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Yield Potential of Sweet Corn as Influenced by Different Levels of Nitrogen and Plant Population

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Abstract: Days to tasseling (55.43), days to silking (68.43), plant height (135.76 cm) and biological yield (11890.6 kg ha^{-1}) was significantly increased at 180000 plants ha^{-1}. Maximum 1000-grains weight (125.97 g) and more number of cobs $plant^{-1}$ (1.61) was obtained at 60000 plants ha^{-1} while highest grain yield (1777.42 kg ha^{-1}) was obtained at 120000 plants ha^{-1}. Maximum days to tasseling (57.35), silking (69.50), maturity (102.7) and tallest plants (140.23 cm) were recorded for 200 kg N ha^{-1}. Maximum number of plants (104185 ha^{-1}) was harvested from plots receiving 150 kg N ha^{-1}. Nitrogen level of 150 kg N ha^{-1} resulted in the greater grain yield (2006.95 kg ha^{-1}) and 1000-grains weight (132.73g). Highest biological yield (12291.1 kg ha^{-1}) was recorded for 200 kg N ha^{-1}. Plant population of 120000 plants ha^{-1} interacting with 150 kg N ha^{-1} gave maximum grain yield of 2195.75 kg ha^{-1}.

Key words: Sweet corn, plant populations, nitrogen levels, yield and grain yield

Introduction

Sweet corn (*Zea mays* sp. saccharata) belongs to the family Poaceae. It has wrinkled seeds and like other types of corn it is used as livestock feed, as human food and as raw material in industry. For increasing human population have to exploit the entire food crops to meet the increasing demand. Among the yield increasing factors, plant population and balanced N fertilization is of primary importance because in case of thick plant population most plants remain barren and grain size also remains small and lodging also takes place. Similarly, if the nitrogen requirements are not fulfilled properly, the lower leaves begin to turn pale and if the deficiency persists, cob size will remain small, the grains are shrinked and vegetative growth will adversely affected.

Park *et al*. (1989) reported that increasing plant density from 40000 plants ha^{-1} to 111110 plants ha^{-1} increase plant height and then starts declining because of more tense competition. Peter *et al*. (1989) who observed that 1000-grains weight decreased with increase in plant population and increase with increase in nitrogen levels. Novero *et al*. (1992) in a field trial on different levels of nitrogen (0, 75, 150, 225 and 300 kg N ha^{-1}) at maize cultivars, reported highest biological yield (15767 kg ha^{-1}) for 225 kg N ha^{-1}. Masheswarappa *et al*. (1994) reported that number of cobs/plant, 100-grains weight and plant at harvest decreased with increased plant population and further reported that grain yield was the highest (5000 kg ha^{-1}) at 165 kg N ha^{-1} with 125000 plants ha^{-1}. Stone *et al*. (1998) reported that yield and quality of super sweetcorn cv. Challenger are sensitive to changes in plant density and nitrogen nutrition.

This study examined the effects of plant population (nine populations ranging from about 30, 000 to 140, 000 plants ha^{-1}) and nitrogen (N) fertilizer (0 or 250 kg N ha^{-1}) on yield and quality. When N fertilizer was added, ear and grain yield increased with increase of plant population, throughout the population range examined. When N was limiting ear and grain yield increased with population up to around 90 000 plants/ha, then remained unchanged. Turgut (2000) reported that increased plant population and nitrogen level delayed days to tasseling, days to silking and days to maturity and increased seed number per ear, fresh ear weight and number of ears per plant.

The research work was conducted on a wide range of plant population and nitrogen levels to determine optimum plant population of the crop and to determine optimum dose of nitrogen, also to determine best interaction of plant population and nitrogen level.

Materials and Methods

A trial was conducted at Malakandher Research Farm, NWFP Agricultural University, Peshawar during 1998-99 to study the effect of various plant populations (60000, 90000, 120000, 150000 and 180000 ha^{-1}), nitrogen levels (0, 100, 150, 200 kg N ha^{-1}) and their interaction on the performance of sweet corn. The experiment was laid out in randomized complete block design with split plot arrangement, allotting plant population to main plots and nitrogen levels to sub plots. Net sub plot area was 12 m^2. The desired plant population was maintained by removing extra plants from each row. In 60000 plants ha^{-1}, plant-to-plant distance was 33cm. In 90000-plant ha^{-1}, plant-to-plant distance was 22 cm. In 120000 plants ha^{-1}, plant-to-plant distance was 16 cm. In 150000 plants ha^{-1}, plant-to-plant distance was 13 cm. In 180000-plants ha^{-1}, plant-to-plant distance was 11 cm. Data was recorded on days to tasseling, days to silking, plant height (cm), days to maturity, number of plants ha^{-1} at harvest, number of ears/plant, biological yield (kg ha^{-1}), grain yield (kg ha^{-1}), 1000 grains weight (g).

Data was statistically analyzed according to RCBD split plot arrangement, the analysis of variance and LSD was used according to Steel and Torrie (1980).

Results and Discussion

Tasseling (Table 1) was delayed with increasing planting density. Maximum days (55.43) to reach tasseling were recorded for planting density of 180000 plants ha^{-1} (Turgut, 2000) Maximum days (57.35) were taken by the plants that received 200 kg N ha^{-1}, while minimum number of 50.95 days was taken by control that received no nitrogen. Plant population and nitrogen levels not significantly interacted regarding days to tasseling.

Plants thinned to 180000 plants ha^{-1} took maximum number of 68.43 days to silking (Table 2). Silking delays linearly with increase dose of nitrogen. Plants that were given 200 kg N ha^{-1} took maximum number of 69.50 days to silking, while plants received no nitrogen took minimum days (63.45 days) to silking. Plant population and nitrogen levels not significantly interacted regarding days to silking.

Tallest plants (Table 3) of 135.76 cm were observed in plots that were thinned to 180000 plants ha^{-1}. These results are not in conformity with Park *et al*. (1989). Plant height increased linearly with the increase in nitrogen and tallest plant height (140.23 cm) was observed in plots that received 200 kg N ha^{-1} and plots that received no nitrogen resulted in the smallest plant height of 123.96 cm (Chabra and Sing, 1986). Plant population of 180000 ha^{-1} interacting with N level of 200 Kg ha^{-1} took produced highest plant height (141.87 cm).

Maximum days to maturity (100.35 days) were taken by plants that were thinned to 180000 plants ha^{-1}, (Table 4) plants population of 60000 plants ha^{-1} took minimum number of 92.45 days to maturity (Turgut, 2000). Maturity of the maize crop was delayed by increased supply of nitrogen and maximum days to maturity (102.70 days) were taken by plants at 200 kg N ha^{-1}, while plants that received no nitrogen took 94.2 days to maturity.

Table 1: Days to tasseling of sweet corn as affected by different levels of nitrogen and plant population

Plant population	Nitrogen levels (kg) 0	100	150	200	Means
60000	48.00	49.75	52.25	56.25	51.56b
90000	50.75	53.00	55.50	56.25	53.87a
120000	51.25	53.00	54.75	56.50	53.87a
150000	52.50	54.50	56.50	58.00	55.37a
180000	52.25	53.00	56.75	59.75	55.43a
Means	50.95d	52.65c	55.15b	57.35a	

LSD value for plant population = 1.692 and nitrogen level = 0.7821

Table 2: Days to silking of sweet corn as affected by different levels of nitrogen and plant population

Plant population	Nitrogen levels (kg) 0	100	150	200	Means
60000	60.25	62.50	64.00	67.75	63.63c
90000	63.75	65.25	67.25	70.00	66.56b
120000	63.25	63.75	68.25	68.00	65.81b
150000	64.50	65.25	68.75	69.50	67.00b
180000	65.50	66.50	69.50	72.25	68.43a
Means	63.45d	64.65c	67.55b	69.50a	

LSD value for plant population = 1.401 and nitrogen level = 0.8724

Table 3: Plant height (cm) of sweet corn as affected by different levels of nitrogen and plant population

Plant population	Nitrogen levels (kg) 0	100	150	200	Means
60000	118.15h	128.52e	134.70cd	138.87ab	130.06b
90000	123.80g	132.80d	135.95bc	140.80a	133.21a
120000	125.00fg	132.37d	135.65c	140.02a	133.26a
150000	126.85ef	135.77c	140.85a	139.6a	135.76a
180000	126.05feg	134.05cd	139.40a	141.87a	135.33a
Means	123.96d	132.60c	137.30b	140.23a	

LSD value for plant population = 2.759 and nitrogen level = 1.352, interaction = 3.024

Table 4: Days to maturity of sweet corn as affected by different levels of nitrogen and plant population

Plant population	Nitrogen levels (kg) 0	100	150	200	Means
60000	93.5k	94.5g	100.0de	102.0cb	97.25c
90000	93.1k	94.5ij	99.1ef	102.2b	98.7b
120000	95.4h	94.2j	95.8h	101.9bc	97.7b
150000	94.2hi	97.4g	101.3bc	102.0b	99.2b
180000	96.2h	98.8fg	103.8a	102.4b	100.35a
Means	94.2d	96.9c	100.8b	102.7a	

LSD value for plant population = 0.7979, nitrogen level = 0.4821 and interaction = 1.078

Table 5: Number of plants at harvest ha^{-1} of sweet corn as affected by different levels of nitrogen and plant population

Plant population	Nitrogen levels (kg) 0	100	150	200	Means
60000	52842lm	52198m	52839lm	52525m	52601e
90000	81582j	79775k	81594j	82178j	81282d
120000	105807h	102201l	104726h	104401h	104782c
150000	125296b	128229e	124455d	126197f	126044b
180000	147012d	153344b	155900a	150137c	151598a
Means	102508c	103149b	104182a	103080b	

LSD value for plant population = 1094.0, nitrogen level = 701.6 and interaction = 156.9

Plant population of 180000 ha^{-1} interacting with 150 Kg N ha^{-1} took maximum days to maturity (103.8)

Number of plants ha^{-1} at harvest (Table 5) was to know the effect of planting densities on mortality rate. A plant population on number of plants ha^{-1} at harvest showed that mortality of plants ha-^{1} was high (28211 plants ha^{-1}, Table 5a) for maximum plant population of 180000 plants ha^{-1}. Maximum number of plants (104182 ha^{-1}) was harvested for N level of 150 kg N ha^{-1} while minimum number of plants (102508 ha^{-1}) was harvested for control plots. Interaction of the two factor was non significant.

Table 5a: Number of plants ha^{-1} lost at harvest of sweet corn as affected by different levels of nitrogen and plant population

Plant population	Nitrogen levels (kg) 0	100	150	200	Means
60000	7158	7802	7161	7472	7398
90000	8418	7225	8206	7822	8717
120000	14193	13799	12274	13599	14291
150000	24704	23777	32545	23803	23957
180000	32988	26656	28110	24100	28211
Means	17492	15851	15659	15359	

Table 6: Number of ears plant^{-1} of sweet corn as affected by different levels of nitrogen and plant population

Plant population	Nitrogen levels (kg) 0	100	150	200	Means
60000	1.26cde	1.37cd	2.10a	1.72b	1.61a
90000	1.27cde	1.32cde	1.33cde	1.42c	1.33b
120000	1.16ef	1.30cde	1.23def	1.17ef	1.22c
150000	1.15ef	1.24cdef	1.30cde	1.24cde	1.20c
180000	1.03f	1.21def	1.32cde	1.28cde	1.19c
Means	1.17c	1.28b	1.45a	1.36b	

LSD value for plant population = 0.1168, nitrogen level = 0.08304 and interaction = 0.1857

Table 7: Biological yield (kg ha^{-1}) of sweet corn as affected by different levels of nitrogen and plant population

Plant population	Nitrogen levels (kg) 0	100	150	200	Means
60000	8906.7j	10133.5gi	10863.7fg	10407.5gh	10077.9d
90000	9042.5j	10780.2fg	11690.7bcd	10876.2fg	10607.8c
120000	10670.2fg	11765.0bcd	11976.5b	11108.7ef	11380.0b
150000	9726.5i	11474.0cde	11892.7bc	11373.7de	11116.7b
180000	10501.2gh	11608.7bcd	12663.2a	12689.2a	11890.6a
Means	9777.9c	11152.3b	11737.4ab	12291.1a	

LSD value for plant population = 322.0, nitrogen level = 217.2 and interaction = 485.6

Table 8: Grain yield (kg ha^{-1}) of sweet corn as affected by different levels of nitrogen and plant population

Plant population	Nitrogen levels (kg) 0	100	150	200	Means
60000	978.65j	1330.70g	1938cd	1734.97e	1498.28c
90000	1089.23ij	1520.00f	2015.1bc	2050.13ab	1668.5b
120000	1243.78gh	1687.55e	2195.75a	2192.57a	1777.42a
150000	1195.07hi	1534.23f	2070.9ab	2174.93a	1743.53ab
180000	1012.92ij	1546.75f	1911.23d	1767.15e	1559.50c
Means	1103.93c	1523.85b	2006.95a	1983.95a	

LSD value for plant population = 76.11, nitrogen level = 56.64 and interaction = 126.6

Table 9: 1000-grains weight of sweet corn as affected by different levels of nitrogen and plant population

Plant population	Nitrogen levels (kg) 0	100	150	200	Means
60000	117.37h	122.90efg	135.67a	127.95bcde	125.97a
90000	106.95ij	120.62fgh	131.35abc	128.50bcd	121.85bc
120000	110.67l	125.00def	132.15ab	126.1cdef	123.51ab
150000	103.27j	117.45def	132.15ab	127bcde	119.96c
180000	103.17j	120.85fgh	131.35ab	125.5bcde	119.83bc
Means	108.29d	121.39c	132.73a	127.3b	

LSD value for plant population = 2.467, nitrogen level = 5.400 and interaction = 5.516 Means followed by different letters are significantly different at P < 0.05

Maximum number of 1.61 ears/plant (Table 6) was obtained from low population density of 60000 plant ha^{-1}. Number of ear/plant

increased in a linear fashion up to 150 kg N ha^{-1} and then started reduction. Maximum ear/plant (1.45) were taken by plots that received 150 kg N ha^{-1}. Population density of 60000 ha^{-1} interacting with 150 Kg N ha^{-1} produced maximum of 2.10 ears/plant (Maheswarappa *et al.*, 1994).

Results deducted from various planting densities showed that biological yield (Table 7) increased with increasing planting densities. Maximum biological yield (11890.90 kg ha^{-1}) was recorded in plants population of 180000 plants ha^{-1} while minimum biological yield (10078 kg ha^{-1}) was recorded in plots with 60000 population of plants ha^{-1}. Highest biological yield (12291.1 kg ha^{-1}) was recorded for 200 kg N ha^{-1} while minimum 9777 kg ha^{-1} of biological yield was recorded in control plots. Maximum biological yield (12689.2 kg ha^{-1}) was recorded for plant population interacting with 200 kg N ha^{-1} (Novero *et al.*, 1992).

The response of grain yield to planting density (Table 8) was such that lower grain yield of 1498.3 kg ha^{-1} was obtained from lower plant density of 60000 plants ha^{-1} as well as dense population of 180000 plants ha^{-1} also gave lower grain yield of 1559.50 kg ha^{-1}. Grain yield increased up to medium plant density but decreased with further increase in planting density. Maximum grain yield of 1777.42 kg ha^{-1} was obtained at planting density of 120000 plants ha^{-1}. Nitrogen level of 150 kg N ha^{-1} resulted in the greatest grain yield (2006.95 kg ha^{-1}); grain yield reduced to 1983.95 kg ha^{-1} by increasing nitrogen from 150 to 200 kg ha^{-1}. Maximum grain yield ha^{-1} (2195.75) was for plant population of 120000 ha^{-1} interacting with nitrogen level of 150 kg ha^{-1}(Novero *et al.*, 1992; Stone *et al.*, 1998).

The result (Table 9) revealed that 1000-grains weight reduced with increase in plant population. Population of 60000 plants ha^{-1} gave heavier 1000-grains weight (125.97 g), while plants population of 180000 plants ha^{-1} gave lighter 1000-grain weight (118.83 g). Nitrogen level of 150 kg N ha^{-1} gave heavier 1000-grains weight of 132.73 g, while plants received no nitrogen gave lighter grain weight (108.29 g). Maximum 1000-grains weight (135.67 g) was recorded for plant population of 60000 ha^{-1} interacting with 150 Kg N ha^{-1} (Peter *et al.*, 1989). Summing up 120,000 plants population ha^{-1} interaction with 150 kg N ha^{-1} gave the maximum grain yield of 2195.75 kg ha^{-1}.

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