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Evaluation Correlation between Traits and Stepwise Regression of Corn Affected Different Level of Chemical and Biological Fertilizer under Warm and Dry Climate Conditions

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ABSTRACT

BACKGROUND: The combined use of chemical and biological fertilizers is recommended due to the reduction in the cost of chemical inputs, alignment with sustainable agriculture goals, and prevention of environmental pollution.

OBJECTIVES: Current study was done to assess the effect of Fertilizer and biological fertilizer on grain yield, its components and morphological traits of Corn.

METHODS: This research was done via split plot experiment based on randomized complete blocks design during 2016 with three replications. The main factor included chemical fertilizers and manure (C_1: 100%, C_2: 50%, C_3: 25% NPK according recommended consumption amount and C_4: Animal manure [Cow manure]). The sub factor consisted three types of biological fertilizer (B_1: Control [none inoculation], B_2: Seed inoculation with a mixture of biological fertilizers such as Peta Barvar2, Phosphate Barvar2 and Azotobacter Barvar2, B_3: Seed inoculation with a mixture of biological fertilizers such as Peta Barvar2, Phosphate Barvar2 and Azotobacter Barvar2 and *Aspergillus niger*).

RESULT: According result of analysis of variance effect of different level of chemical fertilizers and manure (instead number of leaf up of ear, 1000-grain weight and harvest index), biological fertilizer (instead number of leaf up of ear, leaf area index and biological yield) on all measured traits was significant but interaction effect of treatments (instead cob diameter) on all measured traits was not significant. The traits of biological yield (0.85^{**}), number of grain per row (0.84^{**}), number of grain per ear (0.78^{**}), 1000-grain weight (0.83^{**}) and ear length (0.72^{**}), ear diameter (0.70^{**}), cob diameter (0.69^{**}), number of active leaf per plant (0.68^{**}) and leaf area index (0.68^{**}) had significant correlation with grain yield at 1% probability level, also harvest index (0.52^{*}) and dry matter (0.51^{*}) had significant correlation with grain yield at 5% probability level.

CONCLUSION: According results of stepwise regression, traits of number of grains per row, leaf area index, and ear diameter were identified as the most effective traits determining grain yield. Corn grain yield changed with decrease or increase in these traits due to changes in the amount of chemical fertilizer, Cow manure and biofertilizer application.

KEYWORDS: *Aspergillus, Azotobacter, Cow manure, Maize, Phosphate.*

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1. BACKGROUND

Seed yield, as the most important quantitative characteristic, will be a result of genotype, environment and genotype-environment interaction effects (Marjanovic-Jeromela *et al*., 2009). Multivariate analyses are useful for characterization, evaluation and classification of plant genetic resources when a number of accessions are to be assessed for several characters of agronomic, morphological and physiological importance. Different types of multivariate analysis such as regression analysis, path analysis, principal component analysis can be used to identify groups of genotypes that have beneficial traits for breeding and instructing the patterns of variation in genotype accession, to recognize relationships among accessions and possible gaps. Correlation coefficients describe the mutual relationships between different pairs of characters without providing the nature of cause and effect relationship of each character (Sharifi *et al*., 2020). Correlation coefficient, which is used as a standard of measuring linear relationship between two variables, only has one mathematical interpretation, and does not refer to cause and effect relationships (Abozary Gasaforodi, 2002). In this method, Correlation coefficient which exists between two traits is divided in to components which measure direct and indirect effects. Making use of this method requires the knowledge about cause and effect relations which exist between traits, and assuredly must determine the direction of causes according to previous information and experimental evidences (Garcia del Moral *et al*., 1999). Correlation analysis describes the mutual relationship between different pairs of characters without providing the nature of cause and effect relationship of each character. Significant positive correlations were detected between faba bean seed yield and each of number of pods per plant, number of seeds per plant, seed weight per plant and biological yield (Alghamd, 2007). Understanding of interrelationship between component characters helps in determining which character to select when improvement of the related complex character is desired. The correlation coefficient measures the mutual relationship between various plant characters and determines the component characters on which selection can be based for the improvement in associated complex character yield (Sokoto *et al*., 2012; Mohammadi *et al*., 2012). Seed yield is a quantitative trait, which expression is the result of genotype, environmental effect and genotype-environment interaction (Gunasekera *et al*., 2006). Sadat Mohajerani *et al* (2018) by study the effect of irrigation regime and biological fertilizer on seed yield, its components and correlation between traits of Red Bean confirm the relationship between photosynthesis efficiency and seed yield, because seed yield increases when plants can have higher photosynthetic material accumulation. Also, there was a significant correlation between the number of seeds per pod and the number of pods per plant. Mentioned traits are the most important characteristics that constituted the bean yield. A positive and significant correlation between seed yield and harvest index was expected, given that seed yield is one of the components in the seed harvest index. So that when the seed yield increases by the number of seeds per pod and the number of pods per plant, itis a factor to achieve higher harvest index. Soltani Howyzeh *et al*. (2018) by compare seventh spring canola reported the correlation coefficients among the seed yield and 1000-seed weight, number of seed per pod, harvest index and days to maturity were positive and significant. Results of stepwise regression analysis revealed that 1000-seed weight, number of pods per plant and days to maturity had significantly effects on seed yield.

2. OBJECTIVES

Current study was done to assess the effect of chemical and biological fertilizer on grain yield, its components and morphological traits of Corn.

3. MATERIALS AND METHODS

3.1. Field and Treatments Information

This research was conducted in research farm of Ramhormoz, according split plot experiment based on randomized complete blocks design during Summer 2016 with three replications. The main factor included four Chemical Fertilizers (C_1: 100%, C_2: 50%, C_3: 25% NPK according recommended consumption amount and C_4: Animal manure [Cow manure]). The sub factor consisted three types Biological Fertilizer (B_1: Control [none inoculation], B_2: Seed inoculation with a mixture of biological fertilizers such as Peta Barvar2, Phosphate Barvar2 and Azotobacter Barvar2, B_3: Seed inoculation with a mixture of biological fertilizers such as Peta Barvar2, Phosphate Barvar2 and Azotobacter Barvar2 and *Aspergillus niger*). Place of research was located in Ramhormoz at longitude 49°36'E and latitude 31°16'N in Khuzestan province (Southwest of Iran). The metrological parameters such as average annual rainfall, temperature, and evaporation in the region is 267 mm, 24 C and 3000 mm, respectively (Table 1). Also the physical and chemical properties of studied soil was mentioned in table 2.

Table 1. Meteorological information for Ramhormoz city during the summer corn growing period in 2016

Month	Average temperature (degrees Celsius)		Average Relative Humidity (Percentage)	Average evaporation (mm/day)	Precipitation (mm)
	Minimum	Maximum			
July	31.7	47.5	18	16	0
August	32.2	47.2	21	14.8	0
September	29.7	45.1	19	13	0
October	22.7	38.4	22	9.1	0
November	18.0	32.2	32	5.7	3
December	10.1	21.1	55	2.5	64.5

Table 2. Soil properties of studied field

Soil texture	Potassium ($mg.kg^{-1}$)	Phosphorus ($mg.kg^{-1}$)	Nitrogen (%)	O.C (%)	pH	EC ($ds.m^{-1}$)
Silty clay loam	224	16.9	0.13	1.5	7.37	**3.4**

3.2. Farm Management

Based on the results of the chemical analysis of the soil at the research site, the application of 250 $kg.ha^{-1}$ of Urea (115 $kg.ha^{-1}$ of Nitrogen), 50 $kg.ha^{-1}$ of Triple Superphosphate (23 $kg.ha^{-1}$ of P_2O_5), and 150 $kg.ha^{-1}$ of Potassium Sulfate (75 $kg.ha^{-1}$ of K_2O) was considered equivalent to 100% of the recommended NPK application. The manure used in this study was three-year-old rotted cow manure, the results of the chemical analysis of this manure are presented in table (3).

Table 3. Chemical properties of the cow manure

Total Potassium (%)	Total Phosphorus (%)	Nitrogen (%)	O.C (%)	pH	EC ($ds.m^{-1}$)
0.93	2.10	1.05	12.10	7.25	**2.58**

The amount of manure used (with 15% moisture) to provide 115 kg of Nitrogen per hectare was estimated to be 25 tons per hectare, assuming that 50% of the total Nitrogen in cow manure was available to the plant (Van Castle and Rios, 2002; Pourazizi *et al*., 2013) and based on Equation (1). **Equ.1.** Amount of kilograms of nitrogen required per hectare= Dry weight of fertilizer (kg) × Percentage of nitrogen available to plants in manure × Percentage of nitrogen in manure. Biofertilizers such as Peta Barvar 2, Phosphate Barvar 2, and Azotobacter Barvar2 were purchased from "Zistfanavar Sabz" Company. Each gram of Peta Barvar 2 biofertilizer contained 10^7 to 10^8 *Pseudomonas vancouverensis* strain 26 and *Pseudomonas koreensis* strain 104. Each gram of Phosphate biofertlizer by commercial name of Barvar 2 contained 10^7 to 10^8 Phosphate-solubilizing bacteria *Pantoea agglomerans* strain P_5 and Pseudomonas putida strain P_{13}. Each gram of Azotobacter biofertlizer contained 10^7 to 10^8 *Azotobacter vinelandii* strain O_4. The manufacturer recommended using each 100-gram package of the aforementioned biofertilizers to soak the required seeds in one hectare. The Aspergillus fungus used in this study was extracted from the rhizosphere of sugarcane and was obtained from the Khuzestan Province Agricultural and Natural Resources Research Institute, Phytosanitary Research Department (Biological Products Production Laboratory) in the form of talc powder containing the fungus. The amount of Aspergillus fungus used, based on the laboratory's recommendation, was 20 grams of powder for three kilograms of seeds. The field was irrigated regularly in a way that did not cause the plant to affected water stress. Weeds in the field were also weeded manually.

3.3. *Measured Traits*

In this study, seven plants from rows two and four of each experimental unit were randomly selected at the corn tassel stage and marked with ribbons. These seven plants were used to measure traits such as plant height, number of active leaves per plant, number of leaves on the top of the ear, ear length, ear diameter and cob diameter. Three plants were also used in rows two and four of each experimental unit to evaluate leaf area index and dry matter weight at the silk emergence stage. In order to evaluate ear yield, grain yield, biological yield, and yield components, 30 plants belonging to rows two, three, and four of each experimental unit, covering an area of 4.6 m^2 at harvest time were used. At the milky stage (Zadox code 75), the total number of green leaves and the number of green leaves above the ear were counted and recorded in seven marked plants in rows two and four of each experimental unit. In order to determine the yield and yield components, two side rows and a half meters from the beginning and end of the plot were removed as marginal effects. The final harvest was done in an area equivalent to two square meters in each plot. In order to calculate the weight of 1000 seeds, two groups of 500 seeds were separated and if their difference was less than six percent, their total weight was determined as the weight of 1000 seeds. To determine the biological yield, an area of two square meters was taken from each plot and a section of about 500 grams was separated and after transferring the samples to the laboratory, they were placed in a oven dryer at 75°C for 48 hours. And after drying, their weight was calculated. Harvest index (HI) was calculated according to formula of Gardner *et al*. (1985) as follows: **Equ.2.** HI= (Seed yield/Biologic yield) ×100. To determine the leaf area of the linear relationship S= K. L.W was used in which S, L and W were the leaf area, L and W respectively, the maximum length and width of each leaf and K= 0.75 correction coefficient. The leaf area index was calculated from leaf area ratio to ground level.

3.4. *Statistical Analysis*

Analysis of variance and mean comparisons were done by SAS (Ver.9.1) software and LSD test at 5% probability level. The simple correlation coefficients between studied traits were calculated by using SAS software (Ver.9.1). Stepwise regression method was used to study the effect of each trait on grain yield (dependent variable).

4. RESULT AND DISCUSSION

4.1. *Analysis of variance*

Result of analysis of variance revealed effect of different level of chemical fertilizer and cow manure on number of leaf per plant, leaf area index, ear length, cob diameter, number of grain per row, number of grain per ear, grain yield and biological yield was significant at 1% probability level but on dry matter, ear dimeter and number of row per ear was significant at 5% probability level and on number of leaf up of ear, 1000-grain weight and harvest index was not significant (Table 4).

Table 4. The results of analysis of variance of measured traits

S.O.V	df	No. leaf per plant	No. leaf up of ear	Leaf area index	Dry matter	Ear length
Replication	2	0.266^{ns}	0.070^{ns}	0.086^{ns}	45.36^{ns}	0.113^{ns}
Chemical Fertilizer and Cow Manure (A)	3	1.718**	0.135^{ns}	1.005**	1015.94*	9.639**
Error I	6	0.179	0.058	0.124	187.23	0.913
Biological Fertilizer (B)	2	0.347*	0.030^{ns}	0.183^{ns}	346.07*	5.315**
A × B	6	0.070^{ns}	0.054^{ns}	0.041^{ns}	128.33^{ns}	0.701^{ns}
Error II	16	0.0896	0.098	0.118	79.50	0.853
CV (%)	-	2.11	5.83	10.28	8.21	4.53

$^{ns, *\ and\ **}$: no significant, significant at 5% and 1% of probability level, respectively.

Continue table 4.

S.O.V	df	Ear dimeter	Cob diameter	No. row per ear	No. grain per row	No. grain per ear
Replication	2	0.025^{ns}	0.0063^{ns}	0.216^{ns}	0.263^{ns}	456.67^{ns}
Chemical Fertilizer and Cow Manure (A)	3	0.086*	0.0443**	0.352*	41.07**	12225.24**
Error I	6	0.011	0.0051	0.052	3.22	1197.79
Biological Fertilizer (B)	2	0.085**	0.0435**	0.835**	36.53**	13833.72**
A × B	6	0.024^{ns}	0.0143*	0.169^{ns}	2.37^{ns}	1229.56^{ns}
Error II	16	0.014	0.0045	0.148	2.48	768.65
CV (%)	-	2.32	2.40	2.55	4.01	4.69

$^{ns, *\ and\ **}$: no significant, significant at 5% and 1% of probability level, respectively.

Continue table 4.

S.O.V	df	1000-grain weight	Ear yield	Grain yield	Biological yield	Harvest index
Replication	2	17.69^{ns}	167128.5^{ns}	470577.96^{ns}	1282633^{ns}	18.09^{ns}
Chemical Fertilizer and Cow Manure (A)	3	433.96^{ns}	36902786.8**	22097622.70**	108493535.7**	8.43^{ns}
Error I	6	557.32	1335698.2	642004.43	4870148.6	17.74
Biological Fertilizer (B)	2	955.11**	7222540.5*	7870248.47**	906349.6^{ns}	133.24**
A × B	6	86.41^{ns}	1177389.9^{ns}	685112.38^{ns}	1539003.4^{ns}	17.19^{ns}
Error II	16	153.67	1630393.5	1196263.5	1495441.3	6.54
CV (%)	-	4.33	8.6	9.8	5.7	4.9

$^{ns, *\ and\ **}$: no significant, significant at 5% and 1% of probability level, respectively.

According result of analysis of variance effect of different level of Biological Fertilizer on ear length, ear dimeter, cob diameter, number of row per ear, number of grain per row, number of grain per ear, 1000-grain weight, grain yield and harvest index was significant at 1% probability level but on number of leaf per plant, dry matter, cob diameter and ear yield was significant at 5% probability level and on number of leaf up of ear, leaf area index and biological yield was not significant (Table 4). Interaction effect of treatments on all measured traits (instead cob diameter at 5% probability level) was not significant (Table 4).

4.2. *Correlation between traits*

Knowledge of relationship among yield components is essential for the formulation of breeding programs aimed at achieving the desired combinations of various components of yield. The estimates of correlation coefficients among different characters indicate the extent and direction of association. The correlation co-efficient provide a reliable measure of association among the characters and help to differentiate vital associations useful in breeding from those of the non-vital ones (Falconer, 1981). The traits of biological yield (0.85**), number of grain per row (0.84**), number of grain per ear (0.78**), 1000-grain weight (0.83**) and ear length (0.72**), ear diameter (0.70**), cob diameter (0.69**), number of active leaf per plant (0.68**) and leaf area index (0.68**) had significant correlation with the grain yield at 1% probability level (Table 5). Also the traits of harvest index (0.52*) and dry matter (0.51*) had significant correlation with the grain yield at 5% probability level (Table 5). According to the result of correlation coefficients, the trait of number of grains per ear had a highly significant positive correlation with the number of grains per row (r=0.95**), number of rows per ear (r=0.68**), ear length (r=0.80**), ear diameter (r=0.77**) and cob diameter (r=0.56*) (Table 5). Ears with greater length and diameter had a higher number of grains per row and number of rows per ear, and had a higher number of grains per ear. Increases in ear length, ear diameter, cob diameter and number of grains per ear were associated with increases in ear yield and biological yield. Previously, a significant positive correlation between grain yield and the number of grains per ear, thousand-grain weight, and ear length was reported by Kafi Ghasemi and Isfahani (2005). In a study of correlations between various agronomic traits by Kurdi *et al*. (2016), a significant positive correlation was observed between Corn grain yield and ear weight, 100-grain weight and number of grains per row. They reported ear weight and the number of grains per row to be the most important factors to determine Corn yield. Khodarahmpour and Hamidi (2012) reported the positive and significant correlation between the number of grains per ear and grain yield of Corn. Based on the results presented in table 5, a significant positive correlation was observed between the 1000-grain weight and number of grains per ear ($p<0.05$, $r=0.51^*$), which was consistent with the results of Keihani and Modhej (2014). In addition, leaf area index had a highly significant positive correlation with the number of active leaves per plant ($p<0.01$, $r=0.61^*$), but it had no significant correlation with the number of leaves up of the ear (Table 5).

Table 5. Correlation between studied traits

Traits	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	-													
2	0.94**	-												
3	0.91**	0.85**	-											
4	0.27^{ns}	0.27^{ns}	0.13^{ns}	-										
5	0.77**	0.84**	0.70**	0.43^{ns}	-									
6	0.71**	0.78**	0.61**	0.68**	0.95**	-								
7	0.39*	0.83**	0.31^{ns}	0.23^{ns}	0.38^{ns}	0.51*	-							
8	0.66**	0.72**	0.63**	0.40^{ns}	0.82**	0.80**	0.32^{ns}	-						
9	0.64**	0.70**	0.56*	0.52*	0.74**	0.77**	0.42^{ns}	0.77**	-					
10	0.54*	0.69**	0.43^{ns}	0.47^{ns}	0.50*	0.56*	0.16^{ns}	0.65**	0.72**	-				
11	0.60**	0.68**	0.49*	0.46^{ns}	0.57*	0.62**	0.30^{ns}	0.46^{ns}	0.42^{ns}	0.56*	-			
12	0.31^{ns}	0.28^{ns}	0.23^{ns}	0.16^{ns}	0.21^{ns}	0.23^{ns}	0.007^{ns}	0.27^{ns}	0.22^{ns}	0.28^{ns}	0.37^{ns}	-		
13	0.64**	0.68**	0.65**	0.30^{ns}	0.43^{ns}	0.36^{ns}	0.28^{ns}	0.35^{ns}	0.25^{ns}	0.33^{ns}	0.61*	0.14^{ns}	-	
14	0.54*	0.52*	0.59*	0.20^{ns}	0.25^{ns}	0.27^{ns}	0.25^{ns}	0.26^{ns}	0.23^{ns}	0.31^{ns}	0.43^{ns}	0.13^{ns}	0.76**	-
15	0.14^{ns}	0.51*	-0.20^{ns}	0.27^{ns}	0.33^{ns}	0.36^{ns}	0.25^{ns}	0.20^{ns}	0.31^{ns}	0.25^{ns}	0.24^{ns}	0.11^{ns}	-0.05^{ns}	-0.20^{ns}

$^{ns,\ *\ and\ **}$: no significant, significant at 5% and 1% of probability level, respectively.

1: Ear yield, **2**: Grain yield, **3**: Biological yield, **4**: Number of row per ear, **5**: Number of grain per row, **6**: Number of grain per ear, **7**: 1000-grain weight, **8**: Ear length, **9**: Ear diameter, **10**: Cob diameter, **11**: Number of active leaf per plant, **12**: Number of leaf above of ear, **13**: Leaf area index, **14**: Dry matter, **15**: Harvest index.

Goldani and Nassiri Mahallati (2011) reported leaf area index and number of active leaves per plant had a positive and significant relationship with ear yield, grain yield, biological yield, number of grains per row, number of grains per ear, and ear length, such that treatments with more leaves had a higher leaf area index and ultimately had higher yield. By increasing the number of active leaves and leaf area index, the amount of light received increases and photosynthesis increases, which results in improved growth indices and crop production. The positive and significant correlation between leaf area index and dry matter (r=0.76**) is also consistent with current results (Table 5). Al-Salim *et al*. (2017) reported all studied traits except grain weight were highly significantly correlated with grain yield and about 35% of variation in grain yield could be explained by the level of nitrogen fertilizer, and the traits of Plant height and dry and green fodder weight were the major contributors towards grain yield since these traits explained about (57, 52, 50)% respectively of the variation of grain yield, which might be a good traits for breeders to develop high yielding cultivars in sorghum, followed by stem diameter and grain number then leaf area index. The increase of total dry weight and its direct relation with seed yield show the relations between photosynthesis efficiency of plant and seed yield, therefore varieties which have gained more profit of production factor according to growth conditions and they keep more photosynthesis materials in their sinks, have more efficiency. This status was in conformity with the results of some other researchers (Qulipor *et al*., 2004).

4.3. *Stepwise regression analysis*

In Stepwise regression analysis, grain yield was considered as a dependent variable, while other traits were considered as independent variables (Shiapchan, 2012). In order to investigate the effect of each of the evaluated traits on grain yield as a dependent variable and to eliminate variables that have a negligible effect on the dependent variable, stepwise regression method was used. In this study, the traits number of rows per ear, number of grains per row, thousand-grain weight, number of active leaves per plant, number of leaves above the ear, ear length, ear diameter, cob diameter, leaf area index and dry matter were considered as independent variables and grain yield as dependent variable. Based on the results obtained, the number of seeds per row was the first trait to enter the model and remained in the model due to its significant regression coefficient. The number of seeds per row alone explained 73% of the variation in seed yield. In the second stage, the leaf area index trait and in the third stage, ear diameter were entered into the model. These traits remained in the model due to the significance of their regression coefficients and explained about 82% of the grain yield variations. According to the final coefficient of explanation of the model, a multiple correlation coefficient of 91% was obtained, which indicates a strong multiple correlation between the variables in the model (number of grains per row, leaf area index, and ear diameter) and corn grain yield (Table 6). In a study of different cropping systems by Jahan *et al*. (2009), the variables of leaf area index, canopy temperature, chlorophyll meter number, specific root length, and ear number remained in the model and were identified as the main factors affecting corn grain yield. While in the study of Kurdi *et al*. (2016), ear weight and number of grains per row were identified as the most important factors determining corn yield. Keihani and Modhej (2014) also stated, based on the results of stepwise regression in the study of various morphological traits, yield, and yield components of corn, that the two traits, number of grains per row and grain weight, determine the most variation of grain yield. Using the obtained regression model, the grain yield response can be evaluated based on the increasing or decreasing effect of experimental treatments on the independent variables in the model. According to the model obtained in table 6, Corn grain yield will change by decreasing or increasing the number of grains per row, leaf area index, and ear diameter due to changes in the amount of Cow manure fertilizer and biofertilizer application. The increase of biologic yield and its direct relation with seed yield show the relations between photosynthesis efficiency of plant and seed yield, therefore genotypes which have gained more profit of production factor according to growth conditions and they keep more photosynthesis materials in their sinks, have more efficiency. This status was in conformity with the results of some other researchers (Mardin, 2017; Tian, 2017). Ghalejoughi *et al*. (2013) studied regression and correlation between grain yield and related traits of corn hybrids, and revealed a positive significant correlation between grain yield and the weight of grain, stem diameter and the total number of grains. The equation of regression of grain yield indicates that the effective roles of vegetative organs growth and biological yield in grain yield within this experiment.

Table 6. Stepwise regression analysis of grain yield of single cross 703 Corn

Step	Regression equation	Partial R^2	Model R^2
1	**GY**= −10135 + 544.07 NGpR	0.73	0.73
2	**GY**= −10661 + 462.46 NGpR + 1116.19 LAI	0.07	0.82
3	**GY**= −18327 + 360.33 NGpR + 2274.42 ED + 1181.78 LAI	0.02	0.91

GY: Grain yield, **NGpR**: Number of grain per row, **LAI**: Leaf area index, **ED**: Ear Diameter

5. CONCLUSION

According to the results of stepwise regression analysis, the traits of number of grains per row, leaf area index, and ear diameter were identified as the most effective traits determining grain yield. Corn grain yield changed with a decrease or increase in these traits due to changes in the amount of chemical fertilizer and Cow manure and biofertilizer application.

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FOOTNOTES

AUTHORS' CONTRIBUTION: All authors are equally involved.

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