فى مزرعة خاصة بمنطقة المعمورة- الجفارة- طرابلس- ليبيا بهدف دراسة تأثير ثلاث كثافات نباتية (166667، 83333، 55555 ألف نبات/ هكتار) على محصول وجودة السيلاج الناتج من أربعة هجن من الذرة الشامية (SC 10، SC 176، TC 310، TC 360). نفذت التجربة بتصميم القطع المنشقة فى ثلاث مكررات حيث وزعت الهجن عشوائياً على القطع الرئيسية بينما وزعت الكثافات النباتية عشوائياً على القطع الفرعية وتشير النتائج إلى تفوق الهجين الفردى SC 10 على باقى الهجن فى صفات ارتفاع النبات وسمك الساق بعد 55، 90 يوم من الزراعة (183.03، 210.93 سم)، (21.08، 24.46 مم) على الترتيب، نسبة الأوراق إلى السيقان (59.06 %) وعدد الكيزان/ النبات (1.21) ومحصول العلف الجاف بعد 90 يوم من الزراعة (17.059 طن/ هكتار)- من جهة أخرى تفوقت الهجن الفردية (SC 10، SC 176) على الهجن الثلاثية فى ارتفاع النبات (210.93، 209.72 سم) ودليل المساحة الورقية بعد 90 يوم (3.39، 6.28)، وعدد الأوراق على النبات (15.59، 15.31) ومحصول العلف بعد 55 يوم (13.708، 13.508 طن/ هكتار) ومحصول البروتين (1.14، 1.17 طن/ هكتار) لكل هجين على الترتيب.

من جهة أخرى فإن الكثافة النباتية المرتفعة (166667 نبات/ هكتار) أدت إلى إنتاج أطول النباتات وأعلى محصول علف جاف بعد 55، 90 يوم، وأعلى دليل للمساحة الورقية بعد 55 يوم- فى حين أدت الكثافة المنخفضة (55555 ألف نبات/ هكتار) لإنتاج أكثر السيقان سمكاً وأعلى وزن جاف للنبات بعد 55، 90 يوم، أعلى عدد من الأوراق/ نبات، أعلى نسبة من الأوراق/ السيقان وأكبر عدد من الكيزان/ نبات وكذلك أعلى محصول من البروتين للهكتار.

كما أوضح التفاعل بين الهجن × الكثافة النباتية تفوق الهجين الفردى SC 10 المنزرع بالكثافة النباتية (166667 ألف نبات/ هكتار) فى ارتفاع النبات ومحصول العلف الجاف بعد 55، 90 يوم ودليل المساحة الورقية بعد 55 يوم- فى حين تفوق نفس الهجين تحت الكثافة النباتية (55555 ألف نبات/ هكتار) فى سمك السيقان بعد 55، 90 يوم وكذلك عدد الأوراق/ نبات وعدد الكيزان/ نبات- كذلك فإن الهجن الأربعة المنزرعة تحت الكثافة النباتية المنخفضة تفوقت فى وزن النبات الجاف بعد 55، 90 يوم من الزراعة، مقارنة بزراعتها تحت الكثافة النباتية المرتفعة (166667 ألف نبات/ هكتار).