RELIMINARY STUDY ON THE INFLUENCE OF BERELLIC ACID ON *MENTHA ARVENSIS* LINN. R. *PIPERASCENS HOLMES* (JAPANESE MINT)

By B. K. Kaul and L. D. Kapoor, F.A.Sc.

(*Regional Research Laboratory, Jammu*)

Received September 29, 1964

Abstract

"Gibberellic acid (GA^3) solutions (10–200 p.p.m.) when sprayed on *ntha arvensis* Linn. var. *piperascens* at preflowering stage induces 30–50 cent. increase in the yield of total herb. Apart from the elongation of rnode, the leaf area was also increased. The stage of development of plant at the time of treatment, appeared to be a significant factor in aining favourable Gibberellin effects. Pre-soaking of the suckers in GA tion induced early sprouting. Essential oil obtained from the treated es, however, decreased by 5–15 per cent. but had no deleterious effect menthol contents." *Mentha arvensis* Linn. var. *piperascens* (Japanese t) which has been introduced in India by the Regional Research Labora-, Jammu, is now fairly well established for commercial exploitation of ural Menthol. During the course of investigation on the influence of berellic Acid (GA) on various aromatic plants, the authors studied its ct on the growth, volatile oil and Menthol contents of this mint.

Experimental

s from the dormant plants of *Mentha arvensis* were cut into 10–12 cm. eces with a diameter of 0·4–0·6 cm. These were planted in March stance of 30 cm. between the rows in well-prepared plots of 20 sq. to which farm-yard manure was applied at a rate of 1·65 cub. M. per Other agricultural operations such as irrigation, weeding and hoeing gularly attended to. The young shoots started sprouting two weeks the middle of April and continued to grow rapidly. The plants were or application of GA when the aerial shoots had attained a height 0 cms in April. Concentrations of 0, 10, 25, 50, 75, 100 and 200 p.p.m. were sprayed on the plants at the rate of 1 litre per 30 sq. metres. In of plots GA was applied both before the first and second harvest; another set of plots GA was applied only before the first harvest

and second harvest was taken without the application of any more application of GA.

The difference in growth of treated and untreated plants was so marked a week after the treatment that it was considered advisable to discontinue further spraying of GA. The other method of application of GA by immersing the suckers in the various concentrations for a duration of 30–60 minutes before planting was also tried and effects on the growth of plants recorded.

OBSERVATIONS ON GROWTH AND DISCUSSIONS

The elongation of internodes and development of the axillary shoots was well marked in the treated plants and the stems were comparatively larger in diameter than the untreated plants as can be seen in transverse section (Fig. 3). The measurements of cells and linear dimensions showed an increase of 38–84 per cent. in the treated plants that received doses ranging from 10–200 p.p.m., one week after the application; 22·5–59 per cent. after the second week; 20–44 per cent. after the third week and 14·5–42·5 per cent. in the fourth week after the treatment. The main and lateral shoots, which were more numerous in treated plants, obviously yielded a great number of leaves. The leaf area of the treated and untreated plants was measured and is tabulated in Table I. The leaves appear to increase in dimensions and area if the plants are treated at preflowering stage (Fig. 2). Spraying GA on tender shoots of 10–15 cm. height tends to produce tall slender internodes

TABLE I

*Leaf area measurements under various doses of GA in sq. cm.**

[Formula: leaf area of *M. arvensis* = 0·65 + 0·59 (1 × *b*) after Chaterjee and Dutta].

Date of measurements	Leaf area in sq. cm. under treatment with GA p.p.m.					
	0	10	25	50	100	200
22–4–1961	12·32	15·05	13·67	15·38	18·1	19·27
29–4–1961	14·01	17·05	15·48	16·87	17·93	17·75
9–5–1961	14·40	17·71	15·26	19·42	19·30	19·32
25–5–1961	8·30	9·29	12·63	13·83	48·54	39·75

* Measurements from leaves taken from apical regions of 10 cm. (values represent an average area from 20 leaves).

with smaller leaves. The colour of the young and newly developed leaves looked pale green. Concentrations of 200 and 400 p.p.m. of GA proved toxic as it occasionally produced very elongated shoots twining in vine-like manner (Fig. 1). It was also observed that spraying of GA at preflowering stage had more marked "gibberellin effect" than at flowering or post-flowering stage.

Growth measurements were recorded at weekly intervals till the end of April. For harvesting and processing, the flowering plants were cut above the ground level and dry weights noted, as shown in Table II. From the perusal of data, it will be observed that the growth was proportional to the concentration of GA applied and the yield of total herb was up to 30–50 per cent. more in the treated plants, as compared to controls. This has, however, been noted that application of GA before flowering produced longer and larger number of lateral shoots, provided the young plants had not attained more than 20 cm. height at the time of treatment.

TABLE II

Yield of herb in kg. under treatment of different concentrations of GA

Total yield of the herb (GA applied twice; area 3 sq. metres)

Date of harvest	Treatment with GA p.p.m.					
	0	10	25	50	100	200
			I Group			
June 21. 1st harvest before rains	1·55	1·75	1·54	2·27	2·45	1·52
October 14. 2nd harvest after rains. 2nd application of GA	3·50	3·70	4·20	5·00	5·20	4·80
			II Group			
June 21. 1st harvest before rains	3·40	3·60	4·40	4·00	3·50	3·50
October 14. 2nd harvest without second application of GA	4·28	5·12	4·65	4·25	4·20	4·60

Suckers which were immersed in GA solution 10–200 p.p.m. for 30–60 minutes before planting sprouted much earlier than those which were immersed in distilled water for the same length of time. The elongation of the shoots in the first two weeks showed rapid progress in the treated plants. There was no increase in the average leaf area. The young plants below 15 cm. height when sprayed with GA similarly showed no increase in leaf size.

The physiological age of the plant at the time of application of GA appears to be a significant factor in obtaining favourable gibberellin effects. It was, however, observed that internodes which developed within one week after the GA treatment showed more elongation than those which developed 6–8 weeks later.

The data also indicated that second application of GA to plants, whose first flush has been harvested produces an additional 48 per cent. increase of green herb. This increase was more pronounced when GA in 50–100 p.p.m. was sprayed to shoots ranging from 20–30 cm. high at the rate of 1 litre per 30 sq. metres.

The plants treated with 50 p.p.m. showed more elongation of the main stem up to 125 cm. as compared to 80 cm. in the control. The average increase of 35–40 cm. in the main stem was observed when GA in 25–50 p.p.m. was sprayed. This elongation is further increased with higher concentrations, but the number of leaves is reduced per unit length of the main shoots. Concentrations of 10 and 25 p.p.m. of 25 p.p.m. of GA resulted in the main shoots attaining a height of 95 and 105 cm. respectively and with comparatively larger number of leaves per unit length of the shoots.

All the samples were stem-distilled and it was observed that the volatile oil tended to decrease with the application of GA (Table III). These observations are in conformity with the finding of Gonzelez and Gjerstad (1960)[1–2] in the case of *M. spicata* (*Spear-mit*) and *M. piperita* (Peppermint).

The oil distilled from the different treatments was further investigated for menthol and menthyl-acetate percentage (B.P. 1958). No significant differences in the optimum concentrations of 25–50 p.p.m. were noted. Higher concentrations showed a tendency for the menthol percentage to decrease, and the menthyl-acetate percentage showed correspondingly slight increase up to 100 p.p.m. Observations made in *Dill*, and *Chenopodium* similarly showed that the principle constituent in the oils, *viz.*, Carvone and Ascaridole were not altered appreciably.

TABLE III

Volatile oil from the leaves of Mentha arvensis *treated with GA in April*

		Percentage of volatile oil under treatment with GA in p.p.m.					
		0	10	25	50	100	200
arvest in June; first harvest before rains	I	3·90	3·74	3·55	3·70	3·50	3·25
ctober harvest after rains and second application of GA ..	II	4·12	3·95	3·80	3·70	4·00	?
une harvest before rains ..	I	3·50	3·45	3·25	3·00	2·95	2·80
ctober 2nd; Harvest without second application of GA ..	II	4·60	4·10	3·90	3·50	3·40	?
ckers dipped in GA and harvested in June	I	5·00	4·85	4·75	4·70	4·62	4·34
ckers dipped in GA and havested in October	II	Not analysed					

I : Values of First harvest.
II : Values of Second harvest.
An average of 5 estimations; 70–75 per cent. average moisture content.

TABLE IV

Average menthol and menthyl-acetate in oils from treated and untreated plants

Determination	Treatment with GA p.p.m.				
	0	25	50	100	200
r cent. of total alcohols calculated as MENTHOL (w/w)[a]	78·0	78·2	76·8	75·4	73·5
r cent. of esters calculated as MENTHYL-ACETATE (w/w)[b] ..	11·5	12·4	13·6	13·2	13·0

During the course of experimentation the plants were infected with powdery mildew caused by *Erisyphe cichocearum*. It was observed that application of GA delayed the symptoms of this disease, as has been observed in the case of Corn, Barley, Asters, etc. The plants attained above average normal height with the treatment of GA and the leaf fall was delayed for up to 2 weeks. The GA appeared to induce either a temporary physiological resistance or a delay in the production of symptoms due to vigorous growth for about two weeks against the leaf fall resulting from powdery mildew infection.

ACKNOWLEDGEMENT

The authors acknowledge with thanks the keen interest of Dr. I. C. Chopra, Regional Research Laboratory, Jammu, and Mr. H. S. Andotra for estimation of menthol oil samples in this work.

REFERENCES

1. Gonzelez, E. E. and Gjerstad, G. — *Jour. Amer. Pharm. Ass.*, 1960, **49**, 782.
2. Gjerstad, G. .. *Planta Medica*, 1960, **8**, 127.
3. ———— .. *Ibid.*, March 1961, p. 59.
4. Stevens, R., Roberts, J. B. and Williams, I. H. — *Nature*, 1961, **191**. 360–361.
5. Kaul, B. K. and Kapoor, L. D. — "Preliminary studies on the effect of Gibberellic acid on dill seed," *Planta, Medica*, 1962, **1**, 91–97.
6. Kapoor, L. D. and Kaul B. K. — "Influence of GA on *Matricaria chamomilla*," *Ind. Jour. Agron.* 1964, **9**, 295–228.
7. ———— .. "Effect of GA on *C. ambrosoides*," *Jour. Pharm. Sci.*, 1962, **51**, II, 1113-14.
8. Guenther, E. .. *The Essential Oils*, Vol. II, *D.*, Van Nostrand Co., Inc. New York, 1949, 3.
9. Madaus, G. and Schindler, A. — *Arch. Pharm.*, 1938, **276**, 280.
10. Chatterjee, B. K. and Dutta, P. K. — *Jour. Sci. and Ind. Res.*, Dec. 1961,
11. Sinchetti, L. A. .. *Jour. Pharm. Sci.*, 1961, **56** (12), 981.
12. Stuart, N. W. and Cathey, H. M. — *Ann. Rev. Plant Physiol.*, 1961, **12**, 369.

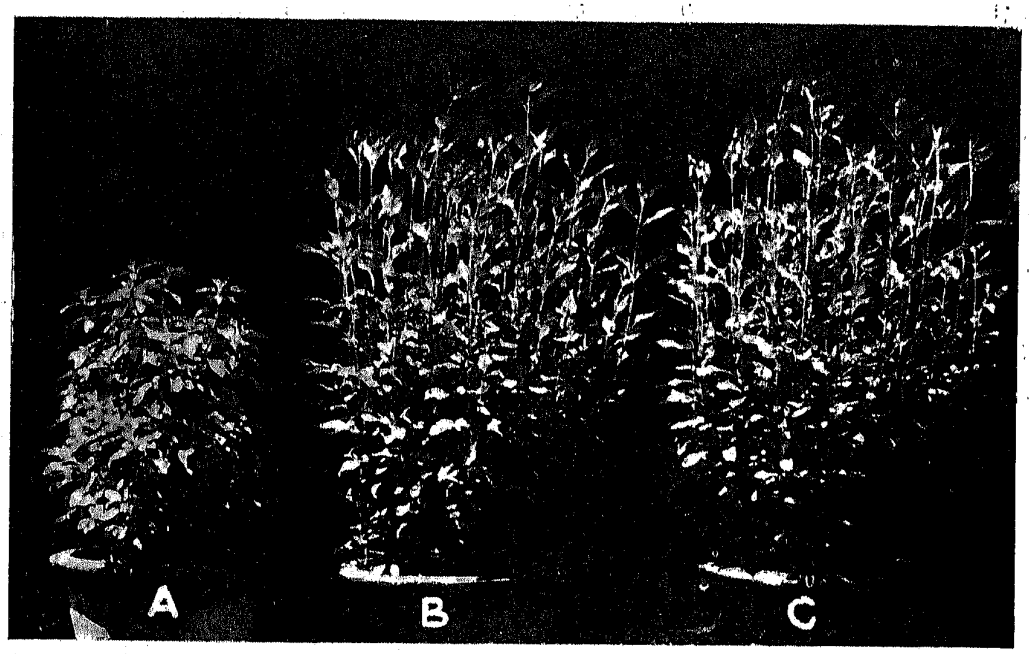

FIG. 1

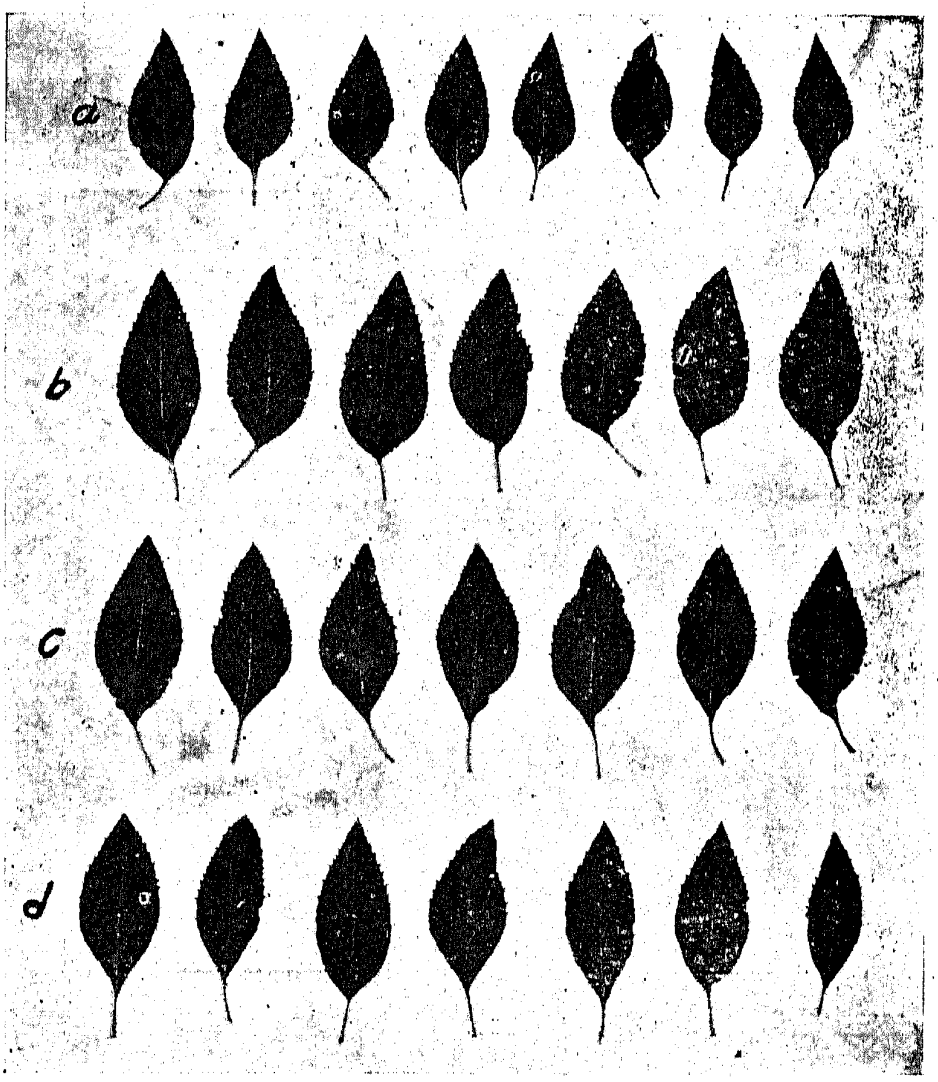

FIG. 2