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STUDY THE CORRELATION, REGRESSION AND PATH COEFFICIENT ANALYSIS IN SWEET CORN (*Zea mays* var. saccharata) UNDER DIFFERENT LEVELS OF PLANT DENSITY AND NITROGEN RATE

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ABSTRACT

In order to evaluate the effect of plant density and nitrogen rates on ear yield of sweet corn (*Zea mays* var. saccharata) cultivar KSC. 403, an experiment was conducted at research field of Tarbiat Modares University on summer 2008. The experiment was carried out in a split plot design based on randomized complete blocks with four replications. In this research plant density (60000, 80000 and 100000 plant/ha) and nitrogen rate (120, 180, 240 and 300 kg N/ha) were arranged in main plots and sub plots respectively. Seeds were sown on these plots on July 3rd and were harvested at soft dough stage on September 24th. Sweet corn yield components including ear number.m^{-2}, row number.ear^{-1}, grain number per row, 1000 grain weight and grain yield.m^{-2} were measured. Some morphological traits like as plant height, leaf area, ear length and diameter have also investigated. Correlation, regression and path coefficient analysis were used to better understanding the direct and indirect effects of plant density and nitrogen rate on sweet corn ear yield and yield components. The results revealed that the grain yield was affected by plant density but it was not affected significantly by different levels of nitrogen rate. However by increment of plant density, the ear number.m^{-2} and grain yield were increased in expense of ear weight. The higher ear length and ear number was obtained in the lowest plant density and nitrogen rate (D_1N_1). Highly significant and positive correlation was observed between grain yield with ear number, 1000grain weight and grain number per ear. In this respect D_3N_1 treatment (100000 plant.ha^{-1} and 120 kg N.ha^{-1}) which produced more ears and grain yield are recommended for the sandy soil as superior treatment, in studied area. The results of regression analysis by stepwise method for grain yield showed that grain number and 1000 grain weight made 98 percent of the grain yield variation. It is concluded that sweet corn grain yield can be improved by increment of grain number per m^2 and 1000 grain weight through increasing of plant density.

Keywords: sweet corn, plant density, nitrogen, correlation, regression, path coefficient analysis.

INTRODUCTION

Sweet corn (*Zea mays* var. saccarata) is extensively grown in temperate, subtropical and tropical regions. This new crop differs from field corn as a result of mutant genes affecting the endosperm. The mutations alter the starch synthesis pathway resulting in kernels with endosperm higher in sugar or phytoglycogen and lower in starch (Tracy, 2001).

Reduced starch content is one of the reasons for decreased germination, emergence, seedling vigor, and uneven stands in commercial sweet corn as compared with field corn (Tracy, 2001). Fresh sweet corn is also perishable a result of rapid decrease of sugar content, kernel desiccation, husk discoloration, and risk of pathogen infestation (Rodov *et al*., 2000).

To make available high yield is one of the most important target for most sweet corn growers. As known, grain yield is a complex character that can be determined by several components which reflect positive or negative effects upon these traits meanwhile, it is important to examine the contribution of each of the various components in order to attract the attention to which one has the greatest influence on grain yield (Öser *et al.*, 1999).

In many parts of Iran, after harvesting of winter cereal crop (wheat and barley) and rapeseed at the end of spring season to the next planting in autumn there is a time gap as 80-90 days. Being a short duration summer cereal crop, sweet corn has attained top priority for planting in this period. Since sweet corn planting and its investigations in Iran are very scarce evaluating its response to plant density and N rates would be a necessary field research topic.

It was reported that the grain yield and dry matter accumulation in corn would be decreased by increasing plant density (Duncan, 1985). Some researchers indicated that increasing the plant density has partly increased the grain yield and then it remained steady. At very high plant density, because of high intra-specific competitions and resources limitations such as water, light, mineral nutrients the grain yield was decreased (Scarbrook and doss, 1993; Termunde and Driks, 1993). According to the results of Early (1986) increasing plant density, will decrease singular plant yield because of the reduction of solar radiation in the lower part of the canopy. Corn response to plant density may be appeared through changing in weight and number of different grain yield components.

Nitrogen is one of the most important nutrients that its optimum amount in the soil is very essential for plants growth such as sweet corn (Khajehpour, 1999). Commercial N fertilizers are a cost-effective means of supplementing soil N for plant growth and are necessary for sustaining high crop yields. However, it has been documented that improper or excessive use of N fertilizer can lead to nitrate pollution of ground or surface water (Khajehpour, 1999). Tsai *et al.* (1984) reported that increasing the nitrogen fertilizer from 0 to 200 kg/ha, have had significantly effect on increasing ear and 1000 grain weight.

Some earlier researchers reported that grain yield per plant was positively and significantly correlated with plant height, cob length, leaf area, number of rows, grain number per cob and 1000 grain weight (Devi *et al*., 2001; Kramer, and Boyer., 1995; Mohsan *et al*., 2002; Parth *et al*., 1988; Sharma, R.K and Viola., 2003; Yousef, and Saleem.2001). Number of rows, grain per cob and 1000 grain weight showed positive direct effect on grain yield (Devi *et al*., 2001; Mohsan *et al*., 2002; Viola *et al*., 2003). Usefulness of the information obtained from the correlations coefficient can be enhanced by partitioning in to direct and indirect effects for a set of a pair cause-effect inter relationships (Kang *et al*., 1983).

The path coefficient analysis has been used successfully to clarify interrelation between yield and several other characteristics for many crops such as maize (Kinaci, and Kinaci, 2001), soybeans (Jiang, and Guan, 1988; Pandey and Torrie, 1973), field bean (Labana *et al*., 1980) and rapeseed (Ozer *et al*., 1999). Path analysis provides a measure of relative importance of each independent variable to prediction of changes in the dependent one. The prepare use of the method requires that cause and effect exist between the variables and that the researcher assign direction in the casual system, either a prior or based on experimental evidence (Steel, and Torrie, 1982). In present study, correlation, regression and path coefficient analysis made to observe the effect of yield contributing characters on yield under different levels of plant density and nitrogen rate.

MATERIALS AND METHODS

A field experiment was conducted at research field of Tarbiat Modares university (Latitude: 35° 43' N., Longitude: 51° 8' E., and 1215 meters above sea level) on summer 2008, to study the effect of plant density and nitrogen rate on yield and yield components of sweet corn (*Zea mays* var. saccarata) cultivar KSC. 403. In this research several statistical analysis were used in order to show the presence or absent correlations among different dependent variables in sweet corn. At the first variance analysis was applied to determine the effect of different of plant densities and nitrogen rates on yield and yield components, then the correlation analysis, regression and path analysis were investigated.

Experimental treatments were arranged in split plot design based on randomized complete blocks with four replications. The soil texture of the experimental site was sandy loam and pH value of 7.4, organic gradients of 1.48. Each plot consisted of 6 rows of 8 meters length 50 cm apart. In this research plant density (60000, 80000 and 100000 plant.ha^{-1}) and nitrogen rate (120, 180, 240 and 300 kg N.ha^{-1}) were arranged in main plots and sub plots, respectively. According to the agricultural calendar and sweet corn planting in double cropping systems, seeds were sown on July 3rd and were harvested at soft dough stage on September 24th. To adjust the 100000, 80000 and 60000 plant ha^{-1}, seeds were planted on the rows spaced 20, 25 and 33 cm, respectively.

The experimental area was fertilized at a rate of 300 kg/ha with triples super phosphate at soil preparation time. Also urea fertilizer was applied by the banding placement at three separated stages, 1-2, 5-6, and 8-9 leaf growing stage. After the emergence for assuring proper plant density, the plants were thinned out at the stage of 2-3 leaf. The physical situation and sandy loam texture of the soil forced us to decrease the irrigation interval and decrease amount of water per irrigation. A destructive sampling was done in economic harvest stage (soft dough stage) to get information about yield and yield components including, ear number per m^2, grain row number per ear, grain number per row, grain number per m^2, 1000 grain weight , plant height, leaf area, ear length, ear diameter, cob diameter and grain yield.

When the soft dough stage was occurred, after removing 2 border lines from each plot, the available plants in 6m^2 (3 meters length from each 4 middle rows of plots) were harvested for evaluate yield and yield components.

After measuring these characters, the data were entered to excel and analyzed by the SAS software. The simple correlation coefficients between all possible combinations of variable worked out by Pearson Correlation analysis method to determine relation between traits especially such those which were related to yield. Regression analysis was done by stepwise method. Based on result the path- coefficient technique was performed to recognize direct and indirect effects of traits which were related to yield.

RESULTS AND DISCUSSIONS

Variance analysis

According to the results of variance analysis D_1N_1 treatment (the lowest plant density and nitrogen rate) produced the most row number per ear. Evaluation of ear diameter confirmed this point. the results in this experiment was in conflict with the results of other researchers such as Sadeghi and Bahrani (2002), Ghasemi pirbalouti, (2002) and Reddy (1987), who indicated that applying more nitrogen rate in sweet corn, some characters as ear length and grain row number per ear were increased. Mokhtarpour (2002) reported that there was positive relation between nitrogen rate and traits such as ear length and its priority for cane industry. By rationalization these results it mostly can be said that the lack of nitrogen effect on mentioned traits was related to leaching of the nitrogen fertilizer due to the low irrigation interval in sandy loam soil of the experimental site.

Correlation analysis

The results of the correlation coefficient among the studied traits are shown in Table-2. Highly significant and positive correlation was observed between grain yield with ear number, 1000 grain weight and grain number per ear. Also basically the same results were observed for correlation between ear numbers.m^{-2} with grain number per ear, but on the contrary the relationship between ear numbers.m^{-2} with grain number per ear was highly significant and negative. These finding seems logic because our field data showed that increasing the plant density increased the ear numbers and decreased the 1000 grain weight. These results are in harmony with those obtained by Sadek *et al*., (2004). Indeed highly significant and positive correlation between row number per ear with grain number per ear and ear diameter was noted. These results are in agreement with those of other researchers (Devi, 2001; Kramer and Boyer. 1995; Mohsan, 2002). Furthermore we noted that there was highly significant and positive correlation between grain number per row with grain number per ear, ear length and ear diameter. These results are in line with some other researchers (Parth, 1988; Sharma, and Viola, 2003; Yousef and Saleem.2001). There was highly significant and positive correlation between grain numbers per ear with ear length and ear diameter. This result seems true because when ear length and ear diameter increased, the grain number per ear would be increased.

Regression analysis

The results of regression analysis by stepwise method for grain yield (Table-3) indicated that grain number.m^{-2} can justify 73 percent of the grain yield variation. So this trait is the most important component of grain yield in sweet corn. Grain number and 1000 grain weight as two components of sweet corn made 98 percent of the grain yield variation. Presence of high significant and positive correlation, between grain number and 1000 grain weight with grain yield shows that the results of stepwise regression are in harmony with correlation results. Furthermore these results are in line with some earlier findings (Devi, 2001; Mohsan, 2002).

Path coefficient analysis

After getting information from the results of regression and correlation analysis, the path coefficient analysis was done to determine direct and indirect effects of traits on grain yield. Results (Table-4 and Figure1) indicated that 1000 grain weight and grain number.m^{-2} had the highest direct effect on grain yield. High correlation between these two traits with grain yield has emphasized on this result. Furthermore their indirect effects via other traits were scarcely. These results are agreed with some researcher as Devi *et al*., (2001); Mohsan *et al*., (2002) and Viola *et al.*, (2003).

Although grain number per ear doesn't have high correlation with grain yield but it has a direct and positive effect on grain yield. Ear number.m^{-2} had a high positive correlation with grain yield but its direct effect on increment of grain yield was scarce, however its positive effect on improving the yield was indirect through the increment of grain number per m^2. Furthermore the grain number per row doesn't have significant correlation with grain yield. But this trait increased grain yield through improving the grain number per.

CONCLUSIONS

It is concluded that sweet corn grain yield can be improved by increment of grain number per m^2 and 1000 grain weight. These results are in line with some earlier findings (Devi *et al*., 2001; Mohsan *et al*., 2002). These characters were affected by the plant density, however different nitrogen rates did not affect the grain yield, so by hence nitrogen rate have not significant effect on grain yield we can choose the minimum amount of nitrogen among the nitrogen rates based on making lowest pollution on the soils. In the other hand highest amount of plant density produced more grain yield. So it can be considered that the highest plant density and lowest nitrogen rate (D_3N_1) were the superior treatment. Therefore increasing sweet corn plant density in sandy loam soils (up to 100000 plant. ha^{-1}) to get the improved grain yield is recommended. Our main discuss for no significant effect of different levels of nitrogen on grain yield has been attributed to nitrogen leaching in sandy loam soils. So in order to do the similar research, it is recommended that irrigation interval or strict measures should be decreased taken to have a good estimation on nitrogen leaching

REFERENCES

Devi I. S., Muhammad S. and Mohammad S. 2001. Character association and path coefficient analysis of grain yield and yield components in double cross of maize (*Zea mays* L.). Crop Res. Hisar. 21(3): 335-359.

Duncan W. G. 1985. The relationships between corn populations and yield. Agron. J. 50: 82-84.

Early E. B., Miller R. J. and Seif R. D. 1986. Effects of shade on maize production under field conditions, Corp Science. 6: 1-8.

Ghasemi pirbalouti A., Akbari G. H., Nasiri Mahalati M. and Sadeghi H. 2002. Evaluation the effect of different rates of Nitrogen on dry matter accumulation and corn growth traits. The 7th Iranian Crop Sciences Congress, Karaj- Iran. Aug. pp. 24-26.

Jiang W.W. and Guan C. X. 1988. Study on relationship between plant height and yield components of a rape inter specific hybrid. Oil Crops of China. 3: 46-50.

Kang M. S., Miller J. D. and Tai P. P. 1983. Genetic and phenotypic path analyses and heritability in sugarcane, Crop Sci. 23: 643-647.

Khajeh Pour M. 1999. Principle of Agronomy. Esfahan University publications.

Kinaci G. and Kinaci E. 2001. Study on relationship between ear weight and some other ear characters in cold tolerant maize populations by path analysis method. University of Ankara, J. of Sci. and Tech. 2(2): 339-344.

Kramer P. J. and Boyer J. S. 1995. Water relations of Plant and Soils. Academic Press, San Deigo.

Labana K. S., Chaurasia B. D.and Singh B. 1980. Genetic variability and inter- character associations in the mutants of Indian mustard. Indian J. Agri. Sci. 50: 803-806.

Mohsan Y. C., Singh D. K. and Rao N.V. 2002. Path coefficient analysis for oil and grain yield in maize (*Zea mays* L.) genotypes. Nat. J. Pl. lmpr. 4(1): 75-77.

Mokhtarpour H. 2002. The effect of sowing date and plant density on ear yield and some agronomical traits of sweet corn. The 7th Iranian Crop Sciences Congress, Karaj- Iran, Aug. pp. 24-26.

Özer H., Oral E. and Doðru Ü. 1999. Relationships between yield and yield components on currently improved spring rapeseed cultivars. Tur. J. of Agriculture and Forestry. 23: 603-607.

Pandey R.P. and Terrie J. H. 1973. Path coefficient analysis of seed yield components in soybean (*Glycin max* L.). Crop Sci. 13: 505-507.

Parth D. K., Hamid M. A., Rahman M. H. and Talukard M. Z. 1988. Correlation, path oefficient and selection indices in open- pollinated.maize. Bangladesh J. Agric. 15(1): 69-74.

Reddy B. B. 1987. Effect of plant population on the performance of maize hybrid at different fertility levels in a semi-arid environment. Index Journal of Agricultural Sciences. 57(10): 705-709.

Rodov A.C., Aharoni N., Aharoni Y., Wiseblum A., Horev B. and Vinokur Y. 2000. Nested modified-atmosphere packages maintain quality of trimmed sweet corn during cold storage and the shelf life period. Post harvest Biol. Technol. 18: 259-266.

Sadeghi H. and Bahrani M. 2002. The relations of physiological traits to corn yield under plant density and nitrogen rates, The 7th Iranian Crop Sciences Congress, Karaj- Iran. Aug. pp. 24-26.

Sadek S. E., Ahmed M. A. and Abd EL-Gahaney H. M. 2006. Correlation and Path Coefficient Analysis in five patterns Lines and Their Six White Maize (*Zea mays* L.) Single crosses Developed and Grown in Egypt. Journal of Applied Sciences Research. 2(3): 159-167.

Scarbrook G. E. and Doss B. D. 1993. Leaf area index and radiation as related to corn yield. Agronomy Journal. 65: 459-461.

Sharma R.K. and Kumar S. 1987. Association analysis for grain yield and some quantitative traits in popcorn. Crop Imp. 14(2): 201-204 [Pl. Br. Absts. 58(10): 8369; 1988].

Steel R. G. D. And Torrie J. H. 1982. Principles and Procedures of Statistics: A Biometrical Approach. 2nd Ed. McGraw-Hill Int. Book Co., Tokyo, Japan.

Tracy W. F. 2001. Sweet corn. In: A.R. Hallauer (Ed.). Specialty corns. 2nd ed. CRC Press, Boca Raton, Fla. University of Florida. 2006. Florida automated weather network; report generator. 21 Dec. 2006. <http://fawn.ifas.ufl.edu/scripts/reportrequest.asp>. pp. 155-197.

Tsai C. Y., Huber D. M., Glover D. V. and Warren H. L. 1984. Relationship of N deposition to grain yield and N response of three maize hybrids. Crop Sci. 24: 277-281.

Viola G. M.,Ganesh S., Reddy S. and Kumar C.V.S. 2003. Studies on correlation and path coefficient analysis of elite baby corn (*Zea mays* L.). Indian Prog. Agri. 3(1-2): 22-25.

Table 1. Variance analysis of different traits of sweet corn affected by plant density and nitrogen rate.

Source	Degrees of freedom	Mean squares											
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Replication	3	1.028016	2.083	13.283	0.0937	30.66	10229.118	1.054387	0.001296	2319.741	1.03992	11.484	1.122018
Density (A)	2	2.259436**	25.49**	14.05	4.933	148.43**	56917.353	1.336596	0.000961	313.911	1.086426	2.75	1.713957
Error $_a$	6	1.018591	11.88	3.96	1.045	84.056	23535.271	1.083927	0.000121	104.564	1.04472	11.76	1.158777
Nitrogen (B)	3	1.009253	5.9	1.33	2.784	13.608	8181.705	1.025652	0.000169	167.436	1.258925	7.585	1.009253
AB	6	1.016249	3.17	9.182	1.225	11.64	4725.401	1.018591	0.001089	137.675	1.099006	19.214	1.069055
Error	27	1.020939	5.7	5.57	2.055	15.277	5329.966	1.035142	0.000196	114.873	1.145513	8.723	1.049542

(1): Grain yield, (2): Ear number.m^{-2},(3): Row number/ear, (4): Grain number/row, (5): Grain number/ear, (6): Grain number.m^{-2} ,(7): 1000 grain weight, (8): Plant height, (9): Leaf area, (10): Ear length ,(11): Ear diameter and (12): Cob diameter, ** significant at 1% of probability level.

Table 2. Correlation coefficients among different traits in sweet corn affected by plant density and nitrogen rate.

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000											
2	0.749**	1.000										
3	-0.065	-0.275	1.000									
4	0.147	-0.354	0.289	1.000								
5	0.086	-0.407**	0.591**	0.939**	1.000							
6	0.855**	0.765**	0.128	0.254	0.240	1.000						
7	0.634**	0.329*	-0.352*	-0.134	-0.236	0.168	1.000					
8	0.118	0.135	-0.086	-0.069	-0.085	0.049	0.12613	1.000				
9	0.029	0.020	0.054	0.023	0.034	0.061	-0.010	0.159	1.000			
10	0.139	-0.329*	0.113	0.779**	0.691**	0.1151	0.059	-0.107	0.051	1.000		
11	0.106	-0.356*	0.489**	0.521**	0.616**	0.068	0.055	-0.066	0.037	0.308*	1.000	
12	-0.058	-0.189	0.058	0.143	0.130	-0.101	-0.015	-0.325*	0.018	0.264	0.164	1.000

(1): Grain yield, (2): Ear number.m^{-2}, (3): Row number/ear, (4): Grain number/row, (5): Grain number/ear, (6): Grain number.m^{-2}, (7): 1000 grain weight, (8): Plant height, (9): Leaf area, (10): Ear Length, (11): Ear diameter and (12): Cob diameter.
*and ** significant at 5% and 1% of probability levels, respectively.

Table 3. Results of stepwise regression method for determination of relative proportion of yield components.

Independent variable	intercept	Regression coefficient b_1	b_2	Accumulative partial R-Square
Grain number per square meter	-553.8^{ns}	1.6**		0.73
1000 grain weight	-6798.6**	1.4**	4819..9**	0.98

** Significant at 1% of probability levels, ^{ns}: non significant

Table 4. Path coefficient values estimated for some yield components of sweet corn.

Grain yield							
Characters	**Direct effect**	(1)	(2)	(3)	(4)	(5)	**Correlation coefficient**
(1)	0.18	---	0.10	-0.18	0.47	0.16	0.75**
(2)	-0.29	-0.06	---	0.42	0.15	-0.06	0.15
(3)	0.45	-0.08	-0.27	---	0.15	-0. 12	0.09
(4)	0.61	0.14	-0.07	0.11	---	0.08	0.86**
(5)	0.49	0.06	-0.04	-0.11	0.10	---	0.63**

(1): Ear number.m^{-2}, (2): Grain number/ row, (3): Grain number/ ear, (4): Grain number .m^{-2}, (5): 1000 grain weight; ** Significant at 1% of probability levels.

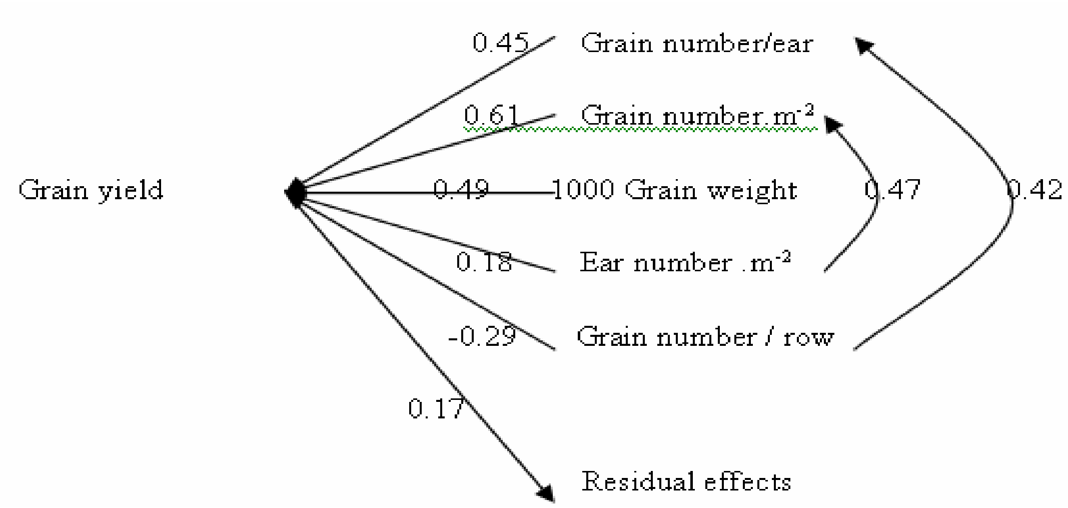

Figure 1. Path coefficient values estimated for some yield components of sweet corn