UTILIZATION CHEMIGATION TO REDUCE PEAS CONTAMINATION WITH PESTICIDE IN NEW RECLAIMED LANDS

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Abstract

The aim of this study is to reduce Peas contamination with herbicide by applying chemigation in new reclaimed lands through drip irrigation systems. The herbicide (butralin) was injected with recommended rate (2.5 Kg/Fed) through subsurface and surface drip irrigation systems with two flow rates of 8 and 12 l/h/m tube under sandy soil conditions in winter and summer seasons 2016. The results showed that the highest productivity of the peas was (5570 kg / Fed) with water use efficiency (WUE) of (2.31 Kg / m3) and more uniformity under the following conditions: the subsurface drip irrigation system at an flow rate of 8 l / h/m – tube (dripper flow rate of 4 l/h) and 50 cm emitters spacing, injection of the herbicide (butralin). It is wearthly to mention that no (butralin) residues were found in Pea yield produced under subsurface drip irrigation systems (10 cm depth), 50 cm emitters spacing and 8 l/h/m flow rate under the manured sandy soil.

Keywords: Drip irrigation, Herbicide (Butralin), Water use efficiency.

INTRODUCTION

The increasing of application both water and agro-chemicals is contributing in environmental problem and human health hazard. So, the cultivating in new reclaimed land with modern techniques such as micro irrigation (drip), fertilizer and protections should be eliminated these problems.

Egyptian government has targeted to increase Pea production in new lands cultivations. The cultivated area reached 19525 fed in 2013 up from 6796 fed in 1995. The increasing ratio was 65% (Agricultural Statistics, 2013). Application of pesticide through a drip irrigation system adds a new dimension to irrigation system and becomes a multifunction unit able to supply crops with necessary water and agrochemicals at the same time (El-Gindy & El-Araby, 1996 and Locascio *et al.,* 1997). The advantages of drip-injection of insecticides over ground application methods include a uniform distribution of insecticide throughout the plant; a reduction in pesticide application inputs, including manpower and vehicle or tractor fuel; and a reduction in soil compaction, plant disturbance, and applicator exposure to pesticides. Insecticides applied through a drip irrigation system can replace or reduce the number of foliar insecticide sprays, reducing the risks to nontarget species (Gerald *et al.* (2012). The emitters' line materials and other equipment must be resistant to chemicals that may be injected into irrigation system, such as fertilizers, bactericides, insecticides, herbicides and fungicides (Nakayama *et al.,* 1979). Application of pesticide through an irrigation system from a drip source is not prone to aerial drift away from the treated area as in the case with sprinkler and sprayer application. Also, there is less potential for pesticide transport by runoff and erosion because there are no pesticide residues on the plant and soil surfaces to wash off (Threadgill, *et al.,* 1990). Applications of butralin (3000 p.p.m.) increased shoot growth in the tree head and stem thickening (Quinlan and Pakenham,1984). The control of *C. album* and *S. nigrum* was achieved with butralin by 94% and increased yields by 17-29% in soybeans (Regnault, 1986). Low rates of butralin did not control the weed, but normal recommended doses resulted in 85% control. (Demirci and Nemli, 1996). Monitoring and settings of maximum residue levels for pesticide residues in food commodities is an effective control mechanism for safety of the consumers to combat health impacts of toxic chemicals. There is evidence to show that consumption of organic crops is healthier than non-organic. In most of the research findings higher pesticide residues are found in non-organic crops than organic ones, organic crops are also rich in antioxidants. Processing method like washing, immersing, peeling, husking, cooking, boiling and frying are reported to reduce the level of pesticide residue in plant foods (Kumera and Neela 2016). It suits a pest management program well because many of the new-chemistry insecticides labeled for drip/trickle irrigation system application are selective to specific insect pests and, because they are applied to the plant root zone, are generally less toxic to beneficial and non-target organisms (Gerald, 2012). A safe and effective chemigation with drip and overhead irrigation system must include the following components: a functional check valve, vacuum relief valve and low pressure drain on the irrigation pipeline to prevent water source contamination from backflow. The pesticide pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back to the injection pump.

1- The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the system is either automatically or manually shut down.

2- Further, the system must contain a functional interlocking control to automatically shut off the pesticide injection pump when the water pump motor stop.

3- Finally, the water pump must include a functional pressure switch which will stop the water pump when the water pressure decreases to the point where pesticide distribution is adversely affected (Rutgers, 2018). There is an urgent need to educate farmers around Hyderabad megacity to practice organic farming to grow vegetables and other crops to minimize the use of chemical pesticides in order to avoid adverse effects of pesticide residues in urban water bodies and also in food chains. The organic farming practices when adopted have demonstrated its effectiveness in reducing the use of pesticides in farming which resulted in lower pesticide residues (Rajeshwari *et al.,* 2011). The aim of this study is to reduce Peas contamination with herbicide by applying chemigation in new reclaimed lands through drip irrigation systems

MATERIAL AND METHODES

Experimental layout:

The experiments were carried out during 2016 in private farm (green revolution Km 31 Egypt-Alexandria road after the intelligent village). The farm has the latitude of 30°04'37.0 N the longitude of 30°59'53.5 E. The experimental area of 400 m^2 (20m x 20m) was divided into two plots 10 × 20 m for surface and subsurface (10 cm depth) drip irrigation systems (Fig1). Every plot was divided into four subplots. The first four subplots assign to flow rate 8 l/h/m-tube with 50 cm emitters spacing under surface drip irrigation system .The 1 st and 2 nd subplots of them carried out under sand soil and the 3 rd and 4 th subplots sand soil with manure under subsurface drip irrigation system (Farm manure was added to sandy soils with 20kg/Fed). The second four subplots irrigated by flow rate 12 l/h/m-tube (33 cm between drippers) with sand soil and sand soil with manure (Farm manure was added to sandy soils with 20kg/Fed) at the same procedures with the first four subplots. Every plot was treated by Butralin (Amex) and injected through the drip irrigation systems by using positive displacement magnetic pump after one month of planting as a protection treatments. Pea seeds were sowed on 1 October, 2016.

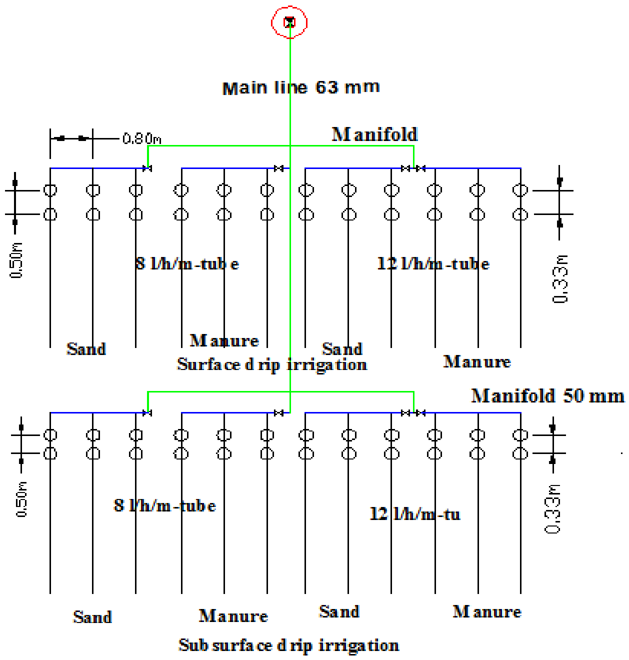

Fig 1: The experimental layout

Herbicide characteristics

Herbigation studies were conducted for limiting herbicide contamination on Peas in new land via drip irrigation systems (surface and subsurface). According to Ministry of Agriculture Herbicide (Butralin) was applied with the recommended rate of 2.5 kg/fed. According to Hartley and Kidd (1985) Butralin having the following characteristics:

-Molecular formula: $C_{12} H_{21} N_3 O_4$

-Chemical name: 4-(1, 1-dimethylethyl)-N-(1-methylpropyl)-2, 6-dinitrobenzenamine

- Solubility in water: 0.3 mg/ l (25 °C)

-Toxicity classification (WHO) of formulation: Low III

-Environmental Fate in soil: 21 days.

-EPA classification: IV

-Toxicity: Male rat (Oral) LD $_{50}$ 1170, female rats 1049 mg/Kg. Inhalation LC $_{50}$ for rats >9.35 mg/L of air.

-Recommended tolerance: Code of federal register EPA revised July 1, 83 : 0.1 p p m.

Determination of yield:

Yield=Average weight fruit/ plant × Number of plant/fed

Amount of irrigation water Applied:

Table 1. Showing that :Growth period, References Evapotreanspiration (ET_O),Crop Evapotreanspiration (ET_C) and Crop Coefficient(K_C) according to(FAO 1998).

	Growth period				Total
	Initial stage(25 day)	Development stage(30 day)	Mid stage(35 day)	Late stage(25 day)	
K_c	0.45	0.8	1.15	1.05	
ET_o	11.1	6.25	4.3	4.8	
ET_c mm	4.99	5.00	4.95	5.04	
Total	25×4.99=124.75 mm/ period	30×5.00=150 mm/ period	35×4.95=173.25 mm/ period	25×5.04=126 mm/period	574 mm/season

As crop evapotranspiration ET_C can be calculated as (Allen *et al.,* 1998).

$$ET_C = ET_O \times K_C$$

ETc=Crop evapotreanspiration

KC= Crop coefficient

ETo=Reference crop evapotreanspiration

The amount of Crop water Requirements was (2411 m^3/Fed/season) according to (Allen *et al.,* 1998).

$$CWR = ET_C \times 4.2$$

CWR=574 mm/season/Fed ×4.2 = 2411 m^3/season/Fed

CWR= Crop water Requirements

Experimental Treatment:

-Irrigation system: Surface and subsurface drip irrigation

-flow rate: 8 and 12 l/p/h/m-tube flow rate

-Soil texture: Sand soil and sand soil with manure-

-Control treatment: Area (10m ×10m). Soil: sand. Herbicide treatment: Non chemigation

Calculating water use efficiency (WUE): Water use efficiency WUE) was **computed as following** :(Howell *et al.,* 1995).

W.U.E. (kg / m^3), = Yield (kg / Fed) / Water use (m^3/ Fed) × 100

Determination of the relative productivity% = **Treatment** / **Control × 100**

Determination of pesticide residues in Pea fruits by Gc- chromatograms:

Determination of butralin residues in Pea fruits by Gc- chromatograms according to the Environmental Research Unit Toxicology, Faculty of Agriculture, Ain-Shams University.

RESULTS AND DISCUSSION

The effect of drip irrigation systems on Pea productivity can be presented in Table (2) that revealed the productivity of Pea (kg / Fed) was affected by drip irrigation systems performances, distance between emitters, flow rates, and injected herbicide to the soil through irrigation. The highest yield value (5570 kg/Fed) was obtained by using the subsurface drip irrigation systems (10 cm depth), 50 cm emitters spacing and sand soil mix with manure and of 8 l/h/m flow rate chemigated by herbicide Butralin .The yield was increase by 26.6% as compared to no applied herbicide with subsurface drip irrigation systems . This may be due to the performance advantages of using the new of herbigation techniques. (Agarcio , 1985). On the other hand, the lowest yield (4075 Kg/Fed) was recorded by using herbicide with surface drip irrigation systems, emitters spacing 33 cm, sand soil, and 12 l/p/h/m flow rate .The yield decreased by 7.4 % as compared to no applied herbicide with surface drip irrigation systems. This may be due to the great interference between chemicals in the area of the root zone.

Data in the same table showed that the productivity with 12 l/h/m-tube was less than that of 8 l/h/m-tube. This may be attributed to the good performances of both tested drip irrigation systems and herbigation process in improving the water use efficiency and prevention weeds to share the nutriment with Pea plants.

Table 2. Effect of butralin herbicide application through drip irrigation systems on Pea productivity.

Irrigation system	Soil condition	Applied flow rate l/h/m-tube	Yield		Yield of control treatment	The amount control of water use
			kg/Fed	Relative productivity%		
Surface drip irrigation	Without manure	8	4949	112.5	4400 Kg/Fed (Surface (irrigation	3520 m^3/season (Surface (irrigation
		12	4075	92.6		
	With manure	8	5110	116.1		
		12	4489	102.0		
Subsurface drip irrigation	Without manure	8	5041	114.5		
		12	4436	100.8		
	With manure	8	5570	126.6		
		12	4650	105.7		

Also, the results in Table (2): showed that the productivity of pea with12 l/h/m flow rate was less than that achieved with 8 l/h/m-tube flow rate by using both of subsurface and surface drip irrigation systems. This may be attributed to the good characteristics of both drip irrigation systems, herbigation approach, improve the water use efficiency and prevention weeds to share the nutrient of pea. Because of the close relation between the rate of soil intake and the actual flow rate for the irrigation systems, so the application of 8 l/h/m flow rate may improve the sandy soil intake losses. This approach will reach to the highest graduate for water management under arid conditions.

As conclusion, the obtained results showed that, the use of subsurface drip irrigation systems buried at 10 cm depth, with 8 l/h/m-tube flow rate and 50 cm emitters spacing under mix soil proved more suitable to cultivate Pea, in comparison with other irrigation systems. These results are in agreement with Sultan, 2002 who found that irrigation systems with 8 l/h /m-tube flow rate, 50 cm distance between emitters, and 10 cm (subsurface) depth were more efficient to use in the new land for vegetable production.

In this concern, weed control by proper herbicide with subsurface drip irrigation systems, 8 l/h/m-tube flow rate, 50 cm emitters spacing , under sandy soil mix with manure proved necessary for achieving good production of pea (5570 kg/fed) with more uniformity in case of the suitable 8 l/h/m-tube flow rate .

Data presented in Table (3) show that water use efficiency (WUE) of pea was markedly affected by the drip irrigation systems characteristics and butralin application. The herbicide butralin showed the highest values of WUE 2.31 and 2.12 kg/ m^3 with 8 l/h/ m-tube flow rate were obtained when Pea was irrigated by subsurface buried at 10 cm depth and surface drip irrigation systems, respectively. The WUE was increased by 54 % as compared to no chemigation treatment. Whereas the systems with 12 l/h/ m flow rate, 33 cm emitters spacing for surface and subsurface drip irrigation systems with sand soil showed the lowest WUE (1.69-1.83 kg/ m^3).The other treatments gave an intermediate WUE values (1.90 to 1.86kg/ m^3).

Table 3. Effect of butralin herbicide application through drip irrigation systems on Pea Water use efficiency WUE (Kg/m^3).

Irrigation system	Soil condition	Flow rate l/h/m-tube	WUE (Kg/m^3).	Yield (kg/Fed)
Surface drip	Without manure	8	2.05	4949
		12	1.69	4075
	with manure	8	2.12	5110
		12	1.86	4489
Subsurface drip	Without manure	8	2.09	5041
		12	1.83	4436
	with manure	8	2.31	5570
		12	1.90	4650

WUE Control 1.25 Kg/m^3 (No chemigation)

Data concerning the residues of the herbicide butralin (Amex) in pea produced under drip irrigation system (surface and subsurface) and chemigation through growing stage of pea plants with irrigation water at 8 and 12 l/h/m flow rates are tabulated in Table (4) . Examination of the obtained result indicated the absence of pesticide residues in pea harvest. This finding was pronounced with the herbicide treatment with the two discharge rates of water 8 and 12 l/h/m flow rate under subsurface and surface drip irrigation systems.

The disappearance of herbicide residues in pea grown under drip irrigation system (subsurface and surface) and chemigation treatments at two rates 8 and 12 l/h/m flow rate in manured and sandy soils may be explained because the rapid degradation and hydrolysis of the tested herbicide in water and soil.

Also, microbial degradation may be played important role besides the adsorption of these compounds in soil. Our findings are in agreement with that obtained by Capri, *et al.,* 1998 who reported that despite the large number of applications done during the cultivation of the crop no residue was found in the plant or the fruit (quantification limit < 0.01 mg/kg). Under these conditions butralin showed a low environmental impact and was of low persistence and mobility in the soil profile.

Table 4. Residues of tested herbicide (Butralin) in Pea under drip irrigation systems and herbicide use.

Pesticides used	Residues in pea harvest (PPM)							
	8l/p/h/m				12 l/p/h/m			
	Subsurface		Surface		Subsurface		Surface	
	Manure + Sand soil	Sand soil	Manure + Sand soil	Sand soil	Manure+ Sand soil	Sand soil	Manure+ Sand soil	Sand soil
Butralin (Amex)	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D

N.D =Not-detected (Less than the limit of detection (LOD) of 1 ppb.)
According to the laboratory of Environmental Research Unit of Toxicology, Faculty of Agriculture, Ain-Shams University.

CONCLUSION

Reviewing the obtained results, it could be concluded that the application of butralin herbicide with subsurface drip irrigation systems, 50 cm emitters spacing and 8 l/h/m-tube flow rate and amended soil by added manure at 20 kg/Fed was more efficient in pea WUE and yield and resulted in the absence of herbicide residue in Pea yield. Drip irrigation systems with 8 l/h/m-tube flow rate proved more efficient to increase pea WUE than 12 l/ph/m flow rate. Weed control by proper herbicide is necessary for achieving good WUE (2.31- 2.12 kg/m^3).

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استخدام الرى الكيميائى فى تقليل تلوث ثمار البسلة بالمبيدات فى الأراضى المستصلحة الجديدة

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تم أستخدام أنظمة الرى بالتنقيط السطحى و تحت السطحى مع تصرفات 8 و12 لتر/ساعة للمتر الطولى للخرطوم الـ 16 مللى وذلك فى حالة اضافة مادة عضوية للاراضى أو بدون اضافة ومع استخدام الجرعة الموصى بها من قبل وزارة الزراعة لمبيد الحشائش بيوترلين (أمكس) بمعدل 2.5 لتر/ للفدان و حقن المبيد بعد شهر من الزراعة كمعاملة وقائية على محصول البسلة موسم 2016 وذلك لإلقاء الضوء على إمكانية استخدام الرى الكيميائى فى تقليل تلوث ثمار البسلة بالمبيدات تحت ظروف الأراضى المستصلحة الجديدة .

وأظهرت النتائج تحقيق أعلى إنتاجية للبسلة (5570 كجم/ فدان) مع حقن مبيد الحشائش بيوترلين (امكس) وعند استخدام نظام الرى بالتنقيط تحت السطحى بمعدل تصرف 8 لتر/ ساعة للمترالطولى ومسافة 50 سم بين النقاطات فى الأراضى الرملية المخلوطة بالمادة العضوية وكذلك امكن تحقيق أعلى كفاءة لاستخدام المياه WUE (2.31 كجم/ م^3) مع نفس نظم الرى السابقة عند نفس المستوى من التركيز لمبيد الحشائش بيوترلين (أ مكس) .وبذلك يكون أضافة مبيد الحشائش بيوترلين أمكس مع نظام الرى بالتنقيط التحت سطحى ومسافة بين النقاطات 50 سم أثبتت انها أكثر فاعلية لزيادة إنتاجية البسلة واحسن إنتظامية لتوزيع المياة (معدل تصرف 8 لتر للمتر الطولى / الساعة).

وأظهرتحليل عينات من ثمار البسلة بعد الحصاد من القطع المعاملة عدم وجود متبقيات المبيد فى الثمار الناتجة تحت نظام الرى الكيميائى بالتنقيط تحت السطحى بمعدل تصرف 8 لتر للمتر الطولى / الساعة ومسافة 50 سم بين النقاطات مع مستوى التركيز الموصى به لمبيد الحشائش بيوترلين (أمكس) فى الأراضى الجديدة الرملية مخلوطة بالمادة العضوية.