than 90% was used within 5 days (15). Pecan differs markedly. Stratified cotyledons, just prior to planting, contained 62% lipids. Four weeks following germination, the cotyledons still contained 32% lipids (unpublished data).

The unusually high fat content in the pecan seed and the long dependency period of the seedling on these reserves appear to be an adaptive survival mechanism that makes it possible for the seedling to become established under adverse environmental conditions. Observations show that taproot elongation is extensive during the dependency period. A deep root system would increase the chance for survival. In other tree species that begin their life cycle in deep forests, maximal height, survival, and presumably root growth increase with mean seed weight (4). The continued attachment of apparently healthy cotyledons after the pecan seedling is self-sufficient may be an additional survival mechanism that allows regeneration of the top when it is destroyed early in its development. This is supported by the common observation that pecan seedlings that have been damaged or have died back frequently resume growth from axillary buds.

The use of carbon from stored reserves for early shoot, root, flower, and fruit development has been demonstrated in pecan (6, 7). However, information on the use of cotyledonary reserves during germination is lacking. To what extent these reserves are used needs further investigation.

Literature Cited

1. Ching, T.M. 1963. Fat utilization in germinating Douglas fir seed. Plant Physiol. 38:722–728.
2. Ching, T.M. 1966. Compositional changes of Douglas fir seeds during germination. Plant Physiol. 41:1313–1319.
3. Eagan, K.J. 1979. The role of nuts in human nutrition, p. 448–450. In: R.A. Jaynes (ed.). Nut tree culture in North America. No. Nut Growers Assn., Hamden, Conn.
4. Grime, J.P. and D.W. Jeffrey. 1965. Seedling establishment in vertical gradients of sunlight. J. Ecol. 53:621–642.
5. Hoagland, D.C. and D.I. Arnon. 1950. The water culture method for growing plants without soil. Calif. Agr. Expt. Sta. Cir. 347.
6. Lockwood, D.W. and D. Sparks. 1978. Translocation of ^{14}C in 'Stuart' pecan in the spring following assimilation of $^{14}CO_2$ during the previous growing season. J. Amer. Soc. Hort. Sci. 103:38–45.
7. Lockwood, D.W. and D. Sparks. 1978. Translation of ^{14}C from tops and roots of pecan in the spring following assimilation of $^{14}CO_2$ during the previous growing season. J. Amer. Soc. Hort. Sci. 103:45–49.
8. Melville, R. 1947. The nutritive value of nuts. Chem. Indus. 22:304–306.
9. Miller, E.C. 1938. Plant physiology. McGraw-Hill, New York.
10. Sparks, D., J.W. Chapman, and D.W. Lockwood. 1974. Stratification promotes germination. Pecan Quart. 8(1):13.
11. Sparks, D. 1977. Effect of nutrition on dieback of germinating 'Curtis' pecan seedlings. HortScience 12:496–497.
12. Varner, J.E. 1963. Seed development and germination, p. 763–792. In: J. Bonner and J.E. Varner (eds.). Plant biochemistry. Academic Press, New York.
13. Von Ohlen, F.W. 1931. A microchemical study of soybean during germination. Amer. J. Bot. 18:30–49.
14. Watt, B.K. and A.L. Merrill. 1963. Composition of foods. Agr. Handb. 8.
15. White, H.B., Jr. 1958. Fat utilization and composition in germinating cotton seeds. Plant Physiol. 33:218–226.

HortScience 18(3):333–334. 1983.

Hoeing and Hand-held Wiper Application of Glyphosate for Weed Control in Vegetables

Howard F. Harrison, Jr.[1]
U.S. Vegetable Laboratory, ARS, U.S. Department of Agriculture, 2875 Savannah Highway, Charleston, SC 29407

Additional index word. herbicide

Abstract. **Hoeing and glyphosate (*N*-(phosphomomethyl)glycine) application with a hand-held wiper were compared for weed control in mixed vegetable plantings. Weed control with wiper-applied glyphosate required significantly less labor and expense than hoeing. Vegetable yields were similar in hoed and wiper-weeded plots and both methods increased the yields of some vegetable species over yields from unweeded plots. Yellow nutsedge (*Cyperus esculentus* L.) shoot populations were reduced significantly by wiper weeding but not by hoeing.**

In recent years, glyphosate applied with rope wick and other types of wiper applicators has become an effective weed control technique for several crops (3, 4). Wiper applicators allow the selective application of nonselective herbicides. They also use less herbicide than conventional sprayers, and reduce expense and the risk of harmful environmental effects. Several hand-held wipers are marketed for use by growers or homeowners. These devices generally consist of a small rope or sponge wiper attached to a PVC pipe handle which contains the herbicide solution in a reservoir (2). Hand-held wipers are relatively inexpensive and appear to offer an attractive alternative to the labor-intensive practices of hoeing or pulling weeds. The purpose of this study was to compare glyphosate application with a hand-held wiper with hoeing for weed control in vegetable crops.

Field experiments were conducted in 1981 and 1982. Plots consisted of one 7.6 m row each of 4 vegetable species with 1 m between rows. Lima beans (*Phaseolus lunatus* L. cv. Jackson Wonder), southernpeas [*Vigna unguiculata* (L.) Walp. cv. Mississippi Silver], eggplant (*Solanum melongena* L. cv. Florida Market), and squash (*Cucurbita pepo* L. cv. Yellow Crookneck) were planted in 1981 and southernpea, lima bean, tomato (*Lycopersicon esculentum* L. cv. Patriot), and okra [*Abelmoschus esculentus* (L.) Moench. cv. Clemson Spineless] were planted in 1982. Okra and tomato were planted in 1982 because they are better adapted to the late season than squash or eggplant. Seeds of lima bean, southernpea, and okra were planted, and seedlings of eggplant, squash, and to-

Table 1. Effect of weeding by hoeing and by glyphosate application with a hand-held wiper on vegetable yields.[z]

Weed control practice	Yield (MT/ha)							
	1981				1982			
	Squash	Eggplant	Southernpea	Lima bean	Tomato	Okra	Southernpea	Lima bean
Control	0.5 b	0 b	2.0 b	6.2 b	1.3 b	1.0 a	3.1 b	2.4 b
Hoed	4.7 a	1.7 a	7.1 a	5.0 a	4.2 a	1.5 a	4.2 a	5.8 a
Wiper-weeded	3.2 ab	1.1 a	5.9 a	4.0 a	4.3 a	1.4 a	4.7 a	5.2 a

[z]Mean separation within columns by Duncan's multiple range test, 5% level.

Received for publication December 1, 1982. Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture and does not imply its approval to the exclusion of other products that may also be suitable. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

[1]Research Agronomist.

Table 2. Time and cost of weeding vegetables by hoeing and by glyphosate application with a hand-held wiper.[z]

Weed control practice	Total weeding time (hr/plot)		Time per weeding (hr/plot)		Total cost of weeding ($/plot)		Cost per weeding ($/plot)	
	1981	1982	1981	1982	1981	1982	1981	1982
Control	0.0 a	0.0 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
Hoed	3.5 c	0.9 c	0.50 c	0.31 c	9.26 c	3.05 c	1.32 c	1.02 c
Wiper-weeded	1.3 b	0.5 b	0.22 b	0.16 b	5.04 b	2.18 b	0.84 b	0.73 b

[z]Mean separation within columns by Duncan's multiple range test, 5% level.

mato in the 2-leaf stage were transplanted. The soil type in both years was a Lynchburg loamy fine sand with less than 1% organic matter. The fields were fertilized with 10-8-5 (N-P-K) analysis fertilizer at 1100 kg/ha prior to bedding. Planting dates were June 16, 1981 and August 6, 1982. Insecticides and fungicides were applied as needed according to local recommendations. Weed control treatments, replicated 4 times in a randomized complete block design, were: 1) weedy control, 2) weeded by hoeing, and 3) weeded by glyphosate application with a hand-held wiper. Glyphosate application was accomplished using a Walk-A-Wick (Walk-A-Wick, Inc., Coolidge, Ariz.) wiper containing glyphosate at 74 g/liter (20% Roundup) in water. In 1981 these 3 treatments were also conducted on plots which were treated with 6.7 kg ai/ha DCPA (dimethyl tetrachloroterephthalate) applied after planting in 180 liters/ha. This treatment did not affect yields or weeding times, and the data from DCPA-treated plots is not reported. In 1981, plots were hoed on July 1, 6, 14, and 21 and on August 4, 13, and 26 and wiper-weeded on July 6, 15, 22, and 31 and on August 11 and 26. In 1982, wiper weeding and hoeing dates were August 31 and September 17 and 29. The predominant annual weeds were goosegrass (*Eleusine indica* L.), Texas panicum (*Panicum texanum* Buckley), large crabgrass (*Digitonia sanguinalis* L. Scop.), spiny amaranth (*Amaranthus spinosus* L.), and common purslane (*Portulaca oleracea* L.). Weed populations prior to weeding averaged 206, 319, and 36 shoots/m^2 in 1981 and 35, 420, and 53 shoots/m^2 in 1982 for the annual grasses, broadleaves, and yellow nutsedge, respectively.

Table 3. Effect of hoeing and glyphosate application on yellow nutsedge shoot populations 2 weeks after the final weeding.[z]

Weed control practice	Yellow nutsedge shoot population (shoots/m^2)	
	1981	1982
Control	36.0 a	75.0 a
Hoed	31.1 a	58.3 a
Wiper-weeded	9.3 b	14.6 b

[z]Mean separation within columns by Duncan's multiple range test, 5% level.

The time required to weed each plot was determined and the amount of glyphosate used was measured by weighing the wiper before and after each plot was weeded. The cost of weeding was determined by the cost of glyphosate at the local retail price and the cost of labor at the minimum wage. Vegetable yields from multiple harvests reported are the fresh weights of eggplant, tomato, and squash fruits and also of okra, southernpea, and lima bean pods and seeds.

Weed control during the summer of 1981 was difficult, due to a high rainfall which necessitated 7 hoeings and 6 wiper weedings. Weed control by hoeing is most effective if weeds are hoed shortly after emergence, before root systems are well-established. Larger weeds are effectively controlled by wiper-applied glyphosate; whereas, wiper application of glyphosate to seedling weeds is impractical. Thus, weeds were removed earlier by hoeing than by wiper weeding in 1981. In 1982 the largest weeds were about 15-cm-tall at the first weeding.

The earlier removal of weeds in hoed plots in 1981 may have caused the observed trend toward higher yields in hoed plots than in wiper-weeded plots (Table 1). This trend was not observed in 1982 when both methods were performed on the same dates. The vegetable yields in hoed and wiper-weeded plots were not significantly different. Both methods increased yields of southernpea, lima bean, and eggplant in 1981, and of lima bean, southernpea, and tomato in 1982.

The total time required and expense for weed control and the average time and cost per weeding were lower for wiper weeding than hoeing (Table 2). In 1982, fewer weedings were required due to the reduced weed pressure during the late season. The time required does not necessarily reflect the degree of exertion required for hoeing. Wiper applications of glyphosate is less strenuous than hoeing and the difference in weeding times would probably become relatively larger as the duration of weeding increased.

At the end of the growing season, yellow nutsedge shoot populations were lower in wiper-weeded plots than in hoed or control plots (Table 3). Foliar-applied glyphosate controls yellow nutsedge and reduces viable tuber production (5). Yellow nutsedge vigor was reduced by hoeing, but shoots were capable of regrowth.

These results indicate that glyphosate application with a hand-held wiper is an economical and efficient alternative to hoeing for weed control in vegetable crops. Potential shortcomings of this technique are: 1) glyphosate is a nonselective and highly translocated herbicide (1) and caution must be exercised to avoid crop injury; 2) smaller weeds in a dense population may escape glyphosate applications necessitating repeated wiping; and 3) early weed competition may reduce crop growth before wipers can be used effectively.

Literature Cited

1. Anonymous. 1983. Herbicide handbook. Weed Science Soc. of America. Champaign, Ill.
2. Cooper, A.S., F. Fraser, L.C. Burrill, and A.E. Dentsch. 1981. Hand-held wiping devices for herbicide application. Intern. Plant Protection Center, Oregon State Univ., Corvallis.
3. Dale, J.E. 1979. A non-mechanical system of herbicide application with a rope wick. PANS 25:431–436.
4. Dale, J.E. 1980. Rope wick applicator-tool with a future. Weeds Today 11:3–4.
5. Stoller, E.W., L.M. Wax, and R.M. Matheson. 1975. Response of yellow nutsedge and soybeans to bentazon, glyphosate, and perfluidone. Weed Sci. 23:215–221.