

<http://www.pjbs.org>

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSI*net*

Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Response of Sweet Corn (*Zea mays saccharata* Sturt) to Nitrogen and Intra Row Spaces in Semi-arid Region

Abdullah Oktem,

Department of Field Crops, Faculty of Agriculture, Harran University, 63200, Sanliurfa, Turkey

Abstract: This study was conducted to investigate the effects of different Nitrogen (N) application rates (150, 200, 250, 300 and 350 kg N ha⁻¹) and different Intra Row Spaces (IRS) (140 mm=102 040 plants ha⁻¹, 180 mm=79 370 plants ha⁻¹, 220 mm=64 930 plants ha⁻¹, 260 mm=54 940 plants ha⁻¹, 300 mm=47 620 plants ha⁻¹) on fresh ear yield of sweet corn which was grown as second crop in south-eastern of Turkey during 1998 and 1999. N, IRS and N x IRS interaction were significant ($p < 0.01$) for fresh ear yield. The highest fresh ear yield (16.01 t ha⁻¹) was obtained from 300 kg N ha⁻¹ x 220 mm (64 930 plants ha⁻¹) IRS application. Increasing nitrogen applications increased fresh ear yield.

Key words: Sweet corn, nitrogen application rates, intra row space, fresh ear yield

INTRODUCTION

Corn is one of the cultivated grain-cum-fodder crops with tremendous yield potential grown round the year under irrigated conditions. It is a quick growing and high yielding crop and considered as a valuable fodder crop. In many parts of the world, corn is the most important food stuff and most efficient field crops in producing superior amount of dry matter per unit area. Due to its early maturation, sweet corn is very suitable for rotations. Early harvested plants can also be used as a green forage crop.

In order to optimize the use of moisture, nutrients and solar radiation, sweet corn must be grown under optimum seed density and nitrogen application rates. Stone *et al.*^[1] reported that increasing nitrogen applications rate increased yield. Raja^[2] stated that increment in nitrogen levels (0-120 kg ha⁻¹ N) and raising of plant population (53333 to 88888 plants ha⁻¹) significantly increased the fresh ear yield. The most profitable and suitable nitrogen application rate for sweet corn was reported as 150 kg ha⁻¹ N^[3] 160 kg ha⁻¹ N^[4]. Khan *et al.*^[5] recommended 53000 plants ha⁻¹ sowing density and 240 kg ha⁻¹ N. Akbar *et al.*^[6] reported that the most proper sowing density was 100000 plants ha⁻¹. The objective of this study was to determine the optimum seed density and nitrogen application rate for sweet corn production in semi-arid region.

MATERIALS AND METHODS

This study was conducted during 1998 and 1999 in the Field Research Facility of the Faculty of Agriculture at Harran University, Sanliurfa, Turkey. The experimental

field is located in Harran Plain (altitude: 465 m; 37°08' north and 38°46' east) where the climate varies from arid to semi-arid.

The texture of the research field was clay. Field capacity of the soil was 33.8% in dry basis, permanent wilting point was 22.6% and volume weight of the soil was 1.41 g cm⁻³. The amount of nitrogen in the soil and other features of the experimental area are given in Table 1. The variety Merit hybrid sweet corn (*Zea mays saccharata* Sturt) was used. Table 2 provides the climatic data for the Sanliurfa City Meteorological Station located about 2 km distance from research field. During the time period for the treatments, the weather conditions were hot, dry and the relative humidity was very low.

The experiment was set up as a split plot with three replications. Main plots were N application rates (150, 200, 250, 300 and 350 kg N ha⁻¹) and sub-plots were intra row spaces (140 mm = 102040 plants ha⁻¹, 180 mm = 9370 plants ha⁻¹, 220 mm = 64930 plants ha⁻¹, 260 mm = 4940 plants ha⁻¹ and 300 mm = 47620 plants ha⁻¹). Each subplot area was 14 m² (5x2.8 m) and consisted of 4 rows. Distance between rows was 700 mm. In both years, sweet corn was seeded to the field after where unfertilized wheat was harvested. Soil samples were taken a day prior to seeding and were analysed. Amount of N in the soil was determined using Kjeldahl method and it was subtracted from the application rates being applied. At sowing, triple super phosphate (46% P₂O₅) and potassium sulphate (50% K₂O) fertilisers were applied at the levels of 80 kg ha⁻¹ pure P₂O₅ and K₂O. According to N application rates, urea (46% N) was applied to bands in two equal applications; one at seeding, second at 6 leaf stage. The

Table 1: Some chemical characteristics of research area soil

Depth (m)	CaCO ₃ (%)	Total salt (%)	pH	Org. matter (%)	N (kg ha ⁻¹)	P ₂ O ₅ (kg ha ⁻¹)	K ₂ O (kg ha ⁻¹)
0.0-0.3	26.8*	0.071	7.6	1.0	22	24	1260
	25.3	0.076	7.5	1.1	28	25	1340
0.3-0.6	29.0	0.076	7.8	0.7	11	19	930
	23.1	0.073	7.7	0.8	13	22	890
0.6-0.9	34.0	0.070	7.4	0.8	5	17	850
	32.0	0.077	7.3	0.7	8	18	820

* Upper and down rows are 1998 and 1999 year values, respectively

Table 2: Monthly minimum, maximum and average temperature, relative humidity and total precipitation values during the growth period of sweet corn in 1998 and 1999*

Months	Temperature(°C)			Average relative humidity(%)	Total precipitation (mm)
	Min.	Max.	Ave.		
June	17.8†	41.2	29.4	46.2	0.60
	18.80	40.0	28.8	43.6	1.60
July	19.80	45.4	33.0	43.8	-
	21.50	43.2	32.5	39.7	-
August	22.60	43.0	33.4	41.4	-
	20.50	43.0	31.2	44.7	26.00
September	15.10	39.6	27.0	53.3	-
	17.00	36.6	26.2	46.8	-
October	10.20	34.1	21.5	49.5	0.10
	11.30	35.6	21.0	51.2	8.40
November	8.80	27.9	16.7	66.4	22.70
	1.20	25.0	13.5	50.9	0.80

* Data collected from Sanliurfa Meteorological Station

† Upper and down rows are 1998 and 1999 year values, respectively

banded N was 50 mm to the side and 50 mm below the seed.

The seeds were sown at a 50-60 mm depth on the 20th of June, 1998 (Day of Year (DOY 171) and the 23rd of June, 1999 (DOY 174). In both years, first irrigation water was applied to all treatments using a sprinkler irrigation system. After emergence of plants, plots were irrigated equally with drip irrigation system to the end of the starch filling period. There was 5 m distance between the main plots. Surface runoff was not occurred during the research years because of drip irrigation system used. When the kernel moisture was about 72%, ears from two rows in the center of each plot were harvested manually on the 11th of Sept., 1998 (DOY 254) and the 16th Sept., 1999 (DOY 259). Data were not collected for outer rows in each of every sub-plots to avoid any border influence. Then all fresh ear yield values were collected from the center two rows from each sub-plots in all main plots. Collected ears due to determination of fresh ear yield values were husk off.

An split-plot statistical analysis of variance (ANOVA) and Least Significant Difference (LSD) tests was conducted on the data combined over years. Least Significant Difference (LSD) tests were used to determine differences among treatments using the Mstat-C™ statistical software. Regression analyses were performed to determine the effect of N rates on corn fresh ear yield for the 140, 180, 220, 260 and 300 mm intra row spaces.

RESULTS AND DISCUSSION

As seen Table 3 that Nitrogen (N), Intra Row Spaces (IRS) and NxIRS interaction were found significant on fresh ear yield ($p < 0.01$). Nitrogen rate was plotted against fresh ear yield in Fig.1 and regression equations are given in Table 5. A linear relationship between nitrogen rate and fresh ear yield was found to be significant only on 220 IRS. A second order polynomial relationship between the nitrogen application rates and the fresh ear yield was found to be significant at some levels of IRS (140, 180 and 260 mm). A 3.5% decrease in yield was observed with N fertilizer applied above 300 kg ha⁻¹ N rate (Table 4 and Fig.1). Oktem *et al.*^[7] stated that high amount of nitrogen increases the vegetative growth of plant with increasing number of leaves. In that case middle and lower located leaves of plants do not have sun light effectively because of the upper leaves' shadow. This causes low yield due to low photosynthesis activity. Increasing N application rates from 150 to 300 kg ha⁻¹, resulted in an increase fresh ear yield by 41.8%. In this study, 300 kg ha⁻¹ N application rate appears to be the optimum at all levels of IRS for fresh marketing of sweet corn, along with the soil N. Some researches reported different N dosages; 150 kg ha⁻¹ N^[3], 240 kg ha⁻¹ N^[5] and 160 kg ha⁻¹ N^[4].

There was 22.1% increase in fresh ear yield until IRS value hits 220 mm. But after that point a decrease was observed. The regression relationship indicated an optimum IRS value of 220 mm for fresh marketing of sweet corn (Fig. 1). An increase in yield with dense plant population was reported^[8], but some researchers have found the opposite^[1]. Plant numbers without ear increased when sowing density increased, yield was low due to reduced number of ear per unit area at low plant populations. Therefore, application rate of nitrogen and plant population have to be in balance.

In addition, leaf area per plant decreases with dense plots although total leaf area index increases linearly by increasing plant density per unit area. Higher amount of water consumption accounted for increasing plant transpiration rate at high sowing densities. This higher water consumption with higher densities require much shorter time period for irrigation. Reduction in dry matter production due to low photosynthesis and plant

Table 3: Mean square from the analysis of variance for sweet corn fresh ear yield

Source of variation	df	Mean square
Year(Y)	1	0.155
R(Y)	4	0.086
Nitrogen(N)	4	73.400**
YxN	4	0.017
Error-1	16	0.087
IRS	4	75.336**
YxIRS	4	0.268
NxIRS	16	3.954**
YxNxIRS	16	0.195
Error-2	80	0.129

**Significant at the $p < 0.01$ probability levels

Table 4: The effect of N application rates and intra row spaces on fresh ear yield of sweet corn

(Fresh ear yield (t ha ⁻¹))**						
Nitrogen (kg ha ⁻¹)	Intra row spaces (mm)					
	140	180	220	260	300	Average
150	7.78p*	9.79lm	10.64k	9.13n	8.61o	9.19
200	11.06j	11.50l	11.93h	11.45ij	9.16n	11.02
250	12.24gh	13.65cd	13.78c	12.90ef	9.47mn	12.41
300	12.51fg	13.80c	16.01a	12.93e	9.90l	13.03
350	12.03h	13.35d	15.52b	12.49g	9.46mn	12.57
Average	11.12	12.41	13.58	11.78	9.32	

LSD: 0.4127

* There are no statistical differences among the treatments having the same letter(s) at 0.05 level according to LSD test

**Fresh ear yield values are without husk

Table 5: Regression equations and R² values for sweet corn fresh ear yield (Y) versus N rate (x)

Regression	Intra row spaces	Equation	R ²
1st order	140	$Y = 0.020x + 6.143$	0.650
	180	$Y = 0.019x + 7.702$	0.740
	220	$Y = 0.028x + 6.656$	0.910*
	260	$Y = 0.016x + 7.674$	0.660
	300	$Y = 0.005x + 8.094$	0.650
2nd order	140	$Y = -0.0002x^2 + 0.1405x - 7.7227$	0.987*
	180	$Y = -0.0002x^2 + 0.1093x - 2.6973$	0.974*
	220	$Y = -9E-05x^2 + 0.0731x + 1.4317$	0.943
	260	$Y = -0.0002x^2 + 0.1157x - 3.7439$	0.995**
	300	$Y = -5E-05x^2 + 0.0315x + 5.0354$	0.927

*, **Significant at the $p = 0.05$ and $p = 0.01$ probability levels, respectively

competition to macro and micro nutrition in soil were resulted in lack of growth and lowered yield^[7].

Table 4 shows that 300 kg ha⁻¹ N x 220 mm IRS interaction provided the highest fresh ear yield (16.01 t ha⁻¹) whereas 150 kg ha⁻¹ N x 140 mm IRS interaction has resulted in the lowest yield of 7.78 t ha⁻¹. Increasing N application rate and IRS decreased the fresh ear yield above the levels of 300 kg ha⁻¹ N application rate and 220 mm IRS. Competition promoted by increased plant population sets a gradual type of stress that intensity along the cycle due to progressive interplant interference related to plant growth. Higher density of corn plants more rapidly create a leaf canopy that blocks sunlight from reaching lower leaves, preventing their growth. However increased plant population caused

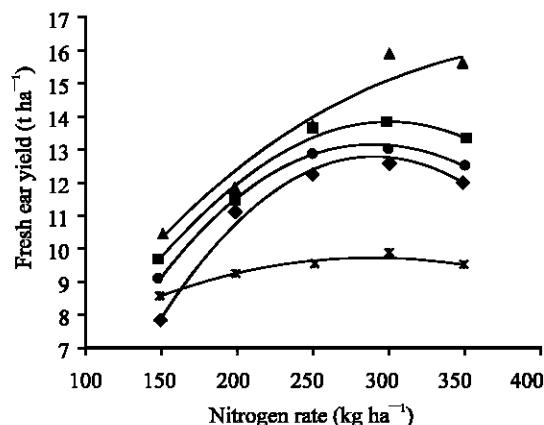


Fig. 1: Sweet corn fresh ear yield response to five N rates as affected by five intra row spaces (♦140 mm, ■180 mm, ▲220 mm, ●260 mm and ✕300 mm). The lines were fitted by a second order polynomial-regression equation

drastic decrease in leaf area, grain yield and kernel number per plant.

Plants grown on high plant population intercepted more light per plant during much of their life cycle than those grown in low plant population. Greater light capture coupled with less inter-plant competition may have allowed these plants to utilise photosynthate more efficiently. Efficient light capture and use by plants is believed to be a major determinant of this response. On a per plant basis, all other factors being equal, greater light interception leads to larger plants and greater seed yield.

Increasing N application rates from 150 to 300 kg ha⁻¹ resulted 41.8% increases in fresh ear yield. But 3.5% yield decrease was observed at 350 kg ha⁻¹ N. Fresh ear yield increased by 22.1% when IRS was increased from 140 to 220 mm. The highest fresh ear yield was obtained from 220 mm IRS, but the yield decreased more than 220 mm IRS. An increase in marketable ear number was observed after 300 kg ha⁻¹ N and 220 mm IRS. But yield was low after that point. Research results indicated that N application rate and row spacing have to be in a balance for high yield. When the plant population raises, N requirement of plants increases. Yield was found to be the lowest at low N and high plant population conditions. This situation should be consider at practical applications.

In semi-arid regions similar to south-eastern of Turkey and in light of economics and environmental considerations, the best combination of N and IRS for fresh marketing of sweet corn was determined 300 kg ha⁻¹ N x 220 mm IRS (64 930 plants ha⁻¹) interaction, along with the soil N.

REFERENCES

1. Stone, P.J., I.B. Sorensen and J.B. Reid, 1998. Effect of plant population and nitrogen fertilizer on yield and quality of supper sweet corn. *Agron. Soc. New Zealand*, 28: 1-5.
2. Raja, V., 2001. Effect of nitrogen and plant population on yield and quality of super sweet corn (*Zea mays*). *Indian J. Agron.*, 46: 246-249.
3. Salardini, A.A., L.A. Sparrow and R.I. Holloway, 1992. Sweet corn responses to basal and top-dressed rates and sources of nitrogenous fertilizers. *Australian J. Agric. Res.*, 43: 171-180.
4. Stoyanova, S.D., I. Babik and J. Rumpel, 1994. Influence of nitrogen fertilisation on the dynamics of growth and productivity of sweet corn. *Acta-Horticulturae*, 371: 421-429.
5. Khan, A., A. Aziz and M. Salim, 1993. Response of two maize cultivars to management inputs. *Sarhad J. Agric.*, 9: 355-358.
6. Akbar, H., P. Shah, K. Az, H. Saeed and M. Munir, 1996. Biomass, grain yield and harvest index and criteria for comparing corn types at different nitrogen levels and planting densities. *Sarhad J. Agric.*, 12: 261-267.
7. Oktem, A., A.C. Ulger and Y. Kirtok, 2001. The effect of different doses and intra row spaces on grain yield and some agronomic characteristics of pop corn (*Zea mays everta* Sturt.). *J. Agric. Fac. Cukurova Univ.*, 16: 83-92.
8. Eckert, D.S. and V.L. Martin, 1994. Yield and nitrogen requirement of tillage corn as influenced by cultural practices. *Agron. J.*, 86: 1119-1123.