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EFFECT OF SOME MICRONUTRIENTS ON THE YIELD AND ALKALOIDS CONTENT OF HARMAL CULTIVATED PLANT (*PEGNAUM HARMALA* L.)

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Abstract

In a study conducted on harmal plant (*peganum harmala* L.) at Seds Experimental Station in Beni-Swaif Governorate, three powdered micronutrients formulations and two liquied ones named Wadi (3% Zn, 4.5 Mn and 1.5% Fe), Sahara (5% Zn, 3.5% and 1.7% Fe), Giri (3.8% Zn,, 3.8% Mn and 3.8% Fe), Shiring-Zn (4% Zn, 2.7 Mn and 1.3% Fe) and shiring-Mn (2.8% Zn, 4.2% Mn and 1.4% Fe) respectively, were foliarly applied for three times at the rate of 1.5 g/L. or 1.5 ml/L for the powedered and liquid forms, respectively, starting at flowering and after three week intervals. The results revealed that all the formulations applied increased the fresh and dry weight yields of herb, roots and the whole plant, as well as the alkaloid content in comparison with the control. The "Wadi formulation produced the highest yield of fresh and dry herb and roots. However, it may be considered that the "Shiring-Mn" formulation is the favourable one to obtain the highest yield of alkaloids.

INTRODUCTION

Peganum harmala L. (Harmal) Zygophyllaceae, is a herbaceous plant growing wild in deep sandy places in Egypt, Miditerranean coast strip from El-Sallum to Rafah (Tackholm 1974). The plant was used medicinaly as anthelmintic (tape worms),

lactagogue and against malaria (Chopra and Chopra 1958), antimicrobial (Ross *et al.* 1980) and hypotensive (Siddiqui *et al.* 1987). Also normal seeds have nematocidal effects (Sharma *et al.* 1982) and allelopathic effects on seed germination (Mohammad *et al.* 1982). In this connection, most of the work done on *P. harmala* L. dealt with isolation and indentification of alkaloids as well as their uses and applications in medicine or in other purposes (e. g. nematocide). Hilal *et al.* (1977) identified the alkaloids peganine, harmaline and harmine in the different organs of the plant, also they estimated the individual alkaloids by using T.L.C. and G.L.C. techniques; and reported the sum of total alkaloids calculated as harmine in the following values for the cultivated plants. 1.60%, 1.88% and 1.88% for leaves, stems and roots respectively. Jado *et al.* 1979 isolated the alkaloids of *peganum harmala* L. growing in Saudi Arabia and they determined the total alkaloids in the plant organs by non-aqueous titration method.

Regarding the effect of micronutrients on the active ingredients in the medicinal plants, (Ebrahim 1981) reported that Zinc deficiency affected the total content of alkaloids of *Hyoscyamus muticus* L. Koreish and Helmy (1984) found that spraying of *Datura stramonium* L. plants with 0.25% zinc sulfate singly or in combination with 0.1% ferrous sulfate increased fresh and dry weight of leaves as well as the total alkaloids. Zaied (1984) reported that spraying of Saponaria officinalis L. with Zn, Mn and Fe either separately or combined, resulted generally in high significant increases of saponin content in the different plant organs and the whole plant compared with the control. Haridi (1986) working on periwinkle plants (*Catharanthus reseus* G. Don.), reported that spraying plants with Zinc at the rate of 100 ppm stimulated significantly the herb and dry matter production as well as alkaloid perecentage and yield (as perivine).

The aim of this investigation is to study the effect of three chelated microelments namely, zinc, manganese and iron, and alkaloids of harmal. Such a study was achieved by the foliar application of five commerical formulations containing the suggested three elements in order to find out the favourable one leading to obtain higher yield of harmal herb and alkaloids as well.

MATERIALS AND METHODS

Harmal seeds were collected from the desert area of Borg El-Arab (north

Table 1. Chemical composition of five micronutrient commerical formulations.

No.	Commercial Name	% Micronutrient Zin	Manganese	Iron	Form	
1	Wadi	3.0	4.5	1.5	Powder	(1)
2	Sahara	5.0	3.5	1.7	Powder	(1)
3	Giri	3.8	3.8	3.8	Powder	(1)
4	Shiring-Zn	4.0	2.7	1.3	Liquid	(2)
5	Shiring-Zn	2.8	4.2	1.4	Liquid	(2)

coast of the Mediterranean sea) and used in the present investigation. The experiment was conducted in Seds Experimental Station, Beni-Swaif Governorate for two successive seasons of 1987 and 1988 respectively. Such experiment was performed to study the effect of foliar spraying with five commerical formulations containing zinc, manganese and iron in a chelated form.

Three powdered micronutrient commerical formfulations in addition to two liquid ones were used in the present investigation. The powdered formulations were produced by BASF Company, West Germany and having the following names Wadi, Sahara and Giri, while the liquid ones were produced by Shiring Company West Genmany and having the following names Shiring-Zn and Shiring-Mn. The chemical composition of the used formulation. are shown in Table1.

The experiment consisted of the five previously mentioned formulations (i. e. Wadi, Sahara, Giri, Shring- Zn and Shiring - Mn respectively) in addition to the control treatment so, there were 6 treatments with three replicates, The plot area was $12m^2$ comprising 5 rows 60cm apart and 4m long. The plants were spaced by 40 cm apart. The complete Rand. block design was followed as experimental design in this respect. Soil samples representing the experimental area were taken, well mixed and subjected to chemical analysis for macro and micro elements. The macro element contents were 6.32, 7.83, 180.10 and 58.95 mg/100 grams for nitrogen,

phosphorous, potassium, magnesium and sodium respectively whereas the contents of microelements were 44.9, 24.9, 0.42 and 6.03 pppm for iron, manganese, zinc and copper respectively. Also, the conductivity and pH were found to be 0.36 mmohs and 8.44 respectively.

The seeds were sown on February 1st, major element fertilization was done for all plants using the following quantities: 200 kg calcium super phosphate (15.5% P_2O_5), 400 kg ammonium sulfate (20.6 %N) and 100 kg potassium sulfate (48% K_2O) per feddan (4200 m^2). Soil and plant management were done as usually followed for herbacous plants. Regarding micronutrient application, the plant received 3 sprays in the concentration of 1.5 gram or 1.5 milliters per liter for the powdered or liquid types respectively. The first spray was applied at the begining of flowering, while the second and third sprays were applied later at 3 week intervals. The flowering started on April 9th and 5th of the 1987 and 1988 seasons respectively while fruit setting started on April 22th and 16th of the two respective seasons. The statistical analysis was carried out according to Snedecor and Cochran (1956). At harvesting date on July, two representative plant samples were taken from each plot, then fresh weight of the whole plant and plant parts (herb and roots) followed by the deternination of dry weight at 105°C (AOAC 1960) were recorded in order to calculate fresh and dry weight yields. Meanwhile similar samples were taken, dried at 50oC, finely ground and kept for chemical estimation of alkaloids.

The estimation of alkaloids was carried out using non-aqueous titration method according to Jado *et al.* (1979) and Vogel (1975). The alkaloids previously extracted according to Hilal *et al.* (1977) were dissolved in 5 ml of chloroform and 5 ml of glacial acetic acid then the alkaloids were titrated with 0.05 N acetous perchloric acid in the presence of crystal violet indicator to the green violet color. The results were calculated in terms of harmine ,using the molecular weight of harmine ($C_{13}H_{12}N_2O$) and the volume of perchloric acid consumed in the titration.

RESULTS AND DISCUSSION

The results mentioned herein are dealing with the effect of foliar spraying

with five commerical formulations (i. e. Wadi, Sahara, Giri, Shiring-Zn and Shiring-Mn). Containing Zinc, Manganese and Iron, on both plant and alkaloidal yields of *P. harmala* L. in 1987 and 1988 seasons.

1 Fresh and dry weight yields:

Data presented in Tables 2 and 3 show the effect of foliar spraying with the five used formulations. on the fresh and dry weight per plot of the whole plant herb and roots or p. harmala L. in 1987 and 1988 seasons respectively. The results indicated that most of the applied treatments produced a high significant fresh and dry weight yield/plot in comparison with the control. The exception was found in formulation 3 (Giri) which did not exhibit significant effect. The highest significant value was recorded in treatment 1 (Wadi) followed by treatments 5, 2 and 4 corresponding to Shiring manganese, Sahara and Shiring zinc formulations respectively. The

Table 2. Effect of foliar spraying with some micronutrient formulations on the fresh weight yield (kg/polt) of harmal plants in 1987 and 1988 seasons.

No.	Commercial Name	1987			1988		
		Herb	Roots	Whole plant	Herb	Roots	Whole plant
1	Wadi	159.50	7.70	167.20	150.40	8.03	158.43
2	Sahara	140.15	6.67	146.82	134.78	6.25	141.03
3	Giri	94.50	3.70	98.20	103.78	4.75	108.53
4	Shiring-Zn	106.52	4.27	110.79	119.27	5.53	124.80
5	Shiring-Mn	149.23	6.88	156.11	144.28	7.52	151.80
6	Control	91.03	3.67	94.70	100.12	4.73	104.85
L.S.D 5%		15.70	2.71	13.40	20.77	1.38	7.14

Table3. Effect of foliar spraying with some micronutrient formulations on the dry weight yield (k/plot) of harmal plant in 1987 and 1988 seasons.

No.	Formulation	1987			1988		
		Herb	Roots	Whole plant	Herb	Roots	Whole plant
1	Wadi	88.38	5.57	93.95	84.65	5.83	90.48
2	Sahara	78.96	4.83	83.79	75.65	4.49	80.14
3	Giri	53.20	2.69	55.89	59.23	3.46	62.69
4	Shiring-Zn	61.23	3.10	64.33	67.11	4.00	71.11
5	Shiring-Zn	83.50	4.96	88.46	80.86	5.42	86.28
6	Control	51.64	2.63	54.27	57.25	3.40	60.65
L.S.D 5%		10.57	1.973	7.57	9.61	0.99	3.72

obtained result could be explained by refering to Table 1. It is obviously shown that formulation 1 (Wadi) contains the highest content of manganese (4.5%), also formulation 5 (Shiring manganese) has high content of manganese (4.2%) but lower than that of formulation 1. On the other hand, it is also shown from Table 1 that formulation 2 (Giri) contains the highest content of zinc (5%) followed by formulation 4 (4%) shiring zinc. Moreover foremulation 3 which did not exhibit significant increase of yield is characterized by the highest value of Fe (3.8%), in balanced proportions with zinc and manganese. Consequently. It could be concluded that spraying with manganese in combination with Zn and Fe is more effective than the other used formulations to increase both fresh and dry yields since it existed in a higher proportion than that of both zinc and iron. However, it may be mentioned that zinc element, as existed in the formulation used, is of moderate effect on the fresh and dry yields so that formulation 2 (Sahara) produced yield slightly higher than those resulted from both farmulatiens1 and 5. The obtained results were in agreement with those obtained by Haridi (1986) on periwinkle, Koreish and Helmy (1984) on datura and Zaied (1984) on *Saponaria officialis* L.

Alkaloid percentage:

Table 4 shows the alkaloid percentages in harmal plant parts (herb and roots) as affected by 5 micronutrient formulations in the 1987 and 1988 seasons. The data revealed that all the applied treatments increased the alkaloidal percentages in both herb and roots of the plant in comparison with the control. It could be observed that formulation 4 gave the highest alkaloidal percentage in the herb in both seasons but such increment was also produced in response to formulation 5 in the second season in comparison with the other treatments. In general it can be observed that formulations 2, 4 and 5 produced higher values in both seasons in comparison with the other treatments. Howerver, the alkaloidal percentages in the roots exhibited a response with formulation 3 (3.8% Fe) which showed the highest value in this concern. It is shown from Table 1 that formulations 2 and 4 are of higher content of Zn and formulations 5 is characterized by a high content of Mn, moreover formulation 3 have the highest content of Fe. It may be concluded that zinc and manganese are required for

Table 4. Effect of foliar spraying with some micronutrient formulations on the alkaloid percentage in harmal plants in 1987 and 1988 seasons.

No.	Formulation	1987		1988	
		Herb	Roots	Herb	Roots
1	Wadi	0.64	1.44	0.54	1.26
2	Sahara	0.77	1.31	0.77	0.95
3	Giri	0.60	1.51	0.52	1.71
4	Shiring-Zn	0.95	1.17	0.86	1.04
5	Shiring-Mn	0.73	1.44	0.85	1.45
6	Control	0.41	1.00	0.26	0.83
L.S.D .05%		0.10	0.10	0.06	0.16

the plant to synthesize the alkaloids in the herb. The obtained results agreed with those obtained by Haridi (1986). Koresish and Helmy (1984) Zaied (1984) and Ebrahim (1981).

Alkaloid yield:

Table 5 shows the effect of 5 micronutrient formulations on the total alkaloid yield in g/ plot in the whole plant as well as in the plant parts (herb and roots) in 1987 and 1988 seasons. It could be observed from the results that all the applied treatment led to a significant increase in the alkaloid yield either in the whole plant or the plant parts in comparison with the control. Data of the first season revealed that foemulation 5 recorded the highest value (680 g/ plot) followed by formulation 2 (670 g/plot). Regarding the data of the second season, it may be noticed that a similar trend was shown in most cases. It can be concluded that, formulation 5 (Shiring manganese) was the highest treatment since it produced the highest yield of alkaloids in the herb.

Table 5. Effect of foliar spraying with some micronutrient formulations on the akaloid yield of harmal plant (g/polt) in 1987 and 1988 seasons.

No.	Formulation	1987			1988		
		Herb	Roots	Whol plant	Herb	Roots	Whol plant
1	Wadi	570	80	650	460	70	530
2	Sahara	610	60	670	580	40	620
3	Giri	320	40	360	310	60	370
4	Shiring-Zn	580	40	620	550	40	590
5	Shiring-Mn	610	70	680	690	80	770
6	Control	210	30	240	150	30	180
L.S.D 5%		130	20	71	170	20	45.9

Regarding the alkaloid yield produced by the roots, it was shown that the appliclation of the five formulations has increased significantly the alkaloid yields especially in formulations 5 and 1 which recorded higher values. The previous results are in agreement with those obtained by Haridi (1986) and Zaied (1984).

It could be mentioned that although formulation 2 led to produce alkaloild yield slightly lower than that of formulation 5, such a treatment (2) was not the highest of all treatments in the second season 1988 as that produced from formulation (5). Consequently the later formulation (Shiring manganeses) may br considered the favourable one to increase the alkaloid yield, since the results were confirmed for the two seasons 1987 and 1988.

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تأثير بعض العناصر الصغرى على المحصول والقلويدات في نبات الحرمل في مصر

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أجريت دراسة على نبات الحرمل الناتج من بذور جمعت من منطقة برج العرب وذلك فى محطة بحوث البساتين بسدس محافظة بنى سويف بتسميدها بخمسة أنواع من الأسمدة المحتوية على عناصر الزنك والمنجنيز والحديد بنسب مختلفة وهى : وادى (٣٪ زنك ، ٥ر٤ ٪ منجنيز ، ٥ر١ حديد) ، صحراء (٥ ٪ زنك ، ٥ر٣ ٪ منجنيز ، ٧ر١ حديد) ، جيرى (٨ر٣ ٪ زنك ، ٨ر٣ ٪ منجنيز ، ٨ر٣ ٪ حديد) ، شيرنج زنك (٤٪ زنك ، ٧ر٢ ٪ منجنيز ، ٣ ر ١ ٪ حديد)، شيرنج منجنيز (٨ر٢ ٪ زنك ، ٢ر٤ ٪ منجنيز ، ٤ر١ ٪ حديد). على الترتيب استخدمت رشا على النباتات ثلاث مرات بتركيز ٥ر١ جرام أو ميللتر فى اللتر عند التزهير ثم كل ثلاث أسابيع . أوضحت النتائج ان كل انواع أسمدة العناصر الصغرى الخمسة أدت الى زيادة كل من محصول الطازج والجاف من العشب والجذور والنبات الكلى وكذلك محصول القلويدات مقارنة بالكنترول. وقد أوضحت النتائج أن استخدام السماد المركب (وادى) أدى الى الحصول على أعلى محصول من الوزن الطازج والجاف للنبات الكلى والعشب والجذور ، ولكن يمكن أن نعتبر أن السماد المركب شيرنج منجنيز هو التركيبة المفضلة نظراً لأنها أدت للحصول على أعلى محصول للقلويدات خلال موسمى الزراعة.