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EFFECT OF VARIOUS IRRIGATION REGIMES AND NITROGEN FERTILIZER ON YIELD AND WATER USE EFFICIENCY IN SOYBEAN (GLYCIN MAX)

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ABSTRACT

An experiment was conducted to evaluate the Effects of water infiltration to soil in yield and water use efficiency in soybean (Glycin max) in Langeroud, North of Iran. The study was done on a split plot in a complete random block plan with 3 replications in the 2011 crop year. In this pilot study, a randomized complete block design with a split plot design and 3 replications was carried out in the field. Each plot had a dimension of 2×5 meters and 7 rows respectively. The main factor management without irrigation (rainfed) and irrigated with a period of 6, 12 and 18 days, and nitrogen fertilizer treatments consisted of 0, 30, 60, 90 and 120 were considered as sub plots. Different levels of irrigation and nitrogen fertilization on the yield and interaction between them, pods significant at the 5% level were reported. 12 days to a yield maximum of Irrigation Management 5125.6 kg per hectare, respectively. The lowest seed yield without fertilizer at 3888.1 kg/ha was but with increasing fertilizer significantly increased seed yield. The level of 90 kg.N/ha, the maximum yield of 4228.1 kg per hectare was obtained. The highest pod yield of 12 day irrigation management with the 5312.3 kg per hectare was obtained. The highest pod yield was of 90 kg per ha of nitrogen was increased from 90 to 120 kg of nitrogen reduced pod yield from 5438.3 to 4804 kg/ha

Keywords: Irrigation, Water use efficiency, Nitrogen, Leaf relative water content.

1. INTRODUCTION

Soybean *(Glycin max)* yearling, a dicot, is one of the most important oilseeds [1]. Farm irrigation to maintain soil moisture environment, in an ideal situation and to minimize stress to the crop during the growing season was done. The soybean plant available soil water content during all stages of plant growth exerts a significant effect [2]. Soybean plants under drought stress on field observations indicate that significant amounts of soil water access during all stages of plant development has an important effect on plant growth imposed. Briyer, et al. [3] also concluded that climatic factors have no tangible impact on the spread of soybean roots, but in his view there is some contrary information. Thus, certain planning for water consumption level and how to optimize it should be done [4, 5]. Bingru and Hongwen [6] believe that supplying sufficient water for a plant during its growth and development and prior to the occurrence of adverse effects of water stress are very important for physiological processes inside a plant . In their study results, Li, et al. [7] showed that under recommended complete irrigation conditions and supplementary irrigation programs, plants would have higher yields compared with those without any irrigation. Also, Lai and Katul [8] reported that under water deficit conditions in the soil, the plant's physiological characteristics and root density at different layers are of great significance. For example, as stress occurs in surface layers, roots in lower layers are more effective and efficient in terms of water absorption. For soybean, germination to 50% of their weight needs extra moisture from the soil [9]. Eshli and Etraj [10] observed that the bulk of the survey responses of the vegetative organs of soybean cultivars to water stress-induced changes in stem weight. Schmitt, et al. [11] showed that there is sufficient soil nitrogen resulting from Rhizobium especially late in the reproductive cycle of flowering and pod formation resulting in increased performance of soybean. Taylor and Keliper [12] observed that the application of nitrogen fertilizer in late-planted soybean yield is improved. Kumudini, et al. [2] stresses at the Soybean plant height factor for predicting dehydration tolerance of cultivars. This study aimed to evaluate the effect of irrigation and nitrogen management on yield of soybean.

2. MATERIALS AND METHODS

This field experiment in 2011 in the province and the city Langeroud latitude 36 degrees 54 minutes and longitude 40 degrees, 50 minutes, with an average height of 4 meters above sea level, was performed. Meteorological data during the study was received from the weather station, Langeroud city. Rainfall during the growing season was 180 mm. Before land preparation and fertilizer, the soil around the field at a depth of 20-0, 40-20 and 60-40 cm to determine the physical and chemical properties of soil samples were taken randomly (Table 1). In this pilot study, a randomized complete block design with a split plot design and 3 replications was carried out in the field. Each pilot had a dimension of 2×5 meters and 7 rows, respectively. The main factor management without irrigation (rainfed) and irrigated with a period of 0, 6, 12 and 18 days, and nitrogen fertilizer treatments consisted of 0, 30, 60, 90 and 120 kg/ha were considered as sub plots. The ground was ploughed in May and then again in June 2011, disk powder and furrows were created in order to prepare the ground well. When planting seeds, 4 may 2011 was performed. During the operation of the farm, three weeding for weed control and soil around the root system was performed. Irrigation methods used in the study of surface irrigation and furrow system, so that the distance between two stacks of 80 cm and 30 cm between plants in the row. To measure the amount of irrigation water delivered to any of the meter test unit was used. Management of water in 6, 12 and 18 days was respectively 380, 260 and 210 mm. After omitting two tiers for estimating the yield of both plants, harvested by laboratory weighing scales were accurate. To determine the number of pods per plant, eight plants were randomly selected, the number of healthy pods, were isolated from the plant were counted. To determine seed weight per plot, 200 g of dry pod as sample was separated from the pod and 100 seeds were randomly selected and precision scales weighing fractions of a gram per record. To determine the relative water content, the plants were removed before sunrise and transported to the laboratory and the wet weight was measured immediately. The sample was placed into a beaker of distilled water until fully imbibed. The samples were placed in a container for 4 to 6 hours in the dark at about 4°C to stop respiration. After time passed, the leaves were removed and the weight was determined, the leaves were then placed in the oven at 70˚C for 72 h to obtain the dry weight of the leaves. With fresh weight, dry weight and imbibition, leaf relative water content was calculated using the following equation [13].

$$RWC\ (\%) = \frac{FW - DW}{TW - DW} \times 100$$

FW = fresh weight (gram), TW = turgid weight (gram), and DW = dry weight (gram).

Table-1. Mean meteorological data in the studied

Month	Max Temp(C°)	Min Temp(C°)	Max Humidity (%)	Min Humidity (%)
Jun	29.3	27.6	87	67
Jul	33.3	22.4	84	58
Agu	22.9	22.6	80	59
sep	31.5	18.8	88	65
Oct	27.8	15	92	71

Table-2. Soil properties related to the experimental field

Soil depth (cm)	EC (dS/m)	Organic carbon (%)	Total nitrogen (%)	Phosphors Absorbent (ppm)	Potassium Absorbent (ppm)	Clay (%)	Silt (%)	Sand (%)
0-20	0.361	0.68	0.084	0.07	239	19	32	49
20-40	0.656	0.66	0.065	2.17	191	19	32	49
40-60	0.681	0.36	0.051	0	119	17	38	45

Water use efficiency (WUE) was calculated by Division Yield (kg/ha) on Water use [14]. For variance analysis and the comparison of mean values (Duncan test, probability level of 5%) and in order to draw relevant diagrams, *MSTATC* and *Excel* software were used.

3. RESULTS AND DISCUSSION

3.1. Seed Yield

The highest yield of 5125.6 kg/ha irrigation management was 12 days (Figure 1). Given that the conditions without irrigation, rainfed and irrigation management, there is little difference in 6 days; there was no effect on yield increase and number of seeds that can come into full affect. The negative response of plants to water stress during pod filling will lead to the formation of smaller seeds on the other hand, the amount of fertilizer consumption will increase from zero to a higher level leading to yield increase. In other words, in terms of fertilizer use, lowest seed yield was 3888.1 kg/ha. Increasing fertilizer significantly increased seed yield, so that the highest yield of 90 kgN/ha, 5228.1 kg per hectare was obtained. Most applications of nitrogen fertilizer on seed yield and plant did not affect the level of 120 kg.N/ha yield loss occurred. The results were consistent with those of Hatami, et al. [15] and Ebadi, et al. [16]. Nitrogen consumption by increasing the number of pods leads to an increased in seed yield. The number of pods per plant is influenced by the potential to produce the greatest effect on seed yield. The interaction between irrigation regime and nitrogen fertilizer level, the highest average yield in irrigated for 12 days and 90 kg.N/ha (Figure 3). Starling, et al. [17] reported that application of nitrogen fertilizer on dry matter accumulation of soybean flowering stage of growth lines are limited and unlimited growth to 25 %, and the yield increases at least 8 %. Nitrogen consumption is associated with dry matter accumulation and seed yield of soybean, which will lead to an increase [15]. The results are consistent with those of Azizi [18]. Soybeans need to accelerate the transfer of nitrogen from leaves to seeds, the nitrogen remobilization from old leaves to hasten green organs [2]. Many studies on the performance increase of nitrogen application on dry matter accumulation have been reported by Wood, et al. [19].

Table-3. Analysis of variance in terms of irrigation and nitrogen fertilizer

Source of variation	df	Seed yield	Number of pods per plant	1000-seed weight	RWC	Water use efficiency
Bloks	2	84776.696 ^{ns}	315.393 ^{ns}	3166.683 ^{ns}	1.09 ^{ns}	0.0064 ^{ns}
Irrigation	2	77409.116 *	558.694*	10079.27 ^{ns}	9809.9**	9.384 **
Error	4	196282.102	141.141	425.417	5.68	0.0194*
nitrogen fertilizer	4	2491816.4*	637.632 ^{ns}	9946. 96 ^{ns}	14.85 ^{ns}	0.087**
Irrigation×nitrogen	8	653932.99*	105.06 ^{ns}	906.42 ^{ns}	9.378 ^{ns}	0.0162*
Error	24	174457.25	199.16	596.5	5.70	0.0063
CV (%)		10.27	19.37	5.68	11.44	8.20

^{ns} non significant, *significant at $P<0.05$, **significant at $P<0.01$

Figure-2. Effect of irrigation management on seed yield

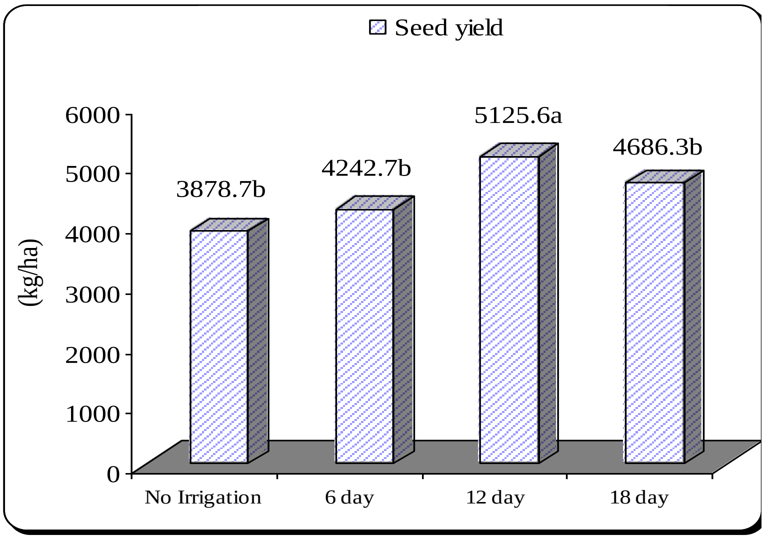


Figure-3. Effect of nitrogen fertilizer on seed yield

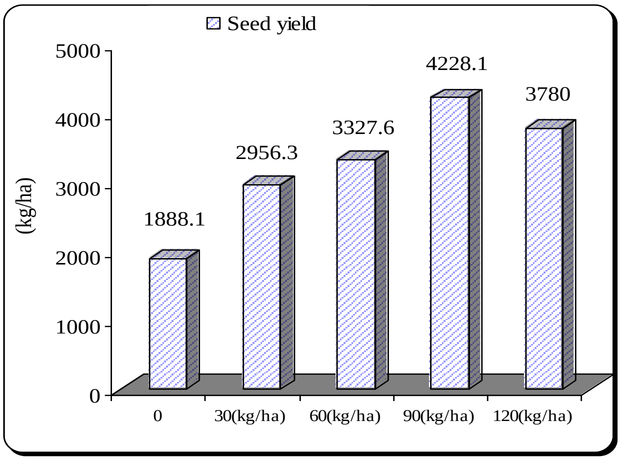
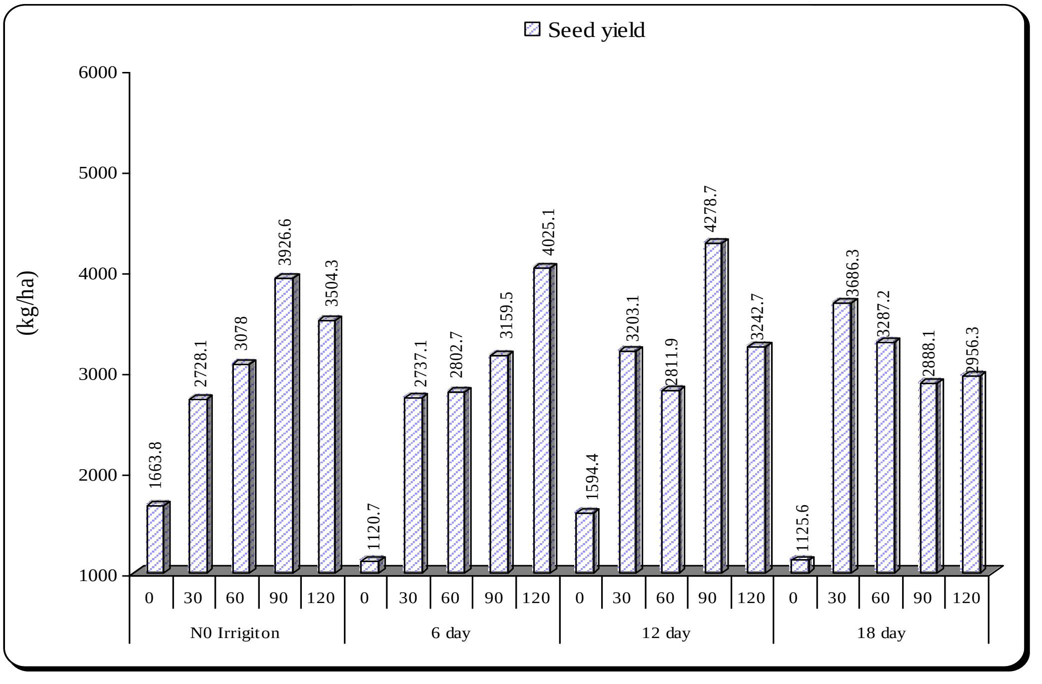


Figure-4. Interaction of irrigation management nitrogen fertilizer on seed yield



3.2. Number of Pods per Plant

Irrigation and nitrogen levels had no significant effect on number of pods per plant at the 5% level (Table 3). The highest numbers of pods per irrigation management in irrigation levels were similar and no irrigation had the lowest value (Table 4). The lowest number of pods per treatment without fertilizer value of 68.3, but the numbers of plants with pods were added to increase fertilizer consumption (Table 4). Brevendan, et al. [20] reported that increasing nitrogen levels during soybean flowering, number of pods per plant, number of pods per node, respectively increased by 22 and 40% compared to the control (no fertilizer). Fathi, et al. [21] also showed that nitrogen application up to 100 kg N/ha by increasing the number and weight of soybean yield from 2430 to 3387 and 4230 kg per hectare, respectively, the application of 50 and 100 kg.N/ha increased. Borkert and Sfredo [22] showed that the number of pods per plant and seed yield per unit area is less affected by water stress. Sensitivity of soybean pods after flowering under water stress during the seed filling stage was reported by Smiciklas, et al. [23]. Reduced soil water before or after flowering significantly reduced water potential and this hinders its development [24].

Figure-5. Interaction of irrigation management nitrogen fertilizer on water use efficiency

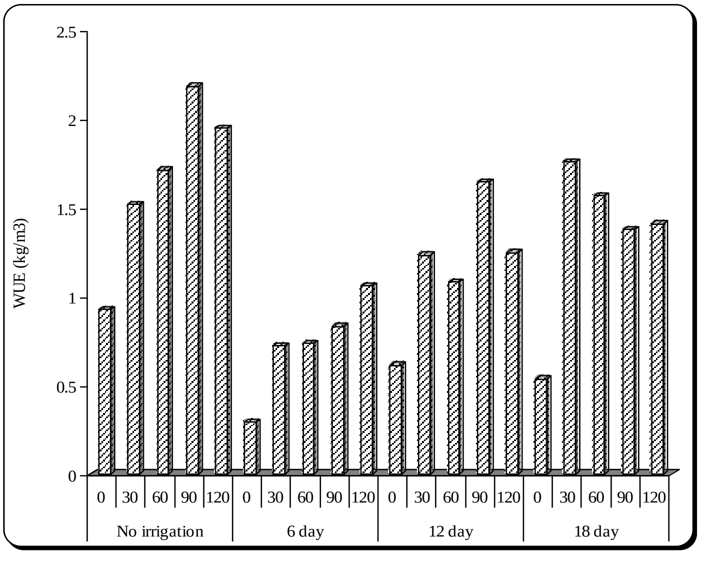


Table-4. Mean Analogy by Duncan Test

Treatments	Number pods per pod	1000-seed weight (g)	RWC	Water use efficiency (kg/m³)
no irrigation	69.2 c	434.6 b	43.3 c	1.1 b
6 day	82 a	467.4 ab	85.5 a	0.85 cb
12 day	86.9 a	482.8 ab	61.3 b	1.59 a
18 day	83.7 a	494.1 a	64.2 b	1.76 a
0	68.3 c	417.4 b	45.2 a	0.73 d
30 (kg/ha)	70.6 b	443.3 ab	46.1 a	1.07 cd
60 (kg/ha)	83.7 a	476.7 ab	47.1 a	1.33 bc
90 (kg/ha)	88.7 a	492.5 a	46.2 a	1.70 a
120 (kg/ha)	85.4 a	504 a	44.3 a	1.46 b

3.3. 1000-Seed Weight

Irrigation showed that seed weight was significant at the 5% level in the (Table 3). Irrigation management in such a way that the highest seed weight of 18 days with the 494.1 g were obtained. Conditions without irrigation, seed weight and the minimum value of 434.6 g were observed (Table 4). Increasing the effective factor of seed yield in irrigated and stress in several sources was reported by Smiciklas, et al. [23]. Analysis of variance showed a significant effect of nitrogen fertilizer on seed weight at the 5% level (Table 3). The highest mean seed weight of 90 and 120 kg of fertilizer with the 492.5 and 504 grams and no fertilizer treatments with the lowest seed weight 417.4 g was assigned. Increasing fertilizer amounts from 90 to 120 kg lead to increase in mean seed weight from 492.5 to 504 g.

3.3. Leaf Relative Water Content (RWC)

Leaf relative water in irrigation management was significant at the 1% level (Table 3). Irrigation management for 6 days with relative water content of 85.5% is the maximum when compared to other treatments (Table 4). Relative water content is used in the selection of appropriate methods for crop yield stresses [25]. It can be found that drought stress reduced the leaf relative water content [26]. Traits related to plant water can be used in breeding for drought tolerance; because the amount of water stored in the plant survives the stress conditions [27]. Singh and Singh [28] have reported the drought stress on sorghum, maize and millet in the field resulted in reduced leaf relative water content. Wakrim, et al. [29] in their study of the beans have shown that less water irrigation and irrigation set resulted in lowered RWC in leaves.

3.4. Water Use Efficiency

The authors report a condition such that the highest water use efficiency was 12 and 18 days (Table 2). Increasing irrigation intervals of 6 to 12 and 18 days gradually increase the amount of water use efficiency. Greater seed yield was noted under irrigation after 12 days. Irrigation management in 6 days, most of the plants have enough water constantly and plants under these conditions were ever faced with a water shortage Saraei, et al. [30] corresponded to the soybean in investigating the Deficit irrigation water use efficiency in soybean plants by about 70%. However, with increasing levels of nitrogen fertilizer and irrigation, increased plant water use efficiency and seed yield increases. Nitrogen fertilizer levels have a significant effect on the efficiency of water use based on seed yield (Table 4). The lowest water use efficiency in the fertilizer treatments were in the absence of fertilizer. The interaction of different levels of irrigation and nitrogen management at the 5% level of significance based on water use efficiency for seed yield (Table 4). Seed yield to fertilizer treatment of 90 kg.N/ha and 2.06 kg/m^2 with no irrigation amounts found (Table 4).

5. CONCLUSION

The results revealed that the zero to a higher level of fertilizer consumption, seed yield increases. In other words, the lowest seed yield without fertilizer was 3888.1 kg per hectare but with increasing fertilizer, a significant seed yield of 90 kg N/ha 5228.1 kg per hectare was obtained. The highest pod yield of 12 day irrigation management with a yield of 6312.3 kg per hectare was obtained. The highest pod yield was obtained from 90 kg/N/ha increased from 90 to 120 kg of nitrogen leads to a reduction in pod yield from 6438.3 to 5804 kg/ha.

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