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Effect of surface and local irrigation on seed yield of three pinto common bean cultivars (*Phaseolus vulgaris* L.)

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Abstract. An experiment was conducted in split, split plot in three replications, based on completely randomized block design during 2010 in North West of Iran (Zanjan province) and the altitude was 1547 meters above sea level. Irrigating methods in two levels including surface (I_0) and local irrigation(using T-Tape) (I_1), were assigned to main plots, cultivation methods in two levels including traditional (C_0) and furrow method (C_1) were assigned to subplots and three cultivars including three pinto common bean varieties including Talash (V_1), Khomain (V_{21}) and COS16(V_3) were assigned to sub-subplots. The most Water Use Efficiency (0.79 Kg dry matter/ m^3) was obtained from local irrigation (T-Tape method) and furrow or ridge planting method. COS16 pinto bean cultivar had many characteristics superior to others such as seed yield, biological yield, seed number in pod and harvest index. Using the T-Tape method (local irrigation) and furrow planting are most effective on growth of crop, seed yield and W.U.E.

Keywords: Iran, COS16, Pinto Bean, Water Use Efficiency.

1. Introduction

Most of the surface and groundwater are used for agriculture and gradual decline in water resources quality and quantity are the factors to limiting agricultural production in many parts of the world and Iran so research on water use efficiency is essential (Khoramian, 2002). Because Iran is in the range of arid and semi-arid, it is necessary to implement modern agricultural methods, to raise the Water Use Efficiency. Surface Irrigation is the oldest method which has prevailed in most places. One of the most important issues in modern agriculture is the appropriate cultivation pattern for each product (Haydari, *et al*., 2008). Efficient use of water can increase water productivity in irrigated crop production (Mintesinot *et al*., 2002). Improved irrigation systems and introducing new methods of irrigation, with emphasis on water conservation in agriculture are considered (Horst *et al*., 2005). Common Bean is very sensitive to soil conditions and selection of accurate methods of planting will reduce water losses and increase production efficiency and change in the planting arrangements can influence on yield (Powelson *et al*., 1999). Furrow cultivation method caused higher seed yield in common bean than traditional method, because there was no direct contact between water and plant organs and it is very effective in erect types of common bean (Taherkhani et al., 2009).

Costs, soil erosion and water consumption will reduce and W.U.E and seed yield will increase by ridge-planting (Griffit et al., 1990). The goal of this investigation is the study of surface and local irrigation on common bean cultivars in two cultivation methods.

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2. Material and Method

In order to study the surface and local irrigation methods on yield of common bean cultivars under furrow and traditional (plot method) cultivation methods, an experiment was conducted in split, split plot in three replications, based on completely randomized block design in 2010 in north west of Iran (Zanjan province) and the altitude was 1547 meters above sea level. Irrigating methods in two levels including surface (I_0) and local irrigation(using T-Tape) (I_1), were assigned to main plots, cultivation methods in two levels including traditional (C_0) and furrow method (C_1) were assigned to subplots and three cultivars including three pinto common bean varieties including Talash (V_1), Khomain (V_{21}) and COS16(V_3) were assigned to sub-subplots. Some traits such as pod number, seed number in pod, seed yield, biological yield, harvest index and water use efficiency was evaluated in during the experiment stages. Water amount was measured on the basis of FC depleting percent formula and then pumped through water pipes and water meter. To obtaining the irrigation depth in soil, in each irrigation turn (d), the following formula was used:

$$d= (\Theta FC- \Theta_{PWP}) \times P_b \times D/100$$

d= Irrigation depth (cm)
Θ_{FC}= Soil weight humidity % in field capacity
$\Theta_{PWP=}$ Soil weight humidity % in permanent wilting point
P_b= Soil bulk density (g/cm^3)
D= Root depth (cm)
And for water application efficiency in each treatment the following formula was used (Smith *et al*., 2005):
ea= (Fc-Θ). P_b.D/ Volume of water flows / Main plot area × 100
ea= water application efficiency in each treatment
Fc= Soil weight humidity % in field capacity
Θ= Soil weight humidity % before irrigation in rhizosphere region
Then for irrigation water volume for each main plot following formula was used:
Vw= (Fc- Θ). P_b.A.D/ea
Which in this formula:
Vw is volume of irrigation water for each main plot and A= Main plot area (m2)
And for Water Use Efficiency (WUE)
WUE= Y_{ec} / ET
Y_{ec} = Economic Yield
ET= EvapoTranspiration
%Harvest index= Economic yield, divided by Biological yield multiplied by 100

Seed yield components in each square, were: The number of plants per unit area, number of pods per plant, the number of seeds per pod and weight per seed.

Table1. Results of soil analysis (0-40cm)

K ppm	P ppm	Total N%	OC%	T.N.V%	pH	EC*1000 ds /m	S.P%
550	13	0.076	1.18	3.4	7.5	1.45	44.5

Data were analyzed with SAS (version 9.1) statistical software.

3. Results and Discussion

There were significant different for mean square of the some traits including: seed yield, pod number in plant, seed number in pod, biological yield and W.U.E in main effect of irrigation levels and cultivation methods at α=1%. Cultivars effect on seed yield, seed number in pod, biological yield, and harvest index were significant at α=5% and the interaction effects of irrigation levels and cultivation methods (I×C) were significant on seed yield and W.U.E at α=5%. Triple interaction effects of irrigation, planting method and cultivars (I×C×V) were significant at α=5% for seed yield. The others interactions did not have significant effects on characteristics. Mean comparison of traits showed that using the T-Tape method (local irrigation) and furrow planting are most effective on growth of crop, seed yield and W.U.E.

Based on the results of figure.1, the interaction of T-Tape irrigation, furrow planting method and COS16 ($I_1C_1V_3$) had the highest seed yield (about 4894 kg/ha).

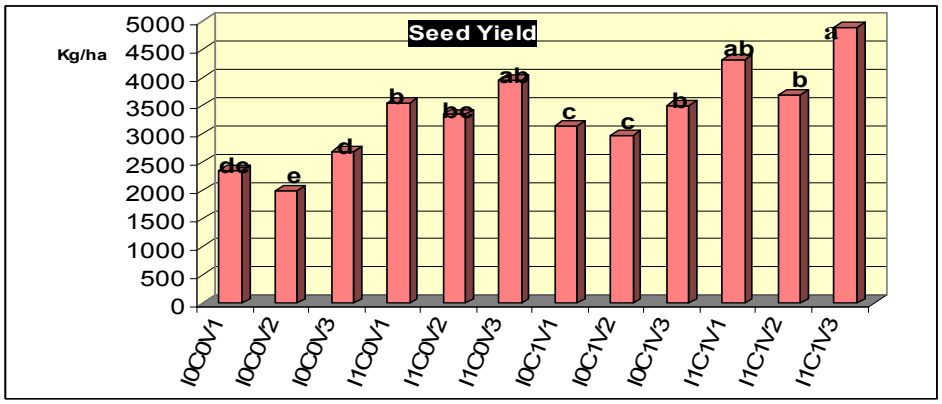


Fig. 1: Mean comparisons of Irrigation method, Cultivation method and Varieties interaction on seed yield of common bean.

The most Water Use Efficiency (0.79 Kg dry matter/ m^3) was obtained from (I_1 C_1 treatment) local irrigation (T-Tape method) and furrow or ridge planting method (Figure 2).

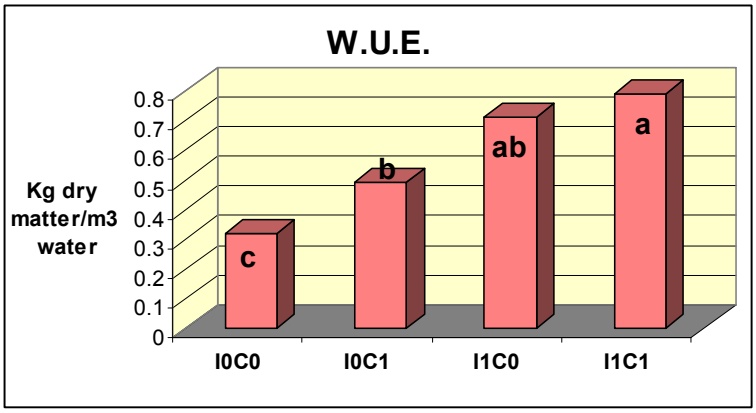


Fig. 2: Mean comparisons of Irrigation and Cultivation methods on W.U.E.

Surface irrigation, Traditional method for cultivation and Khomain cultivar (V_2) had least biological yield (Fig. 3, Fig. 6 and Fig. 9). COS16 (V_3) had many characteristics superior to others such as seed yield, biological yield, seed in pod (6.9) and harvest index (49.3) (Fig. 1, 3, 4, 5).Biological yield, seed in pod and pod number in plant affected significantly by different cultivation methods and furrow or ridge method was better than traditional method (Fig. 9,10 and 11).

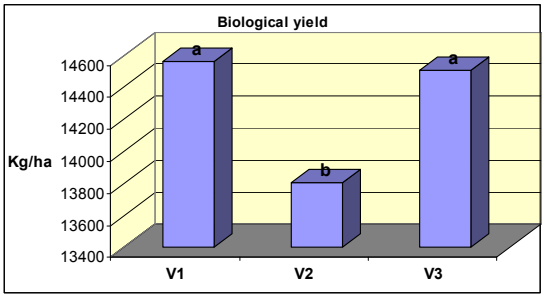


Fig. 3: Biological yield.

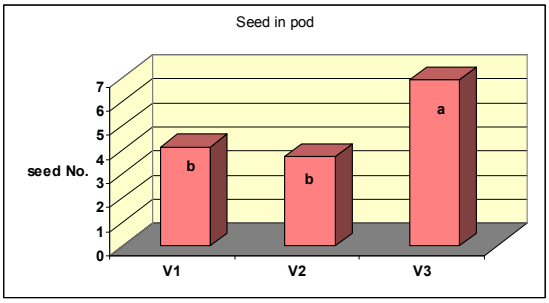


Fig. 4: Mean comparisons of Varieties on Seed number.

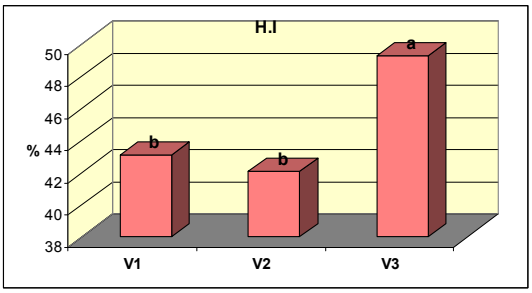
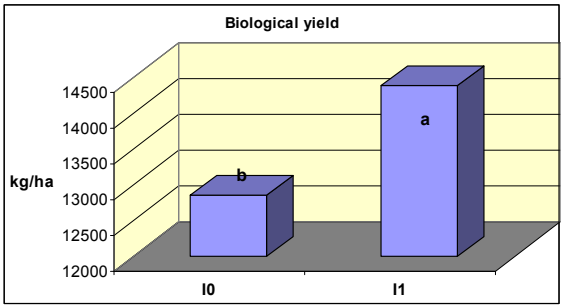
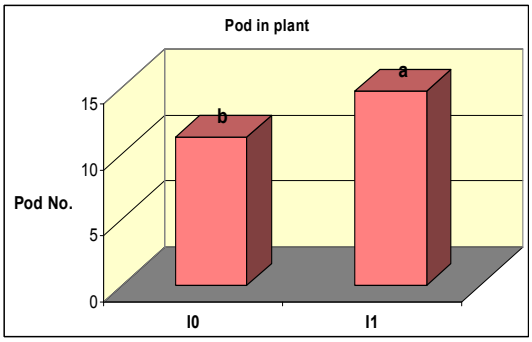


Fig. 5: Mean comparisons of Varieties on H.I



. Fig. 6: Mean comparisons of irrigating on Biological yield.



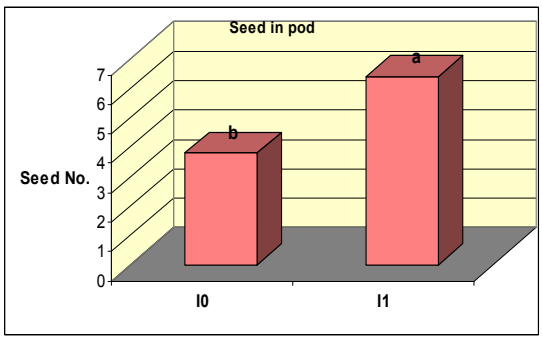
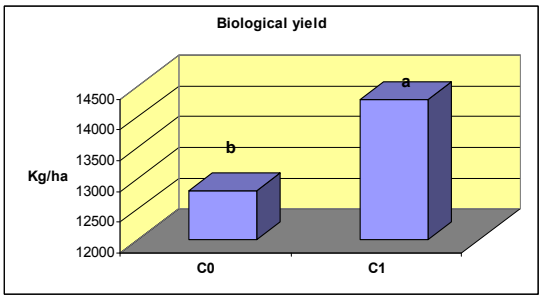


Fig. 7:.Mean comparisons of irrigating methods on Pod in plant. Fig. 8: Irrigating on Seed No.



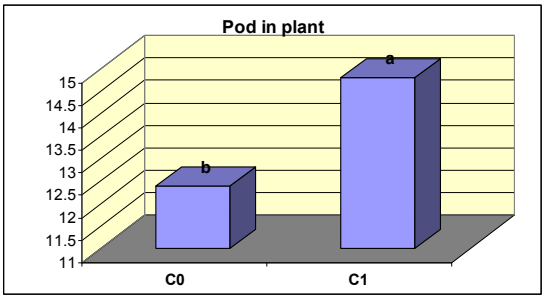


Fig. 9: Mean comparisons of cultivation on Biological yield. Fig. 10: Mean comparisons of cultivation on Pod No.

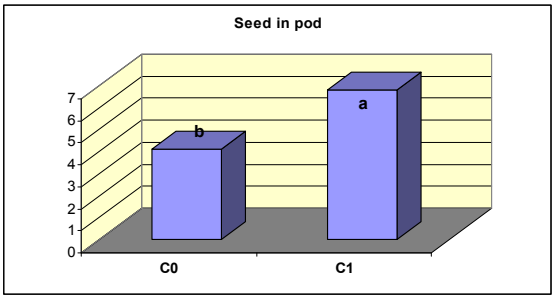


Fig. 11: Mean comparisons of cultivation methods on Seed number in pod.

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