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GREEN BEAN RESPONCE OF FERTIGATION AND CHEMIGATION UNDER DRIP IRRIGATION

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ABSTRACT: The present work was conducted to study the effect of fertigation and chemigation on green bean (phaseolus vulgris) under drip irrigation in sandy soil. The drip irrigation system was carried under three levels of total available water (75, 100 and 125 %), three nitrogen rates (40, 55 and 70 kg N/fed) and two methods of weed control (hand hoeing and herbicide Amex rates of 1.5 and 2 liter/fed) to investigate moisture distribution, emitter clogging, total weeds fresh weight, green beans production, water use efficiency, fertilizer use efficiency, cost production unit and net profit. The results showed that best soil moisture distribution was obtained around the emitter under level of available water of 100%. Minimum emitter clogging was obtained under 40 kg N/fed at different stages. The level of available water of 75% gave the lowest weed fresh weight of 220.8 gm/m^3 under herbicide Amex of 2 lit/fed at 40 kg N/fed, while level of available water of 125% gave highest weed fresh weight of 487.5 gm/m^3 under hand hoeing. Maximum green beans yield and the highest net profit value were 2.2069 Mg/fed and 2545.9 LE/fed at level of available water of 100% under nitrogen rate of 40 kg N/fed and herbicide Amex of 2 lit/fed, respectively.

Key words : Herbicide Amex , emitter clogging , moisture distribution.

INTRODUCTION

Water became one of the most economical scarce resources in many areas of the world. Continuous improvements in water and nutrients applications are essential to keep high agriculture production and low cost production. Today, many agricultural crops producers are using irrigation systems to apply chemicals to crops by injecting them into the water flowing through irrigation system. Salih (1985) found that the soil moisture distribution pattern reflected the high soil water contents adjacent to the lateral line and low contents a way from lateral. El-Sherbeni (1988) reported that the clogging as percent gradually increases with increasing the operation time and decreases sharply by acidification water. Kushwaha (1994) showed that application of N up to 50.4 kg.N/fed significantly increased pods and seed weight/plant. The mean high N use efficiency was 37 kg seed/kg N at 50.4 kg N/fed. Glancey *et al.* (1997) reported that the best method to reduce contamination of the harvested product is effective weed control during the growing season. Kumar *et al.* (1997) showed that, the grain yield phasolues increased with increasing levels of nitrogen up to 50.4 kg N/fed during both years of experimentation. Hochmuth and Smajstrla (1998) showed that drip tube orifices are easily clogged by three types of mechanisms. These three types of mechanisms are: particulate matter, such as limestone particles or sand from well; biological material such as algae or organic matter from surface water; and chemical precipitation such as might result from fertilizer precipitation in the nutrient solution, clogging control begins with careful analysis of the water source for pH, carbonates, iron, and sulfur. It is important to determine what potential problems will lie a head relevant to clogging. Rana and Singh (1998) found that green beans yield increased significantly with each increment in N dose up to 50 kg N/fed. Felsot (1999) found that many herbicides and some insecticides were targeted for the soil, developing weeds would absorb the herbicide directly from the soil that could be easily absorbed by plant roots. Chemigation or application through irrigation systems could be ideal delivery techniques for these types of best management strategies. Bottcher and Rhue

(2000) stated that reduce nutrient losses in efficient irrigation should always be limited to wetting only the root zone, because excessive irrigation can transport nutrients below the root zone through leaching. Proper scheduling and uniform water distribution are necessary to assure control. Shawky *et al.* (2001) showed that the highest yield green bean is produced under irrigation system that has high application efficiency requirements. Tollafson (2002) stated that water is applied continuously and moves into soil and wets root zone vertically by gravity and laterally by capillary action. Sharaf *et al.* (2003) showed that injection of fertilizer through a micro-irrigation system (fertigation) increased the fertilizer use efficiency and beneficial effect on growing plants.

MATERIALS AND METHODS

The field experiments were conducted on an area of about 0.2 feddan at Khattara Experimental Farm, Faculty of Agriculture, Zagazig University, Sharkia Governarate through the growing season of 2003. Conventional analysis of the experimental soil and irrigation water were preformed and results are shown in Tables 1 and 2.

Table1: Some physical and chemical properties of the experimental soil

Particle size distribution (%)			Soil texture	Ca Co₃ (%)	B.D (g/cm³)	pH	EC (ds/cm⁻¹)	F.C. (%)	W.P. (%)
Sand	Silt	Clay							
97.5	1.3	1.2	Sandy	0.28	1.65	8.0	2.31	8.02	3.15

Table 2 : Chemical analysis of irrigation water

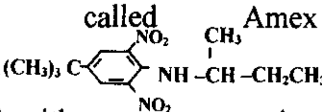
pH	EC (ds/cm^{-1}) at 25C	Anions (mel/L)				Cations (mel/L)			
		HCo_3^{-1}	Co_3^{-2}	Cl^-	So_4^{-2}	Ca^{+2}	Mg^{+2}	Na^+	K^+
8.02	1.46	7.38	0.06	5.79	1.44	1.21	1.08	12.26	0.12

Materials

The drip irrigation system consists of control head (centrifugal pump, back flow prevention device, pressure regulator, pressure gauge, flow meter, sand media filter, screen filter and fertilizer tank). Main and submain lines (110 and 63 mm diameter lines). Lateral built in drip lines(GR system) with 16mm diameter of PE tube. Emitter with discharge of 2 l/h. Orifice emitter diameter was used namely 0.5 mm.

The experimental design was spilt – split, where irrigation water amounts were considered as the main treatment plot. The nitrogen levels were assigned as sub plots. The weed control methods were taken as the sub – sub plots. For that the experimental area was divided into three strips. Each strip was 20 m length and 13.5 m width, contained 27 lateral lines of 20 m length and 0.5 m space between laterals. One kind lateral lines namely GR was installed in each strips. The distance between emitters was 30 cm.

Three levels of available water were used namely 75, 100 and 125 %. Three levels of nitrogen rate (ammonium sulfat) were applied namely 40, 55 and 70 kg N/fed. Each rate was divided into three doses injected with the irrigation water after 10, 20 and 40 days from seeding. Two weed control methods were considered chemigation and hand hoeing. Chemigation with chemical herbicide called Amex (*Butralin*.



was used with two concentration levels of 1.5 and 2 liter/fed to control previous local weed.

Organic matter (30 m^3/fed), potassium sulfate (50 kg/fed), super phosphate (200 kg/fed) and sulfur (50 kg/fed) were applied during preparation of seed bed while super phosphate (150 kg/fed) and potassium sulfate (25 kg/fed) were added after 20 days from seeding.

Measurements

Irrigation water applied

Irrigation water applied was calculated by using the following formula (Black et al., 1965):

$$\mathbf{D = \frac{Fc - Wp}{100} Bd \times Dr}$$

Where:

D = depth of available water cm,

Bd = bulk density = 1.65 gm/cm3

Moisture distribution

The soil samples were taken after irrigation directly and at different distance of 0-5, 5-10 and 10-15cm from the dripper and at different depths of 0-5, 5-10, 10-15 and 15-20 cm. Soil moisture contents percentage by dry weight (Sm_w) was calculated according to (Michal, 1978) the following equation:

$$\mathbf{Sm_w = \frac{W_1 - W_2}{W_1} \times 100}$$

Where:

W_1 : mass of the wet soil samples

W_2 : mass of the oven dried soil sample

Emitter clogging percentage

Clogging percentage was calculated after operation time of 5, 15 and 20 hour by using the following formula (El-Sherbini, 1988):

Clogging % = (No. of clogged drippers/total No. of drippers)× 100

Evaluating method of weed control

Weed fresh weight was measured in g/m^2 for all treatments.

Grain yield production

Total grain yield of phaseious under different treatments were collected through out the growing season.

Water use efficiency (WUE)

WUE was calculated according to the following equation:

$$\mathbf{WUE = Y_t / W_t}$$

Where:

Y_t = Total grain yield (kg/fed),

W_t = Total water applied (m^3/fed)

Fertilizer use efficiency (FUE)

FUE was calculated for all tested variables according to the following equation:

$$\mathbf{FUE = Y_t / F_t}$$

Where:

Y_t = Total grain yield (kg/fed),

F_t = Total applied nitrogen fertilizer (kgN/fed)

Cost calculation

The total production costs of green bean yield included irrigation system, fertilization, weed control and pest control cost are considered.

a) Irrigation system costs

The drip irrigation cost can be calculated as follows:

Total cost = Fixed cost + Running costs

(I) Fixed costs

The annual fixed costs of capital invested in the drip irrigation system were calculated using the following equation:

$$FC = D + I + T$$

Where:

FC : the annual fixed cost (LE/year), D : the depreciation (LE/year), I: the interest rate (LE/year) and T : the taxes and over head ratio (LE/year).

(II) Running cost (RC)

The annual running cost was calculated using the following equation:

$$RC = EC + (R \& M) + LC$$

Where:

EC : energy cost (LE/year),

(R, M): repairs and maintenance cost (LE/year)

LC: labor costs (LE/year).

b) Cost of production unit

Cost of production unit was calculated using the following formula:

$$\text{Cost of production unit} = \frac{\text{Total costs (LE/fed)}}{\text{Total grain yield (Mg/fed)}}$$

Net profit

The economical profit of green bean yield was calculated by using the following formula (Younis et al., 1991):

$$P = (Y_t \times d) - Ct$$

Where:

P : net profit, (LE/fed);

Y_t : total grain yield, (Mg/fed);

d : yield price, 1500 (LE/Mg),

Ct : total production cost,(LE/fed).

Statistical Analysis

The data were subjected to proper statistical analysis of variance (Snedecor and Cochran, 1980). The treatment means were compared by using the least significant difference (L.S.D) test (Waller and Duncan, 1969) at 5% level of significance.

RESULTS AND DISCUSSION

Soil moisture distribution

Fig. 1 presents soil moisture distribution in the soil profile in case of using different irrigation water amounts. Data indicated that the soil moisture content increased around the emitter, but far from the emitter, the soil moisture content decreased progressively. The moisture content generally decreased as the soil depth increases. In the case of using level of available water of 100%, moisture content percentage in sand soil profiles after irrigation directly, ranged from 8.68% in layer surface to 6.49% at depth of 20cm and field capacity ranged from 108.23 to 80.93% in different soil layers. The moisture content became closed to the filed capacity. Therefore the contour lines of moisture content slightly

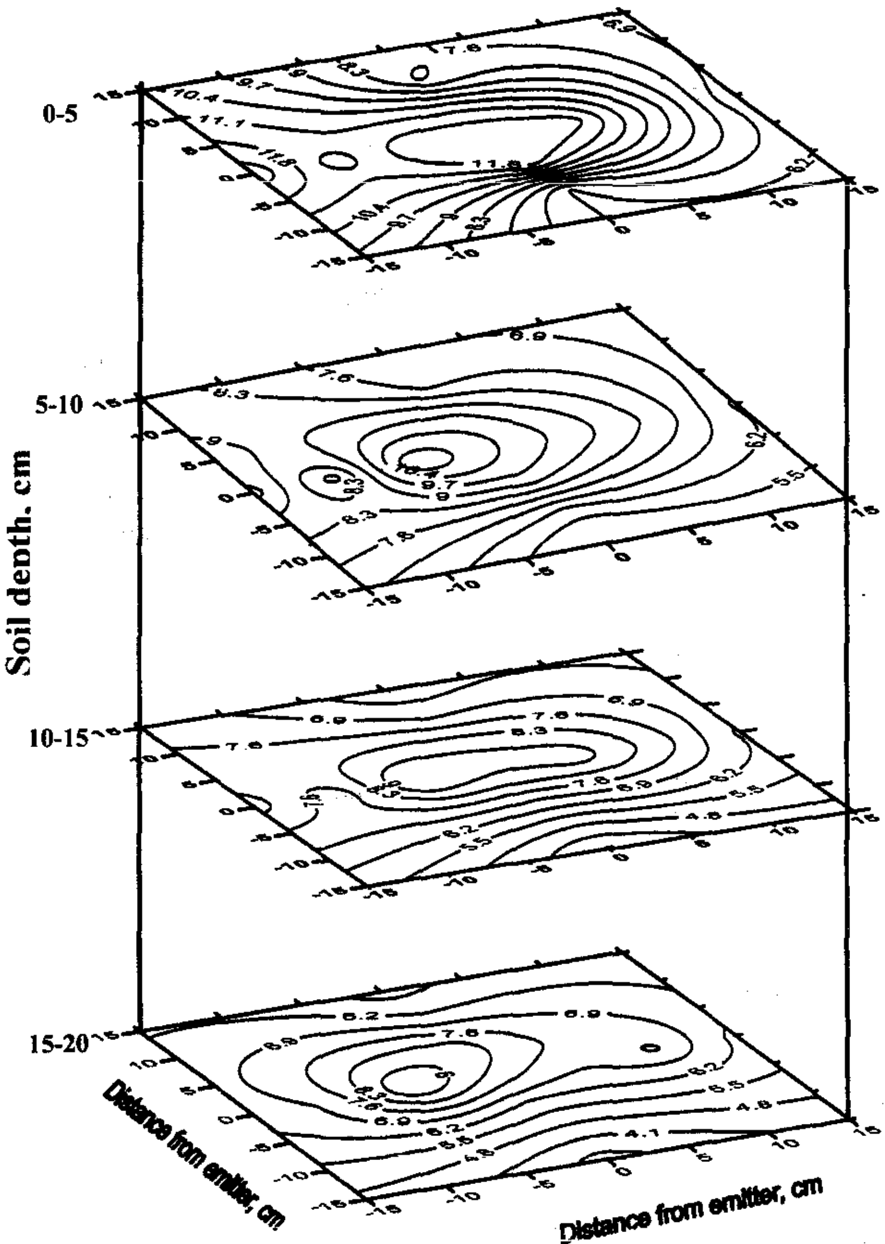


Fig.1: Soil moisture distribution under 100% of available water

became spread more at different soil layers.

Emitter clogging percentag

Data in Fig. 2 revealed that emitter clogging percentage after operation time of 5, 15 and 20 hour was affected significantly by levels of available water and nitrogen rates. Further more, the percentage of emitter clogging increased with increasing the levels of available water and fertilizer doses. Minimum emitter clogging was obtained with nitrogen rate of 40 kg N/fed under different treatments.

Changing operation time from 5 to 15 and to 20 hour, the percentage of emitter clogging increased by 23.5 and 44.56 at nitrogen rate of 70 kg N/fed and level of available water 125%, respectively.

Evaluation weed control method

Data presented in Fig. 3 showed that total weeds (*Datura stramonium, L, Rumex dentatus, L., Chenopodium sip. and portulaca olemacea L.*) weight was significantly affected by levels of available water, nitrogen rates and weed control methods. Increasing nitrogen rates from 40 to 70 kg N/fed, quantity of obtained weed was increased by 18.9%. Furthermore, increasing levels of available water from 75 to 125% lead to increased total weeds by 38.5%. Moreover, using weed control method caused decreasing in total weeds fresh weight. The high value of fresh weight was 372.3 gm/m^2 under hand hoeing, followed by 322.6 and 284.8 gm/m^2 under herbicide Amex of 1.5 and 2 lit/fed, respectively.

Grain yield

The effect of different levels of available water, nitrogen rates and weed control methods on total grain yield of green beans under drip irrigation were illustrated in Fig.4. The highest grain yield 2.2069 Mg/fed was recorded with nitrogen rate of 40 kg N/fed and herbicide Amex of 2 lit/fed under levels of available water of 100%. Meanwhile the lowest value was 0.87724 Mg/fed at nitrogen rate of 70 kg N/fed and hand hoeing under levels of available water of 75%. It could be noticed that increasing levels of available water from 100 to 125% caused a reduction in total grain yield by 29.42% under rate nitrogen of 40 kg N/fed and herbicide Amex of 2 lit/fed. This may be due to leaching fertilization.

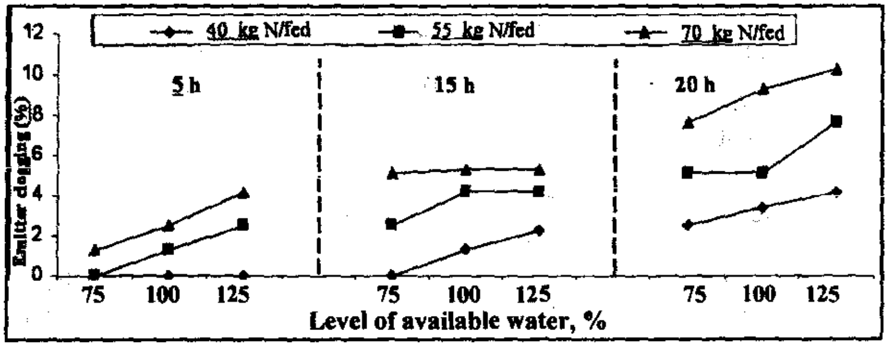


Fig.2: The emitter clogging percentage under different levels of available water and nitrogen rates after 5, 15 and 20 operation time

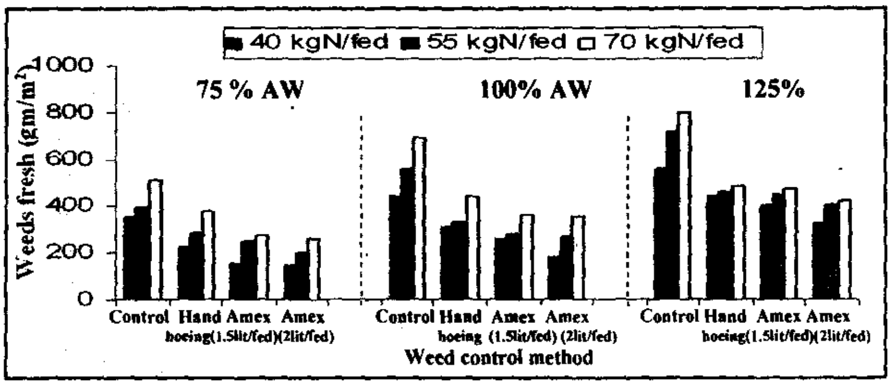


Fig. 3: Total weeds fresh weight under different treatments

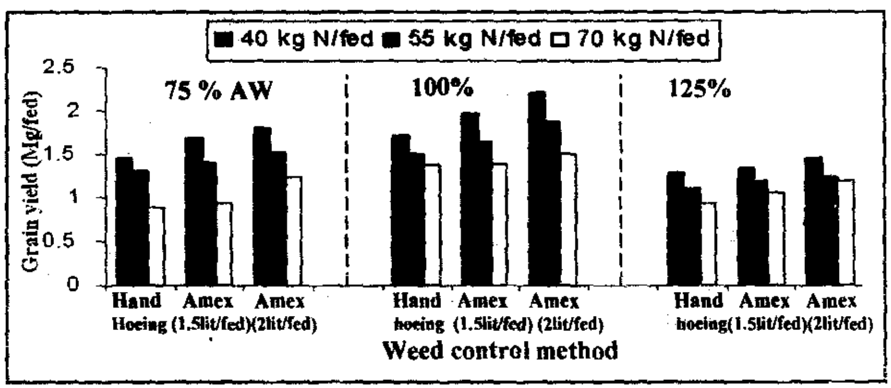


Fig.4: Total yield of green beans under different levels of available water, nitrogen rates, and weeds control methods

Water use efficiency (WUE)

Data presented in Fig. 5 showed that increasing levels of available water from 75 to 125%, the value of WUE decreased by 43.5%. As to fertilization, changing the nitrogen rate from 40 to 70 kg N/fed, the value of WUE decreased by 19.8%.

Fertilizer use efficiency (FUE)

Data presented in Fig. 6 showed that FUE was significantly affected by levels of available water and nitrogen rates. Increasing nitrogen rates from 40 to 70 kg N/fed, lead to decreasing of FUE by 35.9%. Generally, the value of FUE increased slightly as increasing of levels of available water from 75 to 100% and decreased with 125%. The highest value of FUE was 33.43 kg yield/kg N at level of available water 100%, followed by 27.02 and 23.45 kg yield/kg N at levels of available water 75 and 125% respectibely.

Cost of production unit

Results in table 3 revealed that cost of production unit was significantly affected by level of available water, nitrogen rate and weed control methods. The minimum costs of production unit of 346.4 and 370 LE/Mg were recorded with level of available water of 100% and nitrogen rate of 40 kg N/fed under herbicides Amex of 2 and 1.5 lit/fed, respectively.

Meanwhile, the maximum value of 1216 LE/Mg was recorded with level of available water of 125% and nitrogen rate of 70 kg N/fed under hand hoeing.

Net profit

The net profit as influenced by levels of available water, nitrogen rates, and weed control methods shown in table 3. The highest net profit value was 2545.9 LE/fed at nitrogen rate of 40 unit and herbicide Amex of 2 lit/fed under level of available water of 100%, but the lowest value was 324.8 LE/fed at nitrogen rate of 70 kg N/fed and hand hoeing under level of available water of 75%.

SUMMARY AND CONCLUSION

The study concluded to:

1- Best soil moisture distribution was recorded around the emitter under available water of 100%.

2-The emitter clogging percentage gradually increased

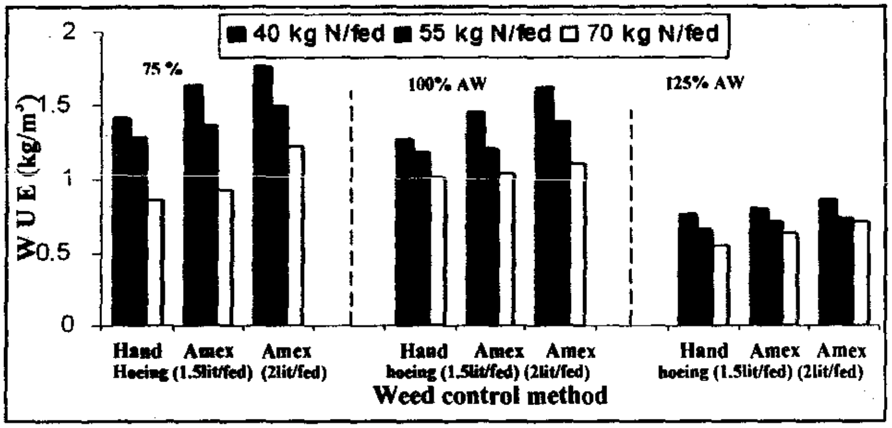


Fig.5: Water use efficiency (WUE) under different levels of available water, nitrogen rates, and weeds control methods

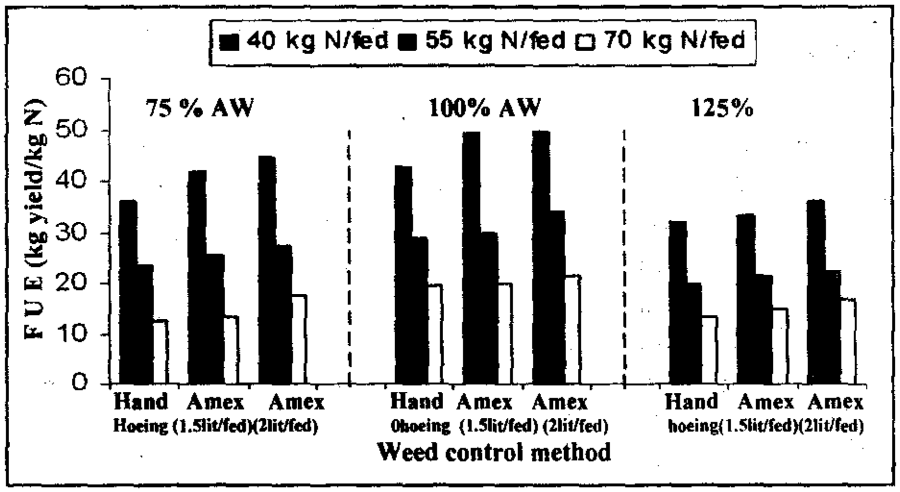


Fig. 6: Fertilizer use efficiency (F U E) under different levels of available water, nitrogen rates, and weeds control methods

Table 3; Total phaseolus production costs and net profit under different treatments

Levels of available water	Weed control methods	Nitrogen rate (kg N/fed)	Irrigation cost (LE/fed)	Fertilize, weed pest cost	Total costs (LE/fed)	Total yield (Mg/fed)	Cost of prod. unit (LE/Mg)	Net profit (LE/fed)
75%	Hand hoeing	40	362.53	536.50	899.03	1.4448	689.6	1267.9
		55	362.53	582.51	945.03	1.3048	727.1	1012.2
		70	362.53	628.51	991.03	0.87724	1070.8	324.8
	Herbicide Amex (1.5 lit/fed)	40	362.53	361.51	724.03	1.6781	546.4	1793.1
		55	362.53	407.50	770.03	1.400	596.9	1329.9
		70	362.53	453.51	816.03	0.9332	800.3	583.7
	Herbicide Amex (2 lit/fed)	40	362.53	396.51	759.03	1.7938	482.3	1931.7
		55	362.53	442.51	805.03	1.5156	574.6	1468.4
		70	362.53	448.51	851.03	1.2412	659.9	1010.7
100%	Hand hoeing	40	368	536.5	904.5	1.7129	577.0	1664.9
		55	368	582.5	950.5	1.5979	603.5	1446.4
		70	368	628.5	996.5	1.3632	770.4	1048.3
	Herbicide Amex (1.5 lit/fed)	40	368	361.5	729.5	1.9712	370.8	2227.3
		55	368	407.5	775.5	1.6342	508.2	1675.8
		70	368	453.5	821.5	1.3896	622.9	1262.9
	Herbicide Amex (2 lit/fed)	40	368	396.5	755	2.2069	346.4	2545.9
		55	368	442.5	810.5	1.8739	405.1	2000.4
		70	368	448.5	856.5	1.5015	570.0	1395.8
125%	Hand hoeing	40	373	536.5	908.5	1.2852	895.3	1019.3
		55	373	582.5	954.5	1.1040	855.0	701.9
		70	373	628.5	1001.5	0.9315	1216.0	395.8
	Herbicide Amex (1.5 lit/fed)	40	373	361.5	733.5	1.1883	617.4	1272.5
		55	373	407.5	779.5	1.3373	694.8	1002.9
		70	373	453.5	826.5	1.05532	800.0	756.5
	Herbicide Amex (2 lit/fed)	40	373	396.5	768.5	1.4404	600.1	1396.6
		55	373	442.5	814.5	1.2334	675.9	1035.6
		70	373	448.5	701.5	1.1706	728.9	918.4

with increasing levels of available water and fertilizer doses.

3- Minimum emitter clogging was obtained under nitrogen rate of 40 kg N/fed at different stages.

4- The level of available water of 75% gave the lowest weed fresh weight of 220.8 gm/m^3 under herbicide Amex of 2 lit/fed at nitrogen rate of 40 kg N/fed, but the level of available water of 125%, gave highest weed fresh weight of 487.5 gm/m^3 under hand hoeing.

5- Maximum yield of phaseolus of 2.2069 Mg/fed obtained under level of available water of 100% at nitrogen rate of 40 kg N/fed and herbicide Amex of 2 lit/fed.

6- Maximum fertilizer use efficiency was 55.172kg yiled/kg N at nitrogen rate of 40 kg N/fed and herbicide Amex of 2 lit/fed under level of available water of 100%.

7- The minimum costs of production unit were 346.4 and 370.8 LE/Mg for level of available water of 100% and nitrogen rate of 40 kg N/fed under herbicide Amex of 2 and 1.5 lit/fed, but the maximum value was 1216 LE/Mg under level of available water of 125% at nitrogen rate of 70 kg N/fed and hand hoeing.

8- The highest nit profit values was 2545.9 LE/fed at herbicide Amex of 2 lit/fed under nitrogen rate of 40 kg N/fed and level of available water of 100%.

Finally, it could be recommended that, under similar conditions, using level of available water of 100%, nitrogen rate of 40 kg N/fed and herbicide Amex of 2 lit/fed for phasolues was recommended for achieving best soil moisture distribution, highest grain yield of phaseolus, the highest fertilizer use efficiency, minimum cost of production unit and highest net profit.

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استجابة محصول الفاصوليا للأسمدة والكيماويات تحت نظام الرى بالتنقيط

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السادات إبراهيم عبد العال - هانى مجاهد سماحه

قسم الهندسة الزراعية- كلية الزراعة- جامعة الزقازيق .

أصبح الماء من أهم المصادر الاقتصادية النادرة فى معظم مناطق العالم العربى لذلك كان من الضرورى عمل تحسين مستمر فى إضافة المياه والأسمدة بهدف الوصول لأعلى كفاءة تسميد مع أقل فقد فى الأسمدة المضافة وأعلى كفاءة ترشيد للمياه والحصول على أعلى إنتاج محصولى وتقليل تكاليف الإنتاج بشكل اقتصادى لذلك اتجه التفكير فى هذا البحث إلى دراسة تأثير إضافة كميات مختلفة من مياه الرى والأسمدة النيتروجينية وطرق مقاومة الحشائش بهدف الحصول على أنسب كمية مياه مضافة وأنسب معدل سماد نيتروجينى وأفضل طريقة لمقاومة الحشائش وأفضل معدل لمبيد الحشائش على إنتاج الفاصوليا الخضراء تحت نظام الرى بالتنقيط فى الأراضى الرملية. حيث تم تنفيذ التجربة فى مزرعة كلية الزراعة بالخطارة خلال موسم صيف ٢٠٠٣ وذلك باستخدام ثلاث كميات من مياه الرى وهى٧٥ ، ١٠٠، ١٢٥ % من الماء الميسر مع استخدام ثلاث معدلات من التسميد النيتروجينى وهى ٤٠ ، ٥٥ ، ٧٠ كجم نيتروجين/فدان وطريقتين لمقاومة الحشائش وهى العزيق اليدوى والمقاومة الكيماوية بإضافة مبيد الحشائش إميكس تحت معدلين ١,٥ ، ٢ لتر للفدان .

وقد كانت أهم النتائج المتحصل عليها ما يلى :

١- حققت الكمية المضافة ١٠٠% من الماء الميسر أفضل توزيع للرطوبة حول النقاطات .

٢- تزاد نسبة انسداد النقاطات عموماً عند زيادة كميات المياه المضافة وجرعات التسميد المضافة .

٣- أدت زيادة كمية المياه المضافة من ٧٥ إلى ١٢٥% من الماء الميسر إلى زيادة كمية الحشائش الناتجة ، وكانت أقل كمية حشائش ناتجة مع مبيد الحشائش إميكس ٢ لتر للفدان .

٤- أعلى كمية محصول فاصوليا خضراء (قرون) متحصل عليه كانت ٢,٢٠٦٩ ميجا جرام/فدان وكذلك نجد أن أعلى كفاءة استخدام للسماد ٥٥،١٧ كجم/كجم.نيتروجين تحت كمية المياه المضافة بمعدل ١٠٠% من الماء الميسر وعند معدل نتروجين ٤٠ كجم نيتروجين/فدان ومبيد حشائش إميكس ٢ لتر/فدان.

٥- أقل تكلفة لوحدة الإنتاج كانت ٣٤٦ جنيه/ميجاجرام وكذلك أعلى ربح لمحصول الفاصوليا الخضراء كان ٢٥٤٥,٩ جنيه/فدان عند معدل تسميد نتروجينى ٤٠ كجم نيتروجين/فدان ومبيد حشائش إميكس (٢ لتر/فدان) تحت كمية المياه المضافة بمعدل ١٠٠% من الماء الميسر.

وبناء على النتائج السابقة يمكن التوصية عند زراعة محصول الفاصوليا فى الأراضى الرملية تحت نفس الظروف باستخدام نظام الرى بالتنقيط مع إضافة كمية مياه الرى بمعدل ١٠٠% من الماء الميسر ومعدل تسميد نيتروجينى ٤٠ كجم نيتروجين/فدان وإضافة مبيد الحشائش إميكس بمعدل ٢ لتر/فدان مع مياه الرى للحصول على أعلى إنتاج للمحصول (٢,٢٠٦٩ ميجا جرام/فدان) وأقل تكاليف لإنتاج الميجاجرام من المحصول (٣٤٦ جنيه) وأعلى صافى للربح (٢٥٤٥ جنيه) .