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Short Communication

Methanol-Induced Growth, Biomass, and Economic Productivity in *Hibiscus esculentus*, *Vigna radiata*, and *V. catjung* in Tropics

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INTRODUCTION

Treatment of agricultural crops in high solar light intensities with methanol was initiated as a source of fixed carbon or supplement of methyl groups for pectin production. Methanol is rapidly metabolized in plants. Study of the path of carbon in photosynthesis revealed very rapid metabolism of (^{14}C) methanol (*1–3*). From comparison of the relative rates of fixation of [^{14}C] carbondioxide and [^{14}C] methanol by *Chlorella* and *Scenedesmus* strains, it was concluded that methanol was utilized for sugar and amino acid production fully as rapidly as carbon dioxide (*4*). Earlier studies of methanol spray in eggplant, cotton, cabbage, watermelon, wheat, grapes, and so forth, revealed that rather than merely supporting normal growth, it stimulated plant growth, which far exceeded that expected of a foliar nutrient. Plants treated with nutrient-supplemented methanol showed up to 100% increases in yield when maintained under direct sunlight in desert agriculture (*5*).

Therefore, a preliminary study of methanol spray under tropical conditions during the dry season (April–July 1993) on crop plants was conducted, and the novel results obtained are presented.

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METHODS

Field experiments were undertaken in the Department of Biotechnology of the School of Life Sciences, Bharathidasan University, Tiruchirapalli-620 024, Tamilnadu, India during the dry season using methanol as a foliar spray to the most popularly cultivated field-grown vegetable crops of *Hibiscus esculentus, Vigna radiata,* and *V. catjung*.

Foliar spray of methanol was given after 10 d of plants' establishment in open-field conditions (relative humidity 30–65%; temperature 25–40°C). Methanol spray was given at five different concentrations (10, 20, 30, 40, and 50%) to find out the optimal dosage. Thereafter, a methanol minimal enhancement medium containing methanol (5, 10, and 15%) with and without 0.2% glycine, urea (250 mg/100 mL), iron EDTA (trace), and triton-X-100 (0.1%) was sprayed weekly once to all the vegetable plants until flowering. Data on plant growth and yield attributes were calculated.

RESULTS AND DISCUSSION

Preliminary tests of methanol spray on plants showed toxicity symptoms, such as wilting and burning of leaves at 30, 40, and 50%. Therefore, methanol just below toxic levels (5, 10, and 15%) was used for further spray with nutrients and a surfactant. No foliar damage was observed when plants were exposed to methanol spray at these concentrations with and without glycine (0.2%) in a high intensity of sunlight (50–60 $w/m^2/s$). Methanol-sprayed plants were vigorous compared to the control. Methanol spray showed increased turgidity in leaves, generally indicative of open stomata. Turgid guard cells and open stomata permit increased carbon dioxide assimilation, concomitantly reducing the rate of transpiration (*6*).

Under direct sunlight, plants gained growth in all the methanol concentrations with and without glycine (0.2%). Plant growth and yield attributes, such as plant height, number of leaves, total leaf area, number of fruits, total number of seeds, fruit length and weight, total dry matter, and harvest index, were calculated and are presented in Fig. 1. Data were collected when the plants were 100-d-old. In *H. esculentus,* methanol alone at 10% promoted growth, but fruit yield was the same at all concentrations. However, addition of glycine (0.2%) to 10% methanol showed twofold increase in plant height, number of leaves/plant, number of seeds/plant, and harvest index, a threefold increase in the number of fruits, and an eight- to ninefold increase in total fruit and seed weight/plant. Dry matter production was also greater (fourfold) in 10% methanol with glycine (0.2%). Harvest index was increased by about 50% at 5, 10, and 15% methanol with glycine (0.2%) spray. Methanol even at 15% coupled with glycine (0.2%) showed promotive effect compared to the unsprayed control and 5% methanol with glycine (0.2%) (Fig. 1). Methanol-sprayed plants had increased stem girth compared to the control. Plants showed

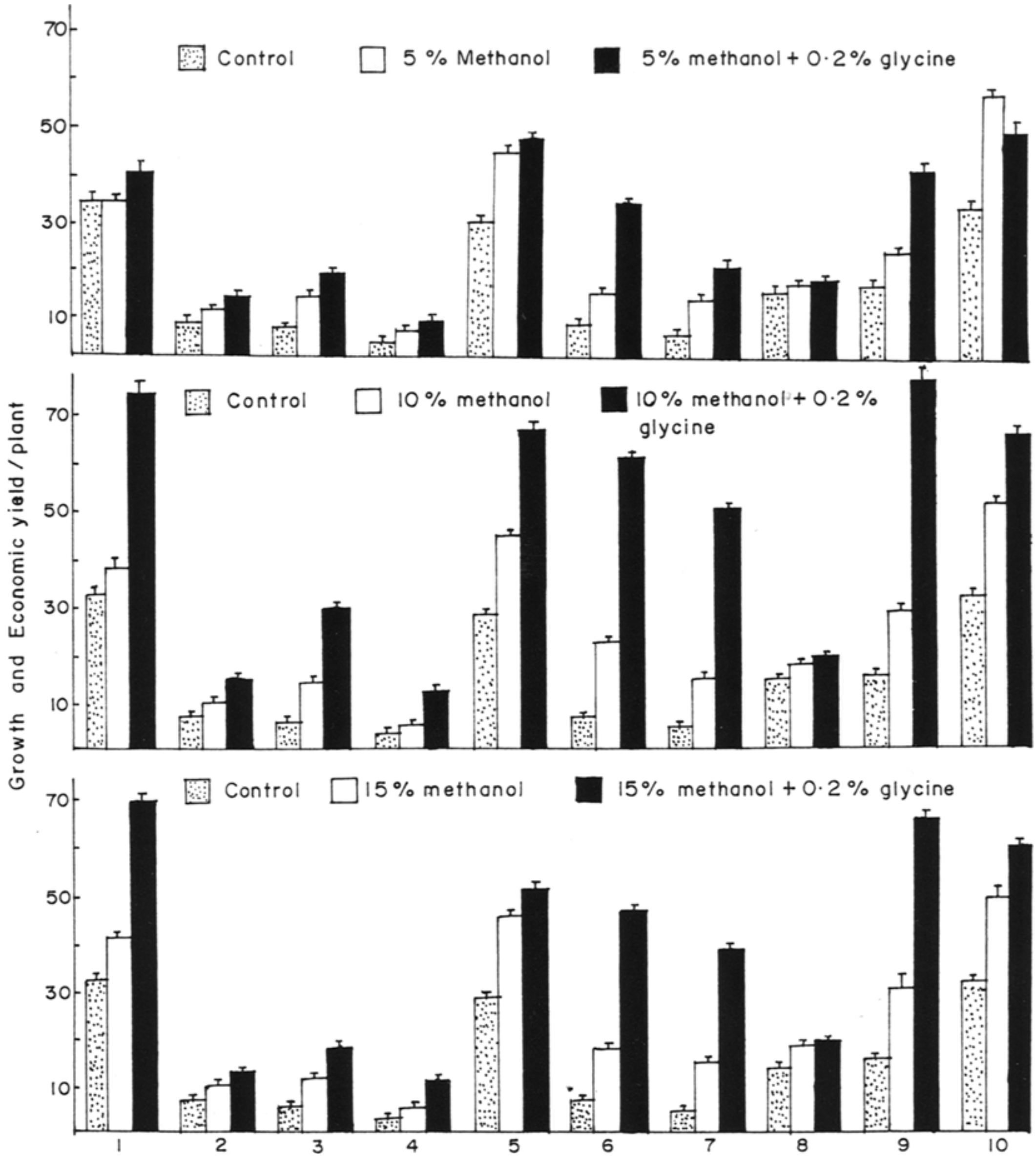

Fig. 1. Effect of methanol spray on plant growth and economic yield in *H. esculentus*. The bars represent ± SE. 1. Plant height (cm); 2. number of leaves/plant; 3. leaf area/plant (m^2); 4. number of fruits/plant; 5. number of seeds/plant; 6. fruit weight (g)/plant; 7. seeds weight (g)/plant; 8. fruit length (cm); 9. dry matter (g)/plant; 10. harvest index (%).

longer petioles with well-spread lamina. Even early flowering was noticed in all methanol-sprayed plants. In *V. radiata* and *V. catjung*, more than three fruits in each bunch could be noticed in methanol-sprayed plants. The whole life-span of the experimental plants increased 20–30 d compared to the unsprayed control.

Table 1
Methanol-Induced Fruit Yield in *H. esculentus, V. radiata,* and *V. catjung*

S. No.	Concentrations of foliar application of methanol	Increase in fruit yield, %		
		H. esculentus	*V. radiata*	*V. catjung*
1.	5% Methanol	66.66	40.00	100.00
2.	5% Methanol + 0.2% glycine	133.33	80.00	150.00
3.	10% Methanol	66.66	50.00	162.50
4.	10% Methanol + 0.2% glycine	300.00	200.00	200.00
5.	15% Methanol	66.66	50.00	150.00
6.	15% Methanol + 0.2% glycine	266.66	180.00	175.00

In *H. esculentus, V. radiata,* and *V. catjung,* number of fruits per plant was two- to threefold higher at 10 and 15% methanol with glycine (0.2%) (Table 1). A very low percentage of fruit yield was observed at 5% methanol spray. Increased growth responses and increased turgidity observed after methanol application indicate that surfactant effectively aids penetration. Early flowering and fruit development in methanol-sprayed plants may be the result of manipulation of C/N ratios for control of maturation processes (7). Sustained growth improvement in crop plants was observed after supplementation with urea (providing nitrogen) and chelated iron. Application of foliar spray revealed dual benefits of nutrient deficiency alleviation and methanol stimulation (5). Addition of glycine actually eliminated methanol toxicity and indicated the involvement of photorespiration. Detoxification of methanol and its oxidation product formaldehyde require both glycine and exposure to light, thus leading to the conclusion that both photosynthesis and photorespiration are involved (7–9).

Thus, in conclusion, it may be pointed out that 10% methanol with glycine (0.2%) stimulated the growth and yield attributes significantly in all the experimental plants. Concentrations of methanol either higher or lower than 10% did not show much response in plant growth and yield. Therefore, further works could be planned with substitution of nutrients increasing the frequency of application of methanol to obtain further higher yield. More importantly, methanol spray reduced the water requirement in field conditions, a welcome feature for crop plants of the tropics where arid and drier conditions mostly prevail.

REFERENCES

1. Benson, A. A. (1951), *J. Am. Chem. Soc.* **73,** 2971.
2. Bassham, J. A., Benson, A. A., Kay, L. D., Harris, A. Z., Wilson, A. T., and Calvin, M. (1954), *J. Am. Chem. Soc.* **76,** 1760–1770.
3. Quayle, J. R., Fuller, R. C., Benson, A. A., and Calvin, M. (1954), *J. Am. Chem. Soc.* **76,** 3610.

4. Calvin, M. and Benson, A. A. (1949), *Science* **109,** 140–142.
5. Nonomura, A. M. and Benson, A. A. (1992), *Proc. Natl. Acad. Sci. USA, Agric. Sci.* **89,** 9794–9798.
6. Farquhar, G. D. and Sharkey, T. D. (1982), *Annu. Rev. Plant Physiol.* **33,** 317–345.
7. Chia, T. F., Hew, C. S., Low, C. S., and Lee, Y. K. (1988), *Hort. Sci* **23,** 599–601.
8. Kato, A., Asakura, A., Tsuji, K., Ikeda, F., and Iijima, M. (1980), *J. Ferment. Technol.* **58,** 373–382.
9. Lawyer, A. L., Cornwell, K. L., Gee, S. L., and Bassham, J. A. (1983), *Plant Physiol.* **72,** 420–425.