Determination of most important part of yield components by Path Analysis in Corn

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Abstract: In order to study of direct and indirect effects of yield components on corn yield for find the most important effective part on yield, an experiment in researching filed of Lahijan Islamic Azad University in 2009 was conducted. This experiment in Split plot format based on Randomized complete block design with two factors, main factor consist of different amounts of nitrogen fertilizer (50, 100, 150 and 200 kg/ha) and sub factor consist of rows spacing (30, 40 and 50 cm) in three replications was performed. In this experiment, Single cross 704 cultivar was used and path analysis for determination of most important part of yield under these treatments was conduced. Determination of most important part of yield can use in agronomical and corrective managements. Results were showed that corn yield had significant correlation with ear length, rows in ear, plant height and ear per plant ($r \geq 0.58$). Among yield components, ear length was most determinative and most effective trait among other traits on yield, ear length increases had a positive effect on yield increasing and also indirectly affect yield from way of rows per ear and 1000 grain weight.

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1. Introduction

Corn (Zea mays L.) is one of the important cereal crops in the world and Iran after wheat and rice (Alvi et al., 2003; Gerpacio and Pingali, 2007). Nitrogen, a plant nutrient is required by plants in comparatively larger amounts than other elements. Nitrogen is essential component of many compounds of plant, such as chlorophyll, nucleotides, proteins, alkaloids, enzymes, hormones and vitamins (Marschner, 1995). Nitrogen deficiency generally results in stunted growth, chlorotic leaves because lack of N limits the synthesis of proteins and chlorophyll. This leads to poor assimilate formation and results in premature flowering and shortening of the growth cycle. The presence of N in excess promotes development of the above ground organs with relatively poor root growth. Synthesis of proteins and formation of new tissues are stimulated, resulting in abundant dark green (high chlorophyll) tissues of soft consistency. This increases the risk of lodging and reduces the plants resistance to harsh climatic conditions and to foliar diseases (Lincoln and Edvardo, 2006). Nitrogen (N) fertilizer use has played a significant role in increase of crop yield (Modhej et al., 2008). Improved cultural practices can play an important role in augmenting yield of corn crop. For an optimal yield, the nitrogen supply must be available according to the needs of the plant.

Suitable plants densities for optimum leaf growth by controlling water, fertilizer and chemical inputs is essential for improving the growth variables responsible for high yield. Optimum plant spacing ensures the plants to grow properly both in their aerial and underground parts through different utilization of solar radiation and nutrients. When the plant density exceeds an optimum level, competition among plants for light above ground or for nutrients below the ground become severe, consequently the plant growth slows down and the grain yield decreases (Hasanuzzaman et al., 2009). Yield can be increased with increased plant density up to a maximum for some corn genotypes grown under a set of particular environmental management conditions and declines when plant density is increased further (Tollenaar et al., 1994). Sezer and Yanbeyi (1997) demonstrated that ear characteristics were negatively affected by increases in plant densities, although plant height, ear height and grain yield increased with increases in plant densities. Grain yield is a complex feature that is affected by many of physiological process (Gozubenli and Konuskan, 2010). Grain yield in cereals obtains from two main parts hence the number of grain per area unit and single grain weight. Also, the number of grains itself is result of number of grain per panicle and number of ear per area unit (Ahmadi et al., 2008). Saorre and Stafer (1999) and Evans (1993), introduce number of grain as most important determinative factor in yield. Also, often observed that one independent variable moreover direct effect on dependent variable, indirectly affect that from way of other independent variable or variables. Therefore recognition of trait or traits that directly and indirectly affect on yield and determination of essence and amount of those effects is necessary (Tourchi and Rezaei, 1996). At many studies, from correlation coefficient used for explain of yield components effect on production. Foundation of this analysis is ontogenetic relations between yield components. This case specially is true for cereals, because yield components successively occurs in this group of plants and often during plant development reparative pattern was occurred (Rezai and Soltani, 1983). Ahmadi and et all (2008), in Zagros and Kohdasht cultivars determine the number of spikelets in panicle as the most important determinative part of number of grain per panicle. Thay also found that in Kohdasht cultivar, the number of grain per plant at different planting times in compare with average of grain weight for determination of grain had further importance. In this research use of path analysis with goal of determination the more important part in corn yield under plant spacings and different amounts of fertilizer, which can be useful for other studies.

2. Material and Methods

This experiment was conducted in researching filed of Lahijan Islamic Azad University in Guilan province (north Iran), with 37˚11' N latitude and 50˚0' E longitude and 20 m above sea level in 2009, in Split plot format based on Randomized complete block design with three replications. In this experiment, Single cross 704 cultivar was used and treatments was include of different amounts of nitrogen fertilizer as the main factor in 4 levels (n_1=50, n_2=100, n_3=150 and n_4=200 kg/ha) and 3 spacing between rows (d_1=30, d_2=40 and d_3=50 cm) as the sub factor. Favorable Irrigation and weeding during growth period was carried out. At the end of period, from each plot 10 plant selected and number of rows per ear, number of ear per plant, 1000 grain weight, grain yield, straw yield, harvest index, plant height and ear length were studied. Analysis of path coefficient was carried out with use of sample correlation coefficient and similar method with Gebeyou and et al (1982) method. In this research, grain yield was assume as the function of ear length, rows per ear and 1000 grain weight that those were affected by other traits too (figure1).

Each of these traits had direct effect on yield that is same standard regression coefficient and has indirect effect from way of other traits that is productive of this coefficient at correlation of these traits. Calculation was carried out with SAS software and for calculate of path coefficients from method of regression with word STB was used (Ahmadi et al., 2006; Rezai and Soltani, 2003). Yield function of grain yield and straw yield obtained by STATISCA software.

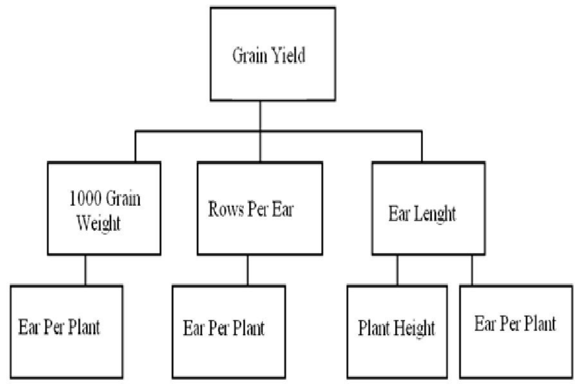

Figure 1. Diagram of effective traits in grain yield

3. Results and Discussions

Results showed that grain yield in corn had significant correlation with ear length, rows per ear, plant height and ear per plant (r≥0.58) that most correlation with ear length and then with rows per ear were observed (table1).

The results of path analysis showed that, ear length was the more effective trait on yield (0.95**) that moreover direct effect, indirectly was effective from way of rows per ear and 1000 grain weight. But influence of 1000 grain weight on yield was very little (Table 2). Devi et al, (2001) reported that ear length, number of seed rows ear-I, number of seeds row and 100-seed weight positively influenced the yield directly and also indirectly through several components.

Plant height was trait which had most effect on ear length (0.59) and ear per plant was trait that affect on rows per ear and 1000 grain weight (respectively 0.34 and -0.06). According to obtained results must be effort to provide the condition than ears length without any limitation increases until extremity optimum yield was obtained (Alvi et al., 2003; Khayatnezhad et al., 2010; Mohan et al., 2002; Nemati et al., 2007; Sadek et al., 2006)

Table 1. Correlation of studied traits in corn

	Rows per ear	Ear per plant	1000 grain weight	Plant hieght	Ear lenght
Yield	0.80**	0.58*	0.40ns	0.68*	0.96**
Rows per ear		0.34ns	0.41ns	0.39ns	0.74**
Ear per plant			-0.06ns	0.64*	0.60*
1ooo grain yield				0.36ns	0.39ns
Plant height					0.73**

** and * respectively significant in 1% and 5% area; ns: none significant

Table 2. Coefficients of path analysis for direct and indirect effects of ear length, rows per ear and 1000 grain weight on corn yield

Path analysis coefficients	yield
Effect of ear length	
Direct effect of ear length	0.81**
Indirect effect of ear length from way of rows per ear	0.14
Indirect effect of ear length from way of 1000 grain weight	0.0003
Effect of rows per ear	
Direct effect of rows per ear	0.14
Indirect effect of rows from way of 1000 grain weight	0.0003
Effect of 1000 grain weight	
Direct effect of 1000 grain weight	0.0007

** and * respectively significant in 1% and 5% area

Relation between amounts of used nitrogen fertilizer and row spacing levels and their effect on grain yield is shown in Figure 2.

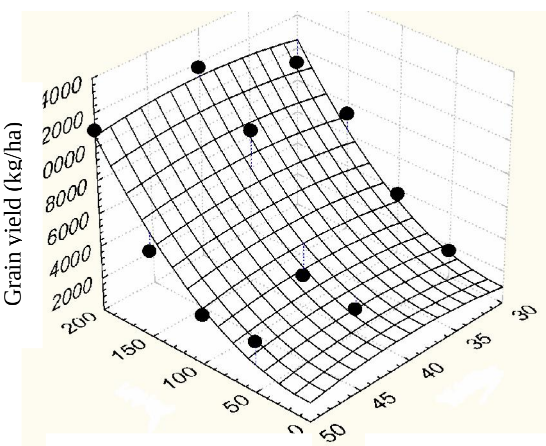

Figure 2. The effect of nitrogen fertilizer and row spacing on grain yield.

With attention to this figure, with increase of nitrogen fertilizer amounts and row spacing levels, grain yield increases. Optimum nitrogen consumption by use of n_4 level case to highest grain yield. Ozkan (2007) reported that the highest grain yield was obtained at 200 kg/ha nitrogen fertilizer. Increasing plant density up to a certain level case to grain yield increases. due to create an optimum condition for light reception, water and nutrient consumption and less competition in d_2 level, photosynthesis rate is high and as a result with more transition of photosynthetic matters for grains formation, yield of grains increases and less or most of this level case to grain yield decreases. Gozubenli and Konuskan (2010) reported same result with this experiment. Yield function of grain yield obtained by following relationship:

$$\text{Grain yield} = 66215.83 - 123.367 \times X - 2195.5 \times Y + 0.414 \times X^2 + 1.243 \times X \times Y + 21.688 \times Y^2$$

Relation between amounts of used nitrogen fertilizer and row spacing levels and their effect on straw yield is shown in Figure 3.

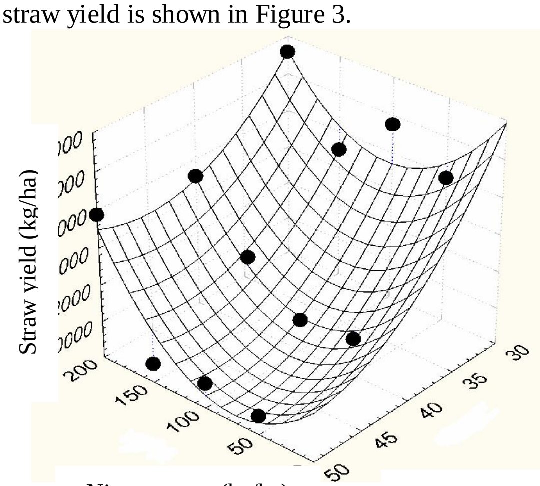

Figure 3. The effect of nitrogen fertilizer and row spacing on straw yield.

With attention to Figure 3 that show Relation between amounts of used nitrogen fertilizer and row spacing levels and their effect on straw yield, with increase of nitrogen fertilizer amounts and decrease of row spacing levels, straw yield increases. Nitrogen increasing photosynthesis rate with increase of green pigment of plant and promotes rapid growth and increases plant leaf size and height. In this experiment Increase of nitrogen fertilizer up to 200 kg/ha case to straw yield increases. The highest straw yield was obtained of n4 level. Izadi and Emam (2010) same result were reported. In this experiment decrease of row spacing and increase of plant density in d1 level case to straw yield increases. Some researchers reported that taller plants with lower stem diameter were obtained at higher plant densities as a consequence of interplant competitions (Devi et al., 2001; Izadi and Emam, 2010; Ozkan, 2007) Due to more competition for light in d1 level plant height and leaf area increases that case to straw yield increases. Amano and Salazer (1989) same result were reported.Yield function of straw yield obtained by following relationship:

$$\text{Straw yield} = -8282.5 - 1.82 \times X + 490.75 \times Y + 0.246 \times X^2 + 0.001 \times X \times Y - 6.037 \times Y^2$$

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