Res. Prmme. No. 62/Res. Proj. No.62/2/Rep. No. 16

THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH

EFFECTS OF HAND WEEDING TIMES ON MINT YIELD

BY
SONGKIAT VISUTTIPITAKUL
WEERAWOOT PROMMA

TISTR, BANGKOK 1979
not for publication

THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH

RESEARCH PROGRAMME NO. 62
MINT OIL PRODUCTION

RESEARCH PROJECT NO. 62/2
MINT OIL PRODUCTION IN THAILAND

REPORT NO. 16
EFFECTS OF HAND WEEDING TIMES ON MINT YIELD

BY

SONGKIAT VISUTTIPITAKUL
WEERAWOOT PROMMA

TISTR, BANGKOK 1979

อิทธิพลของเวลากำจัดวัชพืชด้วยมือต่อผลผลิตมินต์

โดย ทรงเกียรติ วิสุทธิพิทักษ์กุล และ วีรวุฒิ พรหมมา

บทคัดย่อ

ได้ทำการทดลองการกำจัดวัชพืชด้วยมือเมื่ออายุต่าง ๆ คือ ทุก $\frac{1}{2}$ เดือน, อายุ 1 เดือน, 2 เดือน, 3 เดือน, 1 และ 2 เดือน, 2 และ 3 เดือน, 1, 2 และ 3 เดือน ต่อผลผลิตของมินต์เมื่อเปรียบเทียบกับการไม่กำจัดวัชพืชและกำจัดวัชพืชด้วยยากำจัดวัชพืช terbacil อัตรา 320 กรัมต่อไร่. ผลการทดลองปรากฏว่า treatment ที่ให้ผลผลิต (น้ำหนักสด, น้ำหนักแห้ง, และปริมาณน้ำมัน) รวมเก็บเกี่ยว 2 ครั้งสูงสุด คือ treatment ที่กำจัดวัชพืชด้วยมือทุก ๆ $\frac{1}{2}$ เดือน; รองลงมาได้แก่ treatment ที่กำจัดวัชพืชเมื่ออายุ 1, 2 และ 3 เดือน; 1 และ 2 เดือน; 1 เดือน; พ่น terbacil ก่อนปลูก; กำจัดวัชพืชด้วยมือเมื่ออายุ 2 เดือน; 2 และ 3 เดือน; 3 เดือน, และไม่มีการกำจัดวัชพืช. ผลการทดลองยังแสดงให้เห็นต่อไปว่า ผลผลิตของมินต์สูญเสียเนื่องจากวัชพืชประมาณ 80%, ดังนั้นการกำจัดวัชพืชไม่ว่าเวลาใดจะเพิ่มผลผลิต. ผลการทดลองแสดงให้เห็นว่า การกำจัดวัชพืชเมื่ออายุ 1 เดือน ให้ผลตอบแทนสูงสุด, เมื่อคิดถึงมูลค่าน้ำหนักสด, ในขณะที่กำจัดวัชพืชทุก $\frac{1}{2}$ เดือน ให้ผลตอบแทนสูงสุดเมื่อคิดจากมูลค่าปริมาณน้ำมันที่ผลิตได้.

EFFECTS OF HAND WEEDING TIMES ON MINT YIELD

By Songkiat Visuttipitakul* and Weerawoot Fromma*

ABSTRACT

A study on mint yield as affected by different times of hand weeding has been made in Nan Province. Hand weeding treatments were given at different times after planting. The treatments were : no weeding; every ½ month; 1 month; 2 months; 3 months; 1 and 2 months; 2 and 3 months; 1, 2 and 3 months compared with 320 g per rai+ terbacil herbicide applied before planting. Results showed that the ½ month treatment gave the maximum yields, followed by 1, 2 and 3 months; 1 and 2 months; 1 month; terbacil application; 2 months; 2 and 3 months; 3 months; and the control. Weeds caused 80% reduction of mint yields. If only one hand weeding is available throughout the growing season (5-month period) hand weeding at 1 month after planting is recommended.

Economic consideration revealed that hand weeding at 1 month old gave the best result on fresh weight basis while hand weeding at every ½ month did on total oil production basis. These yielded net profits over the control treatment of 937 and 2,814 Bht‡ per rai respectively.

INTRODUCTION

Mint growing is an important occupation in Thailand where Japanese mint is grown for the extraction of essential oil. Mint oil is used in the manufacture of medicine and flavouring. This product is therefore extremely valuable as the oil sells for 320 baht a kg. The demand for mint oil in Thailand is much greater than the supply so there is no marketing problem as sometimes occurs with other agricultural commodities.

---

* Agricultural Research Department, Thailand Institute of Scientific and Technological Research

+ 1 rai = 1600 m^2

‡ 1 baht = $0.05 (US)

Weeds create an important problem in growing mint and extracting mint oil because they not only reduce the mint yield but also depress the oil quality by changing the colour and odour (Chandra and Srivastava 1971).

The need for proper timing and a subsequent harvest of the mint crop makes weeds an even greater obstacle to production than most other crops. This is because the main purpose of growing mint is to extract its oil. As 90% of the mint oil is in the leaves, it is necessary to harvest the plants before the defoliation of the lower leaves, which is about 2.5 months after planting. After harvest and before the mint plants have started to regrow, sunlight can penetrate through the soil surface and weeds can then germinate and grow quickly.

Even though weeds are the most important factor in determining the success or failure of growing mint, there are few effective herbicides for the crop. A review of research which has been reported by a number of scientists in different countries since 1960, indicates only five out of the many herbicides were found to be effective. These were terbacil prometryne, diuron, simazine and linuron (Migchelbrink 1969; Gulati and Bhan 1971; Visuttipitakul and Promma 1978).

The application of herbicide in mint growing can be a hazard because of the depressing effect on the mint plants even at the recommended rates and using the correct methods (Visuttipitakul and Promma 1978). They are even more hazardous when applied at higher rates and by incorrect methods. Also the herbicide and the application equipment are very costly for many Thai farmers whose total land holdings may average only 25 rais; only part of which may be used for mint production. Hand weeding operations on the other hand are well understood by the farmers and by using family labour, production cost may be kept low. However the questions are when and how many times should the weeds be controlled to give the maximum marginal return? The following experiment was conducted in an attempt to answer these questions.

MATERIALS AND METHODS

The experiment was carried out at Ban Den Village, Muang District, Nan Province in Northern Thailand. The soil at the experiment was clay loam. Some of the important properties before fertilizing are shown in Table 1.

TABLE 1. SOIL CHARACTERISTICS OF THE EXPERIMENTAL SITE

pH	Organic carbon	Total N	Available P	Exchangeable K	Particle size		
					Sand	Silt	Clay
	%	(%)	μg^{-1} O.D. soil	μg^{-1} O.D. soil	%	%	%
5.7	0.15	2.10	88	110	21	50	29

The site used for the experiment had been producing tobacco continuously for 12 years. The latest tobacco was harvested in September 1976. The site was bare fallowed from that time until the experiment was conducted.

The experimental design was a randomized complete block which consisted of 4 blocks with 9 treatments; each plot being 2.1 x 4 m^2. The treatments were as follows.

1. WC. Control, no weeding throughout the growing season.

Treatments 2 to 8 were hand weeded according to the following schedule:

2. W0.5+ every $\frac{1}{2}$ month.
3. W1 One month after planting.
4. W2 Two months after planting.
5. W3 Three months after planting.
6. W1+2 One and two months after planting.
7. W2+3 Two and three months after planting.
8. W1+2+3 One, two and three months after planting.
9. W320 No hand weeding but terbacil herbicide at the rate of 320 g/rai sprayed one day before planting. This rate was made on the basis of recommendation.

On December 24, 1976, mint cuttings were planted at a spacing of 30 x 30 cm at approximately 5-7.5 cm depth in the soil which had been plowed and harrowed three days previously. Each plot consisted of 7 rows of plants.

Two fertilizer applications were made, using a complete N-P-K fertilizer applied one day before planting and after the first harvest. The plants were irrigated once every 2 days.

Two harvests were made, the first on March 9, 1977 when the plants were 75 days old and the second on May 22, 1977 when they were 150 days old. The middle rows, 2.8 m in length were harvested by cutting with a sickle. Harvested plants were weighed and weights recorded. Sub-samples were collected at random from each plot and brought to the laboratory for determination of dry weight and percentage oil content. Oil content was determined by steam distillation. Oil quantity from each treatment could be obtained by multiplying the percentage of oil content with the fresh weight for that treatment.

The percentage of yield loss by weeds of each treatment was calculated by using the formula $100(\frac{1-Wtx}{W0.5+})$.

Where Wtx is the yield of the particular treatment which was to be determined.

W0.5+ is the yield of W0.5+ treatment.

The reason for the use of the yield of W0.5+ as base was that this treatment gave the best control of weeds. For purposes of comparison, it was assumed that there was no loss of yield in this treatment.

In order to obtain the cost of hand labour, labourers were actually timed in the field on hand weeding operations and application of herbicide. Results of different labourers were then averaged to give a composite figure of the cost of each type of labour per hour.

RESULTS

Fresh weights and dry weights were determined for each plot, but as both treatments were quite comparable and as under field conditions, mint is purchased on a fresh weight basis, only fresh weights of mint will be reported here (Table 2).

TABLE 2. FRESH WEIGHT, PERCENTAGE OF OIL CONTENT AND QUANTITY OF OIL OF MINT PLANTS UNDER DIFFERENT WEED TREATMENTS AT THE FIRST AND SECOND HARVESTS+

Treatment	Fresh weight (kg/rai)		Oil content (%)		Quantity of oil (kg/rai)	
	Harvest		Harvest		Harvest	
	1	2	1	2	1	2
Wo	453 d*	169 e	0.50 cd	0.42 d	2.20 c	0.69 e
Wo.5+	1406 a	1586 a	0.56 a	0.64 a	7.77 a	10.05 a
W1	877 bc	1015 bc	0.51 bcd	0.52 bc	4.43 b	5.24 bc
W2	520 cd	639 cde	0.50 cd	0.50 bcd	2.59 c	3.26 cde
W3	405 d	228 cde	0.49 d	0.45 cd	1.98 c	1.02 de
W1+2	937 b	1096 bc	0.54 ab	0.64 a	5.03 b	7.09 b
W2+3	489 cd	622 cd	0.51 bcd	0.53 bc	2.42 c	3.50 cd
W1+2+3	881 bc	1414 ab	0.53 abc	0.58 ab	4.65 b	7.86 ab
W320	569 cd	1180 ab	0.55 a	0.63 a	3.79 bc	7.58 ab

*Figures indicated by the same alphabets show that they are not significantly different at 5% level.

+Averages of four blocks.

The highest yielding plots were obtained from the WO.5+ treatment. This was significantly higher than all other treatments. The weight of treatments W1+2, W1+2+3 and W1 were similar. The WO and W3 treatments gave the lowest fresh weight and were significantly lower than the previously mentioned treatments.

At the second harvest the WO.5+ treatment still gave the highest fresh weight. However this figure was not significantly different from the W1+2+3 and W320 treatments. The WO treatment gave the lowest yield, which was only about one ninth the yield of WO.5+.

The results in Table 2 indicate that those treatments which gave high percentages of oil content at first harvest were the WO.5+, W320

and W1+2. Treatments W0, W2 and W3 gave the lowest percentages of oil content. They were significantly lower than the treatments earlier mentioned.

At the second harvest the percentage of oil content from all treatments could be divided into three groups. The high percentage oil content group comprised the W0.5+, W1+2, W320 and W1+2+3 treatments. The medium group included the W2+3, W1 and W2 treatments. The low group covered the W3 and W0 treatments. The percentages of oil content of all treatments in the high group were significantly higher than those in the low group.

The quantity of oil at the first harvest as shown in Table 2 indicates that the W0.5+ treatment gave the highest amount of oil. This treatment was significantly higher than other treatments. The next ranking treatments were the W1+2, W1+2+3 and W1. The W0 treatment gave the lowest oil quantity. This was significantly lower than the above mentioned treatments.

Considering the oil quantity at the second harvest, the W0.5+ treatment still resulted in the highest oil weight. This was significantly higher than all other treatments except the W1+2+3 and W320. The lowest oil quantity was obtained from the W0 treatment which gave only one fifteenth of the yield of the highest yielding treatment.

The yield loss by weeds was calculated on the assumption that no plant weight or quantity of oil was lost by weeds in the W0.5+ treatment. The loss caused by weeds in different treatments as calculated using the formula shown in the materials and methods section is shown in Table 3.

The data in Table 3 show that for the plots which received no weeding at the first harvest the loss of fresh weight was 67.8% and of oil quantity 71.7%. The loss of yield caused by weeds became even more serious at the second harvest where the loss of fresh weight and oil quantity were 89.3 and 93.1% respectively.

TABLE 3. PERCENTAGE LOSS OF FRESH WEIGHT AND QUANTITY OF MINT OIL CAUSED BY WEEDS AT THE FIRST AND SECOND HARVESTS

Treatment	Fresh weight		Quantity of oil	
	Harvest		Harvest	
	1	2	1	2
W0	67.8	89.3	71.7	93.1
W0.5+	0.0	0.0	0.0	0.0
W1	37.6	36.0	43.0	47.9
W2	63.0	59.7	66.7	67.6
W3	71.2	85.6	74.5	89.9
W1+2	33.4	30.9	35.3	29.4
W2+3	65.2	58.3	68.9	65.2
W1+2+3	37.3	10.8	40.2	21.8
W320	59.5	25.6	51.2	24.6

Data in Table 3 also show that any hand weeding regardless of time or frequency could reduce the yield loss caused by weeds. However, early weeding gave a better yield than weeding later as can be seen by comparing the W1 with the W2 or W3 treatments.

The results given so far indicate the losses caused by weeds. Table 4 indicates the marginal return from different weed control methods using as the basis of the fresh weight of mint and using the average time required for different tasks recorded during the experiment. Cost of labour was calculated at 20 baht per day (8 hours). The value of 1 kg of fresh mint was taken as 1 baht. The terbacil herbicide cost was 760 baht per kg and required 5 hours of labours to spray one rai.

Marginal returns were calculated on a fresh weight basis by taking the total yield of each treatment, the sum of harvest 1 and harvest 2 (column 3) and multiplying by the value of 1 kg of fresh mint (1 baht) to give the value (column 4). The marginal return was obtained by subtracting from the value obtained for a particular treatment that of W0 (no weed control) and the weeding cost (column 2) of that particular treatment.

TABLE 4. MARGINAL RETURNS FROM DIFFERENT WEED CONTROL TREATMENTS

Treatment	Weeding cost (baht/rai)	Fresh weight value basis		
		Yield (kg/rai)	Value (baht/rai)	Marginal return (baht/rai)
W0	0	622	622	0
W0.5+	1,963	2,992	2,992	407
W1	333	1,892	1,892	937
W2	556	1,159	1,159	-19
W3	992	633	633	-981
W1+2	667	2,033	2,033	744
W2+3	894	1,151	1,151	-365
W1+2+3	1,169	2,295	2,295	504
W320	256	1,749	1,749	871

The data in Table 4 indicate that hand weeding at one month after planting (W1 treatment) gave the maximum marginal return followed by the W320, W1+2, W1+2+3 and W0.5+ treatments in order of magnitude.

The marginal returns resulting from the different treatments using quantity of oil as the basis of value are shown in Table 5. Marginal returns were calculated as in Table 4; using the value of 1 kg of mint oil instead of the value of 1 kg of fresh mint. This was 320 baht.

TABLE 5. MARGINAL RETURNS FROM DIFFERENT WEED CONTROL TREATMENTS

Treatment	Weeding cost (baht/rai)	Quantity of oil value basis		
		Yield (kg/rai)	Value (baht/rai)	Marginal return (baht/rai)
W0	0	2.89	925	0
W0.5+	1,963	17.82	5,702	2,814
W1	333	9.67	3,094	1,836
W2	556	5.85	1,872	391
W3	992	3.00	960	-957
W1+2	667	12.12	3,878	2,286
W2+3	894	5.92	1,894	75
W1+2+3	1,169	12.51	4,003	1,909
W320	256	11.37	3,638	2,457

The results from Table 5 indicate that all weeding treatments except W3 gave a positive marginal return. The W0.5+ treatment gave the maximum return followed by the W320, W1+2, W1+2+3, W1, W2 and W2+3 treatments.

DISCUSSION

The results indicate that weeding treatments increased the herbage weight. Hand weeding particularly every $\frac{1}{2}$ month, gave a four-fold increase over the non-weeding treatment. This shows the important role of weeds in retarding mint growth.

Hand weeding while the weeds are still young results in higher yields than weeding after the weeds grow old enough to be a stronger competitor as is shown by weeding once a month being more effective than weeding 2 or 3 months after planting. The competition effect on mint is to suppress stolon growth and develop lateral branching.

The treatment with terbacil shows an interesting effect. At the first harvest the application of terbacil reduced the yield of mint greatly but had little depressing effect on the second harvest. This was probably due to the gradual decrease of the effect of the herbicide over time (Visuttipitakul and Promma 1978).

The presence of weeds not only decreased the yield of the mint but also reduced the percentage of oil in the mint which was produced. This may have been due to the competition for light resulting in less leaves and therefore a decrease in the leaf-stem ratio. Since most of the oil is in the leaves, less leaves in relation to total herbage production would decrease the percentage of oil.

The quantity of oil produced in a unit area of land depends on two factors, fresh weight and percentage of oil content. Weeds reduce both factors. Thus weed control will lead to increased quantity of oil produced in the unit area.

The marginal return based on fresh plant weight value indicates that although hand weeding at every $\frac{1}{2}$ month gave the highest fresh weight value, hand weeding once, one month after planting, results in maximum marginal return. This is because the weeding cost of the former

treatment is five-fold as compared to the latter one. Experience indicates that the highest expense in mint growing is involved in the labour cost of weeding.

The marginal returns based on the value of the oil produced indicated that weeding twice a month gave the highest return. This treatment however involves the highest weeding cost. If hand weeding is inefficient, costs might be much higher with no increase in return. This treatment therefore carries the risk of high input as well as the rewards of high return. If hand weeding becomes a problem, a strategy of weeding only once one month after planting (W1) would carry the lowest labour cost and still give a reasonable return. Hand weeding twice at monthly intervals (W1+2) gave a higher return and would seem to be one of the best strategies of hand weeding. The herbicide treatment (W320) involved the least cost of weed control operations and showed an even higher return than W1+2. However capital cost of spray equipment was not included in these costs. Further, this method involves risk from improper application. It should only be undertaken by a person or organization with sufficient capital and a knowledge of herbicide application.

The tables on marginal returns give information on the profitability for different types of enterprise. One enterprise dealt with the production of mint which was then sold on a fresh weight basis to the local distillation factory. The second enterprise consisted of a person or organization which grew mint and also operated the distillation factory.

There may be two kinds of enterprise engaged in mint production. The small land holder uses his own and his family labour to weed the crop twice a month. This type of operation gives the family an income of 2,992 Bth/rai. Even though the marginal return is only 407 Bht/rai the farmer and his family are actually receiving the weeding cost as self-employed income. This enterprise gave a much higher return than some other crops. For an enterprise of a larger scale where labour must be paid for weed control, the best procedure is to use labour for weed control only once (W1) as this gave a marginal return of 937 baht/rai. This enterprise, however, provided only a slightly greater income than producing some other crops.

For an enterprise in which the quantity of oil per rai is the main objective, such as an organization which both produces mint and operates the distillation factory, all weed control practices except weeding only once at the end of three months (W3) gave a positive marginal return as previously mentioned. The maximum marginal return came from weeding every half month, but this carried the risk of high labour input. For an organization with high capital and can employ an expert in herbicides, the use of which might be the best for weed control.

CONCLUSION

The paper shows that weeds and their control play a very important part in mint production, as weeds can reduce yield as much as 80%. Even though mint is a crop of high value weeding is costly and necessary in producing the crop. The most successful producer is the small farmer using his own and his family's labour for weed control. However where the enterprise consists of an oil extraction factory together with field facilities for production, problems may arise because of the need to employ labour for weed control. The marginal return is reasonably high when using most of the methods of weed control, but these data are based on the efficient use of labour. If labour is efficient, the returns may be much lower. Thus, in an attempt to establish a mint oil extraction factory, the local, economic and social conditions in that particular area should be taken into careful consideration.

ACKNOWLEDGEMENT

The authors wish to express their special thanks to Professor E.J. Britten, of the University of Queensland, Dr. Lunduan Maprasert, Mr. Pricha Ratanasukhawat for their kind help in editing and correcting the English manuscript; and finally to Mr. Prabhand Boonklinkachorn, Director of Agricultural Research Department, TISTR, for his encouragement in making fulfilment of this research work possible.

REFERENCES

CHANDRA, V. and SRIVASTAVA, K. (1971).—Chemical control of weeds in Mentha arvensis. Indian Perfumer 15 : 60 a-60 d.

GULATI, B.C. and BHAN, V.M. (1971).—Effect of pre-emergence application of terbacil on control of weeds in Japanese mint. Indian Perfumer. 51 : 53-59.

MIGCHELBRINK, E. (1969).—Two years waiting period necessary following use of Sinbar on mint before some crops can be planted. Belt Fruit Belt Veg. 63 : 33.

VISUTTIPITAKUL, S. and PROMMA, W. (1978).—Effect of herbicides on mint yields. Mimeographed. ASRCT: Bangkok (Report no. 10 on Research Project no. 62/2).