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# Multiple regression analysis for studied traits in intercropping of popcorn and cowpea

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**Abstract**

The goal of multiple regressions is to enable a researcher to assess the relationship between a dependent variable and several independent (predictor) variables. In order to determination of some popcorn yield characteristics with higher effect on yield an experiment was conducted as factorial based on RCB in Islamic Azad University of Tabriz. Studied factors included maize sowing dates (12$^{th}$, 19$^{th}$ and 26$^{th}$ May) and sowing percentage of cowpea as 12.5%, 25%, 37.5%, 50% and 100% of recommended density rate (5, 10, 15, 20 and 40 plants per square meter). Based on results weight of 300 seed in corn ranged from 33.6 g in intercropping of popcorn + cowpea with 50% of recommended density rate up to 39.5 g and 39.7 g in intercropping of the crops with 12.5% and 25% of recommended density, respectively. Weeds biomass in intercropping of the crops with 12.5% and 25% of recommended density rate experienced reduction of 4.5 g m$^{-2}$ compared to the maize mono-cropping and 6 g m$^{-2}$ compared to the mean of intercropping of the crops with 37.5% and 50% of recommended density rate. Increasing of cowpea density when intercropped with maize caused to earlier flowering. The stepwise regression analysis verified that the LAI, 300 seed weight and weeds biomass had a marked increasing effect on the corn seed yield in intercropping with cowpea.

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## Introduction

Multiple regressions is an extension of simple (bi-variate) regression. The end result of multiple regression is the development of a regression equation (line of best fit) between the dependent variable and several independent variables (Hocking, 1976; Draper and Smith, 1981; SAS Institute, 1989).

Popcorn (*Zea mays* var. *everta*) is the most widely grown as a grain crop. Cowpea (*Vigna unguiculata* L.) is a poor competitive plant with weeds (Majnoun Hosseini, 2008). There is need to develop the best cropping systems to increase crop production and decrease weeds damage. Intercropping is an agricultural practice of cultivating two or more crops in the same farm and at the same cropping season (Andrews and Kassam, 1976). When two or more crops are grown together, each must have adequate space to maximize cooperation and minimize competition between the crops. To accomplish this, spatial arrangement, plant density, maturity dates of the crops and plant architecture must be considered (Silva *et al.*, 2009).

It has been shown that intercropping helps in increasing farm income (Kalra and Gangwar, 1980), while Mandal *et al.* (1985) reported that intercropping of wheat, mustard and chickpea decreased number of fruiting branches per plant, number of pods per plant and 1000 seeds weight. In an experiment on maize cultivars intercropping system maximum and minimum land equivalent ratio (LER) of 1.07 and 0.97 were attained by 50%SC704:50%SC604 and 25%SC704:75%SC604 combinations, respectively. Also, 50%SC704:50%SC604 combination showed yield advantage (LER>1) compared monoculture in equal land area (Mazaheri *et al.*, 2006). The main objective of this study was to determination of some popcorn yield characteristics with higher effect on yield.

## Materials and methods

*Experimental procedure*

The field experiment was conducted on a sandy loam soil at the Agricultural Research Station of Islamic Azad University of Tabriz, Iran. The experimental field had been in a bean-wheat rotation cycle for the last two years. Fertilizers used before sowing were 160 and 60 75 kg $ha^{-1}$ of ammonium phosphate and potassium sulfate, respectively. Cowpea seeds were inoculated with *Rhizobium* before sowing for the cowpea symbiosis to work, and then were sown immediately.

*Studied treatments*

The studied treatments were sowing date of corn related to cowpea ($D_1$=7 days earlier, $D_2$= simultaneously with maize, $D_3$=7 days later than cowpea) and sowing rate of cowpea ($I_1$=12.5%, $I_2$=25%, $I_3$=37.5%, $I_4$=50% of its recommended density, and $I_5$= lentil mono-cropping with 40 plants per square meter as optimum density, included a mono-cropping of corn as control).

*Stepwise regression analysis*

In statistics, stepwise regression includes regression models in which the choice of predictive variables is carried out by an automatic procedure (Hocking, 1976; Draper and Smith, 1981; SAS Institute, 1989). In this study, to formulate the relationship among six independent growth variables measured in our experiment for corn crop with a dependent variable, multiple regression analysis was carried out for the five independent variables as corn leaf area index (LAI), 300 seed weight, seed number per ear and weeds biomass and seed yield (SY) as a dependent variable. The multiple regression equation for seed yield is as follows:

$$SY = 15.148 + 1.102(X_1) + 2.200(X_2) + 1.042(X_3) + 0.480(X_4) \quad (1)$$

Furthermore, the stepwise regression analysis was also carried out for the data obtained to test the significance of the independent variables affecting the seed yield. The stepwise regression equation is as follows:

$$SY = 13.158 + 2.222\,(X_1) + 1.508\,(X_2) + 0.461\,(X_4);\ R^2 = 83 \quad (2)$$

**Results and discussion**

*Analysis of variance*

Effect of sowing date on corn leaf area index were significant at 5% probability level. Also, effect of sowing percentage on leaf area index and 300 seed weight were significant at 1% probability level; and on seed number per ear, weeds biomass, seed yield and days to 50% flowering of cowpea were significant at 5% probability level (Table 1).

**Table 1.** Mean squares for studied traits in popcorn.

| SOV | df | LAI | 300 seed weight | Seed number per ear | Weeds biomass | Seed yield | Number of secondary branches | Days to 50% flowering |
|---|---|---|---|---|---|---|---|---|
| Replicate | 2 | 652.78 | 89.14 | 89.44 | 135.78 | 16.01 | 5.70 | 145.10 |
| Sowing date | 2 | 10.01* | 300.14 | 541.10 | 13.52 | 125.11 | 4.77 | 0.10 |
| Sowing percentage | 4 | 15.41** | 1598.56** | 1598.00* | 131.02* | 500.008* | 30.00 | 520.38* |
| Sowing date× Sowing percentage | 8 | 0.54 | 333.45 | 154.00 | 19.31 | 78.12 | 11.00 | 89.88 |
| Error | 28 | 2.86 | 124.45 | 349.12 | 35.90 | 125.75 | 10.45 | 56.43 |
| CV (%) | - | 13.11 | 12.58 | 12.58 | 22.19 | 21.88 | 19.93 | 13.01 |

*, ** mean significant difference at 5% and 1% probability levels, respectively.

*Mean comparisons of data*

*LAI*

In sowing date of 19th May when corn was sown along with cowpea, corn had higher of 3.8, but only 3.5 from 12th and 26th May sowing dates (Figure 1). If the corn crop intercropped with cowpea in 12.5% of recommended density, its LAI will be similar to sole-cropping of corn plots. There is no significant difference between two levels of 37.5% and 50% densities (Table 2).

*300 seed weight*

The corn crop produced larger seeds with 300 seed weight of 39.6 g, when sown with cowpea in 12.5% and 25% of its densities (Table 2).

**Table 2.** Mean comparisons of effect of sowing percentage of cowpea on some of studied traits.

| Sowing percentage | LAI | 300 seed weight (g) | Seed number per ear | Weeds biomass (g $m^{-2}$) | Seed yield (g $m^{-2}$) | Days to 50% flowering |
|---|---|---|---|---|---|---|
| 0 | 4.2 a | 35.3 b | 30 c | 21.7 b | 508.9 b | 81 b |
| 12.5 | 4.1 ab | 39.5 a | 32.5 a | 17.1 c | 571.2 a | 89 a |
| 25 | 3.9 b | 39.7 a | 36 a | 17.4 c | 565.4 a | 89 a |
| 37.5 | 2.9 c | 33.9 b | 30 c | 23 a | 442.7 c | 89 a |
| 50 | 2.9 c | 33.6 b | 30 c | 22.8 a | 444.5 c | 75 c |

Means in each column with the same letter have not significant difference at 5% probability level.

*Seed number per ear*

Also, variation trend in seed number per ear was similar to ear length (Table 2). *Weeds biomass* Biomass of emerged weeds in plots was the highest in two treatments of 37.5% and 50% of recommended densities, but only 17.2% from 12.5% and 25% of densities (Table 2).

*Seed yield*

Seed yield among treatments ranged from 586 g $m^{-2}$ in corn intercropping with cowpea in 12.5% and 25% of recommended densities up to 443 g $m^{-2}$ in 12.5% and 50% of densities. Seed yield in mono-cropping of corn was better than its intercropping with cowpea in two higher densities (Table 2). Xu (2007) indicated that in intercropping of maize+bean, seed yield of

corn improved by 26%-43%. Xu (2007) suggested that these increasing values could be due to organic acidic materials releasing from bean root system and nitrogen fixation. Reported grain legume–cereal intercropping performance indicates some principal advantage worth considering while directing present agricultural practices in more sustainable directions like yield advantages and greater yield stability over years compared to grain legume sole-cropping (Hauggaard-Nielsen and Jensen, 2005; Jensen, 1996). Furthermore, pea (*Pisum sativum* L.)–barley (*Hordeum vulgare* L.) dual-cropping compared to the corresponding sole-cropping has shown a more efficient use of environmental sources for plant growth due to inter-specific complementarity (Corre-Hellou and Crozat, 2005; Hauggaard-Nielsen *et al.*, 2001).

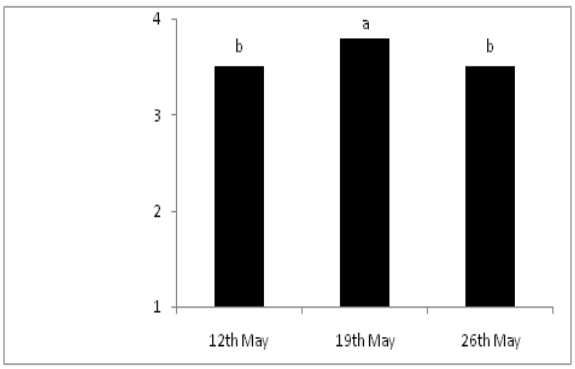


**Fig. 1.** Effect of sowing date on corn leaf area index.

*Days to 50% flowering*

Days to 50% flowering of cowpea extended up to 89 days when intercropped with corn in 12.5%, 25% and 37.5% of densities. But early flowering was observed in 50% of its density (Table 2). In this study, none of treatments was able to complete growth period after flowering.

## Conclusion

The stepwise regression analysis verified that the LAI, 300 seed weight and weeds biomass had a marked increasing effect on the corn seed yield in intercropping with cowpea.

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