Effect of Preceding Winter Crops and Sugar Beet Residues on Maize Nitrogen Requirements

Ali I. Nawar
Crop Sci. Dept., Faculty of Agriculture, Alexandria University.

ABSTRACT

Response of maize to 90, 105 and 120 kg N/fed was examined after faba bean (F), wheat followed by manuring with sugar beet tops (B) and sugar beet (B_0) at Agricultural Research Station, Alexandria University during 2000/01 and 2001/02 seasons. F exceeded B_0 in plant height by 43.9 cm, ear leaf area by 67cm^2 and grain yield/fed by 5.1 ardab. Corresponding increases of B compared to B_0 were 17.2 cm, 12.0 cm^2 and 2.4 ardab for the three traits, respectively.

Nitrogen fertilizer level had significant effect on grain number/ear, ear grain weight, 100-grain weight and grain yield/fed. As an average of the two seasons, application of 120 kg N/fed gave 76.25 grains, 29.46 g, 4.20 and 5.02 ardab as corresponding increases in those traits, compared to 90 kg N/fed level, respectively.

Response of grain yield to N application up to 120 Kg N/fed was significant, and the increase in grain yield for every 1 kg N/fed increase was 0.17 ardab, as an average of the two seasons, as indicated by the linear regression of yield on N application.

Perfect and significant correlation coefficient (r = 1.0) was found when 100-grain weight was correlated to ear-leaf area and grain yield/fed. Correlation coefficients between grain yield and each of plant height, number of leaves/plant, ear leaf area, grain number/ear in addition to grain yield had r values that ranged from 0.70 to1.00, and from 0.80 to 1.00 during the two seasons, respectively.

The obtained data revealed the importance of sugar beet tops as green manure in decreasing the dependence on mineral nitrogen fertilizers and, hence, improving environment through decreasing soil pollution, in addition to decreasing hazards for human health.

Keywords: Maize, nitrogen, sugar beet residues, crop sequence.

INTRODUCTION

Increasing food production to abide with needs of human beings has been a surge of multiple cropping and land use intensification (Francis, 1986). Growing two crops in sequence in one year has been the most common multiple cropping practice (Narwal and Malik, 1989) and may be a subject of interest for yield increases. Benefits as a result of crop sequence were documented in many studies (Danso and Papastylianou, 1992; McCullough *et al* (1994) and Khalil *et al* (1999 and 2001). They all reported that differences in the root growth habit of crops grown in sequence led to the soil aeration correction, which in turn results in better use of underground soil resources at different depths leading to the production of greater yields.

The value of legumes as preceding crops comes from the contribution they make to the yield of following crops (Narwal and Malik, 1989) through the soil residual organic N and improvement of soil physical characters. Danso and Papastylianou (1992) pointed out that the beneficial effects of legumes, compared to non legumes, on the succeeding crops were due to the legume-N low uptake and N-carrying over from the legume residue to the subsequent non legume crop. Khalil *et al.* (1999 and 2001) indicated that sowing maize after faba bean surpassed its cultivation following fodder beet in plant height, ear leaf area, ear grain yield, 100-grain weight and grain yield/fed. Soil incorporation of sugar beet tops represents an organic N-source which contributes to and reduces the amount of applied inorganic N to the following crop (Abshahi *et al*, 1984 and Khalil, 2003). Nevertheless, there were less information regarding sugar beet tops benefits and use as green manure for the following crop. Draycott (1972) and Abshahi *et al* (1984) reported that the residual N from beet tops incorporation into the soil amounted to 19-62 kg/ha.

Nitrogen is an important nutrient for crop longivity; it is necessary for synthesis of biochemical constituents that provide yield producing processes (Sinclair and Horrie, 1989). McCullough *et al* (1994) and Uhart and Andrade (1995a) indicated that nitrogen had greater influences on the leaf expansion and leaf area duration which were reduced by soil N-deficiency. Restrict in light interception and conversion into assimilates, as a consequence of a lack of N supply, indirectly reduced ear dry matter and grain productivity per cultivated unit area through reductions in the number and weight of the kernel (Tollenaar *et al.*, 1992 and Uhart and Andrade, 1995b). In Egypt, Selim and El-Sergany (1995) indicated that increasing N rate up to 120 kg/fed increased 100-grain weight and grain weight/ear in addition to grain yield/fed. Furthermore, Lory *et al.* (1995) concluded that total- N uptake response to fertilizer N application in maize was dependent on the previous crops.

This investigation was conducted to study the response of maize growth, in addition to grain yield and its attributes, to the applied N levels after different winter crops.

MATERIALS AND METHODS

A field study was conducted during 2000/01 and 2001/02 seasons at Agriculture Research Station, Alexandria University. Soil properties of the experimental site were clay-shell type, pH = 8.2, total organic matter = 1.2%, available N, P and K values were 33.4, 10.2 and 608.3 ppm, respectively.

The preceding winter crops, i.e. wheat (cv. Giza 168), faba bean (cv. Giza 461, F) and sugar beet (introduced polygerm cv. Beta Poly, B_0) were sown on 10/11, 15/10 and 10/10 in 2000/01 season, and on 20/11, 1/11 and 15/10 in 2001/02 season respectively. Harvesting of winter crops was conducted on 10/5 and 15/5, 1/5 and 4/5, and 10/4 and 15/4 for the three respective crops in the two seasons respectively. Sugar beet tops were removed and stored in sealed black polyethylene bags for 30 days before incorporation in the soil of plots grown with wheat prior to maize sowing (B) Maize (cv Giza 310, 3-way cross) was sown on 15/5 and 20/5 in the two seasons, respectively

Previous work carried out by the authors (unpublished data) included storage of sugar beet tops for 0,1,2 and 3 months before incorporation into soil prepared for maize sowing. Their data indicated that storage for one month was adequate for complete decomposition of sugar beet tops.

The experimental design in both seasons was a split plot design with three replicates in which the preceding winter crops treatments occupied the main plots, whereas the subplots included three nitrogen fertilization levels of 90 (N1), 105 (N2) and 120 (N3) Kg N/fed (in the form of ammonium nitrate, 33.5%).

Each experimental unit comprised 5 ridges, each 3.0 m long and 0.7 m wide. Seeds were sown in hills spaced 30 cm apart and thinned to one plant/hill. The other cultural practices for winter crops and maize production in the region were applied according to recommendations.

Plant height, number of leaves/plant and ear leaf area were measured at physiological maturity on 10 random plants in each plot. At harvest, a sample of ten ears were randomly taken from each subplot to record the number of grains/ear and ear grain weight. One hundred-grain weight was calculated as the average of 3 samples from each subplot. Grain yield was obtained from the 3 inner rows in each plot and converted into ardab/fed.

Fertilization response curves were worked out for maize, using the equation: $\hat{Y} = a + bX + cX^2$, where $\hat{Y}$ is the expected grain yield (ardab/fed) for a given N rate, X= amount of applied nitrogen, a = the intercept of regression line, whereas, b and c are regression coefficients describing the linear and quadratic terms, respectively.

Statistical analysis was conducted according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

I- Effect of preceding winter crops treatments on maize growth and yield.

Analysis of variance (Table 1) indicated that the effect of preceding crop on plant height, ear leaf area and grain yield/fed was significant over the two successive seasons. Except for plant height and ear leaf area, the other studied traits responded significantly to N-fertilization levels over the two seasons. Interactions between preceding crop and N level were insignificant during the two seasons, indicating that the traits responded independently to the effect of the two studied variables.

Faba bean increased maize plant height to be 26.6 and 43.9 cm, as an average of the two seasons, greater than that of maize following sugar beet tops-soil incorporation in wheat plots or sugar beet, respectively (Table 2). Soil enrichment with nitrogen after faba bean may be responsible for increases in internode number and length, reflecting an ascending increase of plant height. Khalil *et al.* (1999 and 2001) revealed that plots of maize after faba bean gave plants of taller plant height compared to those after fodder beet.

Records for ear-leaf area of maize plants were found to be the largest after faba bean, and higher in wheat followed by manuring with sugar beet residues, relative to those after sugar beet over the two seasons. In maize following faba sequence, increases in that trait were 67.4 and 55.5 cm^2, compared to wheat followed by manuring with sugar beet residues and sugar beet, respectively, as an average of the two seasons. Legume N contribution to soil may have been associated with greater maize nitrogen uptake, thus increasing leaf cell in length and width dimensions, and hence, increasing total ear-leaf area (McCullough *et al*, 1994 and Uhart and Andrade, 1995 a).

Regarding grain yield, the highest response of maize crop was that after faba bean, while the lowest was following sugar beet in the two successive seasons. Reductions in yield potential for maize after sugar beet and soil - incorporated beet residues following wheat, compared to that after faba bean, as an average of the two seasons, were 2.2 and 4.8 ardab/fed, respectively. Faba bean increased soil-N level to increase yield and yield attributes of the following maize. These findings were in agreement with Narwal and Mallik (1989) and Danso and Papastylianou (1992). Abshahi *et al*, (1984) and Khalil (2003) reported that soil incorporation of beet tops provided the following non-legume crops with an amount of its required N.

II- Effect of N level on maize growth and yield.

Increasing N level over 90 kg/fed increased significantly the number of leaves/plant over the two seasons (Table 2). While number of leaves/plant of 120 kg N/fed was the greatest (19.5 leaves), the number of leaves of 105 kg N/fed plants was 1.2 leaves greater, as an average of the two seasons, compared to the lowest N rate. These results were in accordance with Uhart and Andrade (1995a) who reported that increasing N supply increased leaf primordia initiation leading to the increase of leaves number/plant.

Data in Table (2) further indicated that increasing N fertilization level increased both number of grains/ear and ear grain weight. Increases in number of grains/ear at 120 and 105 compared to 90 kg N /fed were, respectively, 126.3 and 71.3 grain in the first season, and 178.6 and 114.7 grain in the second season. The respective increases in ear grain weight were 25.56 and 11.11 g in the first season, and 33.34 and 18.34 g in the second season. Reductions in number of leaves/plant ear leaf area, and consequently photosynthetic rate, at lowest N level, were responsible for lack in assimilates partitioning into the ear and hence spikelet fertility and grain set and weight of the ear (Jacobs and Pearson, 1991, Connor *et al*, 1993 and Uhart and Andrade, 1995b).

Furthermore, data in (Table 2) revealed that 100-grain weight was lowest, intermediate and highest as 90, 105 or 120 kg N/fed were applied, respectively, in the two successive seasons. Increases in that trait with 105 or 120 compared to 90 kg N/fed application were 2.3 and 4.5 g in 2000/01 season, and 2.0 and 3.9 g in 2001/02 season. As reported by Tollenaar *et al* (1992), increases in grain weight was attributed to an excessive translocation of assimilates to the grain. Data were also in accordance to those reported by Selim and El-Sergany (1995).

The effect of nitrogen on grain yield is presented in Table (2). There was an increase in yield with the increase of nitrogen added to the soil. The average increases in such trait, over the two seasons, due to 105 and 120 compared to 90 kg N/fed, were 3.50 and 5.0 ardab, respectively. Nitrogen increased the amount of metabolites synthesized by plants and thus resulted in an increase of yield attributes to grain yield/fed. These results were in accordance with Selim and El-Sergany (1995) who found that application of N up to 120 kg/fed increased grain yield in maize.

The analysis of variance (Table 1) indicated that the response of grain yield and yield components of maize to N levels was linear in both seasons. The regression coefficient (b) values for regression equations of number of grains/ear, ear grain weight, 100-grain weight and grain yield/fed were 0.24 and 0.17, 0.85 and 0.90, 0.15 and 0.16, and 0.16 and 0.18 in the two seasons, respectively. The corresponding R^2 values, in the two seasons, were 0.995 and 0.973, 0.852 and 0.899, 1.0 and 1.0, and 0.947 and 0.998, respectively. These findings indicated that variations in grain yield and yield components in maize were almost totally explained by variation in N level, as revealed by the high R^2 values. The linear response indicated that these traits increased progressively up to 120 kg N/fed, and higher levels of N may also be beneficial since the quadratic response was insignificant in both seasons.

Correlation coefficients (Table 3) for grain yield with all the studied characters, except plant height, were significant and positive over the two seasons. In addition, perfect correlation coefficient (1.00) between 100-grain weight and grain yield indicated that 100-kernel weight was the most important yield attribute affecting grain yield.

In conclusion, the results from this investigation encourage the use of sugar beet tops as green manure for maize to supply a measurable amount of maize N requirements. Such practice may decrease environmental pollution resulting from excessive mineral N residues accumulation and leaching, in addition to improving soil properties and fertility.

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Table 1. Mean squares for maize traits as affected by preceding crop, N levels and their interaction in 2000/01 and 2001/02 seasons.

S.O.V	d.f	Plant height		Number of leaves/plant		Ear leaf area		Number of grains/ ear		Ear grain weight		100-grain weight		Grain yield/ fed	
		2000/01	2001/02	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02
Preceding crop (P)	2	*	*	n.s.	n.s.	*	*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	*	*
Error (a)	4	39.66	37.31	0.31	0.51	714.45	95.37	16868	14755	93.05	109.72	3.49	30.02	0.14	1.17
Nitrogen levels (N)	2	n.s.	n.s.	*	*	n.s.	n.s.	*	*	*	*	*	*	*	*
Linear (L_N)	1	-	-	*	*	-	-	*	*	*	*	*	*	*	*
Quadratic (Q_N)	1	-	-	n.s.	n.s.	-	-	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
P x N	4	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Error (b)	12	52.04	129.9	0.38	0.20	283.9	831.0	1749.8	896.7	46.30	57.41	2.49	3.03	0.91	0.59

*** Significantly different at 0.05 probability level.** **n.s. not significant at 0.05 probability level.**

Table 2. Mean of studied characters as affected by preceding crop and N level in 2000/01 and 2001/02 seasons.

Treatments	Plant height (cm)		Number of leaves/plant		Ear leaf area (cm^2)		Number of grains/ ear		Ear grain weight (g)		100-grain weight (g)		Grain yield/ fed (ardab)	
	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02
Preceding crop:														
Faba bean (F)	288.56	294.44	18.20	18.16	749.11	702.78	471.56	537.22	156.11	179.44	29.22	29.28	22.24	22.92
Wheat + sugar beet tops (B)	267.67	262.11	18.09	17.80	702.78	638.33	467.89	532.78	155.00	178.89	29.00	28.56	19.64	20.13
Sugar beet (B_0)	239.67	255.56	17.91	17.71	677.78	639.44	471.89	539.78	156.11	180.56	28.94	28.40	16.94	18.08
L.S.D. 0.05	**8.24**	**8.00**	-	-	**35.00**	**13.00**	-	-	-	-	-	-	**0.49**	**1.42**
Nitrogen levels														
90 kg/fed N_1	264.22	270.78	16.76	16.44	715.33	657.22	404.56	438.78	163.33	137.22	26.80	26.77	16.88	17.95
105 kg/fed N_2	265.11	271.33	17.82	17.84	711.00	654.44	475.89	553.54	174.44	155.56	29.11	28.78	20.26	20.35
120 kg/fed N_3	266.56	272.00	19.62	19.38	713.33	668.89	530.89	617.44	188.89	170.56	31.26	30.69	21.68	23.19
L.S.D. 0.05	-	-	**0.61**	**0.44**	-	-	**41.40**	**29.70**	**7.5**	**6.70**	**1.56**	**1.72**	**0.94**	**0.76**

Table 3. Correlation coefficients between studied characters during 2000/01 and 2001/02 seasons.

Treatments	Grain yield /fed		100-grain weight		Ear grain weight		Number of grains/ear		Ear leaf Area		Number of leaves/plant	
	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02	2000/01	2001/02
100-grain weight	1.00*	1.00*										
Ear grain weight	0.965*	0.980*	0.85*	0.81*								
No. of grains/ear	0.886*	0.884*	0.77*	0.83*	0.835*	0.865*						
Ear leaf area	0.940*	0.920*	1.00*	1.00*	0.780*	0.810*	0.765*	0.795*				
Number of leaves/plant	0.71*	0.79*	0.68*	0.74*	0.330$^{n.s}$	0.230$^{n.s}$	0.280$^{n.s}$	0.310$^{n.s}$	0.218$^{n.s}$	0.300$^{n.s}$		
Plant height	0.29$^{n.s}$	0.22$^{n.s}$	0.22$^{n.s}$	0.26$^{n.s}$	0.190$^{n.s}$	0.238$^{n.s}$	0.217$^{n.s}$	0.236$^{n.s}$	0.255$^{n.s}$	0.210$^{n.s}$	0.735*	0.710*

*** Significantly different at 0.05 probability level.** **n.s. = not significant at 0.05 probability level.**

الملخص العربى

تأثير المحصول الشتوى السابق ومتخلفات بنجر العلف على احتياجات الذرة من النيتروجين

على عيسى ناجى نوار

قسم المحاصيل - كلية الزراعة - جامعة الاسكندرية٠

تمت دراسة استجابة الذرة الشامية لثلاث مستويات من التسميد النيتروجينى (٩٠ ، ١٠٥ ، ١٢٠ كجم نيتروجين/فدان) المنزرع بعد الفول البلدى (F) ، القمح + بقايا خضرية متحللة لبنجر السكر (B) وبنجر السكر (B_0) بمزرعة محطة التجارب الزراعية بكلية الزراعة - جامعة الإسكندرية وذلك من خلال الموسم الصيفى لعامى ٢٠٠٠ ، ٢٠٠١ ٠

ويمكن إيجاز أهم النتائج المتحصل عليها كما يلى :-

١- كانت هناك زيادة فى طول النبات ومساحة ورقة الكوز ومحصول الحبوب/فدان بما يساوى ٤٣,٩ سم ، ٦٧,٤ سم٢ ، ٥,١ أردب على التوالى بعد الفول البلدى بينما كانت قيم الزيادة المقابلة بعد القمح + البقايا الخضراء المتحللة لبنجر السكر هى ١٧,٢ سم ، ١٧,٢ سم٢ ، ٢,٤ أردب على التوالى وذلك بالمقارنة بتلك الصفات لنباتات الذرة المنزرع بعد بنجر السكر٠

٢- أدت زيادة مستوى النيتروجين حتى ١٢٠ كجم/فدان الى الزيادة المعنوية فى عدد حبوب الكوز (٦,٢٥ حبة) ، ووزن حبوب الكوز (٢٩,٤٦) ، ووزن ١٠٠ حبة (٤,٠٢ جرام) ومحصول الحبوب/ فدان (٥,٠٢ أردب) وذلك بالمقارنة بالمستوى ٩٠ كجم نيتروجين/فدان كمتوسط للموسمين.

٣- كانت استجابة محصول الحبوب بالفدان فى الذرة الشامية للتسميد النيتروجينى استجابة خطية

I- حيث أدى زيادة معدل النيتروجين بمقدار وحدة واحدة (١ كجم/فدان) الى زيادة إنتاجية الفدان بمقدار ٠,١٧ أردب (كمتوسط للموسمين)٠

II- أظهرت معاملات التلازم وجود علاقة تلازم تامة موجبة ومعنوية (+١) بين وزن ١٠٠ حبة وكل من مساحة ورقة الكوز ومحصول الحبوب بالفدان٠ كما انحصرت قيم معاملات التلازم بين محصول الحبوب للنبات وكل من ارتفاع النبات ، عدد الاوراق /للنبات ، مساحة ورقة الكوز، عدد حبوب الكوز بجانب محصول الحبوب للفدان فى المدى ٠,٧ - ١ و ٠,٨- ١ خلال الموسمين على التوالى٠

٤- أكدت البيانات التى تم التوصل اليها ان التسميد الحيوى من خلال خلط الأرض بعروش بنجر السكر المتحللة أدى الى تقليل الاعتماد على الأسمدة النيتروجينية ، ويفيد ذلك فى تحسين البيئة عن طريق تقليل التلوث وحماية صحة الإنسان من مخاطرها٠