Weed Science, 51:471. 2003

My view

Stephen B. Powles
W. A. Herbicide Resistance Initiative,
School of Plant Biology,
University of Western Australia,
Crawley, WA 6009, Australia

The question this brief essay addresses is, Will glyphosate, the world's most popular herbicide, continue to aid world food production? The broad-spectrum herbicide glyphosate makes a major contribution to world food production. Introduced in the 1970s, glyphosate use has grown steadily in many parts of the world, especially where it is used to substitute for tillage in minimum tillage cropping systems. Recently, usage has further accelerated because of price reductions associated with patent expiration, enduring popularity, further adoption of minimum tillage, and new uses. Farmers choose glyphosate over other herbicides or mechanical tools because glyphosate is cheap, effective, safe, and easy to use, is environmentally acceptable, and enables less tillage. Thus, glyphosate significantly contributes to the abundant food produced in many parts of the world. Particularly in North and South America, the advent of genetically modified (GM) glyphosate-resistant crops has further increased glyphosate use because GM glyphosate-resistant soybean [*Glycine max* (L.) Merr], corn (*Zea mays* L.), cotton (*Gossypium hirsutum* L.), and canola (*Brassica napus* L.) have become massively adopted.

Life-saving antibiotics and crop-aiding herbicides such as glyphosate are major contributors to the vibrant health and abundant food available to many people in most parts of the world. Lamentably, they are often regarded just as cheap commodities that will always be there to control what we humans want to control. However, the unfortunate reality is that overreliance results in disease organism and weeds evolving resistance and the consequent potential loss of these precious resources for future harvests and generations. Antibiotic resistance is a looming threat to continued human health, and herbicide resistance, especially to a precious herbicide like glyphosate, is a threat to world food production. Recently, glyphosate-resistant weeds have appeared, first in rigid ryegrass (*Lolium rigidum* Gaudin.) in Australia, then goosegrass [*Eleusine indica* (L.) Gaertn.] in Malaysia, and subsequently, hairy fleabane [*Conyza bonariensis* (LO.) Cronq.] and horseweed [*C. canadensis* (L.) Cronq.] in the United States, where GM glyphosate-resistant crops dominate.

A debate has started in North America as to whether or not the threat of glyphosate resistance should be taken seriously. Naturally enough, there are those that argue that resistance will not be a problem and others warning that current usage is unsustainable. I wish to contribute to this debate based on 20 yr of experience working on the world's biggest resistance problems in Australia. It should now be clear that weeds can develop glyphosate resistance, and if overreliance on glyphosate continues in any agroecosystem, then resistance is a risk. I also know that this does not need to be what happens; it is not inevitable. Glyphosate resistance has been slow to appear, despite long-term use. Therefore, one must conclude that glyphosate-use patterns and the rarity of resistance genes are such that resistant individuals did not reach high frequencies. That resistance did not occur much earlier is very likely because of the rarity of functional resistance genes, sufficient diversity in agroecosystems in which glyphosate has been used, and herbicide use patterns. We can learn from the situations in which resistance is occurring. Glyphosate resistance is appearing in the Australian agroecosystem in intensive cropping in a resistant-prone species rigid ryegrass with long-term glyphosate usage for burn-down in no-till cropping. This system has less diversity than prevailed in the past. Glyphosate resistance is appearing in North America where glyphosate-resistant crops, mainly soybean, are being grown persistently with minimal diversity in the system. Clearly, glyphosate resistance is appearing in these agroecosystems because there is insufficient diversity in the agroecosystems and because of the dominant weed control practices. Increased diversity (e.g., a wider range of rotational crops, diversity of herbicides used, better agronomy leading to more competitive crops, and use of nonherbicide weed control methods) can reduce the dependence on glyphosate and reduce the likelihood of resistance developing.

In my view, it is logical to recognize the biological reality that glyphosate resistance can (perhaps will) evolve if we let it! More important is to recognize that well-chosen farming systems can provide the diversity that can preserve the precious glyphosate resource for many future harvests. I recognize that it is easier to make these statements than it is for those faced with short-term commercial exigencies to show restraint in promoting, prescribing, and using glyphosate. However, on a case-by-case basis, this is what is needed. The maxim is the same for an antibiotic to cure infections and for glyphosate to kill weeds—if we want the chemical to work now and for the next generation, then respect it now as a precious resource and use it prudently so that it will be an option for future health and harvests.