All-round talent for rice fields

Rice is the number one food in Asia, and growing it demands a lot of manual labor from small farmers. Researchers at Bayer CropScience have now developed a new herbicide that combats numerous weed species, saving rice farmers time and labor and securing harvests.

Rice is the elixir of life in Asia. These small, silvery grains feed a large proportion of the world's population. Along with wheat and corn, rice is one of the major staple foods of the world; some 3.5 billion people eat rice every day. India and China are among the main producers of the cereal. But rice plants do not produce a good harvest all by themselves; they require the daily toil of countless small farmers on the rice terraces of Asia. With hard manual labor and largely traditional methods, these small-holders harvest about 90 percent of the world's entire rice crop, according to the United Nations Food and Agriculture Organization (FAO).

Rice farming in Asia is highly labor-intensive and often not very profitable. Researchers at Bayer CropScience are therefore working on improved rice varieties and other ways to increase yields and facilitate cultivation in order to safeguard rice farmers' incomes. After all, the number of rice farmers in Asia's rural regions is dwindling as urbanization continues to draw increasing numbers of people to the cities. A new rice herbicide named Council™ (active substance: triafamone) may become an important instrument for relieving some of the burden on small-holders in Asia. It is currently showing off its capabilities on test fields full of high, lush, green rice plants: not a single weed can be seen growing in between them. "Triafamone exhibits very strong activity against weeds in a wide range of growth stages," says Bayer researcher Shinichi Shirakura. He is the biologist responsible for supervising field testing of the new herbicide and is absolutely delighted with the results: "Triafamone helps combat a whole range of grasses and sedges, even those that have developed resistance to many common crop protection agents." The rice plants themselves remain unharmed. The herbicide has a highly targeted effect, which is due to a critical difference between the metabolism of rice plants and weeds.

Teamwork in the greenhouse: project leader Coralie van Breukelen-Groeneveld (second right) and Bayer researchers Dr. Chieko Ueno, Dr. Christian Waldraff and Dr. Chris Rosinger (left to right) check out rice plants, always with an eye to helping farmers in their rice fields in Asia.

719
million tons

of rice were produced worldwide in 2012. In 2000, the figure was 597 tons.

Source: FAOSTAT

On target with biochemistry: substance only affects weeds

Although the rice plants absorb the active substance through their roots and leaves just like other grasses, they do not activate it. According to current findings of the Bayer researchers, biochemical processes are at the root of this mechanism: the weeds themselves activate the substance by dissociating a small but critical part of the molecule. The activated tri-

Strenuous manual labor: small-holders like Doan Thi Hong and Phan Minh Phat (from left) from Vietnam invest a lot of time and effort in planting and harvesting rice.

Photos: Peter Ginter/Bayer AG (4), Gaby Gerster/Bayer AG (1), IRRI Images (1), private/Bayer AG (1)

Practice test: innovations from Bayer laboratories are urgently needed in fields in Asia, for instance for the rice harvest in India (photo left). Bayer researchers such as Shinichi Shirakura and his marketing colleagues (photo right) monitor the effects in the field, for example in Thailand.

afamone blocks the enzyme acetolactate synthase, putting a halt to the production of protein that is vital to the survival of the unwanted plants. "The weed withers, its leaves fade and it dies in one, at most two weeks," says Dr. Chris Rosinger, describing the effect. He was the Bayer researcher who managed the greenhouse testing and first identified the potential of triafamone.

Testing a thousand different molecular variations

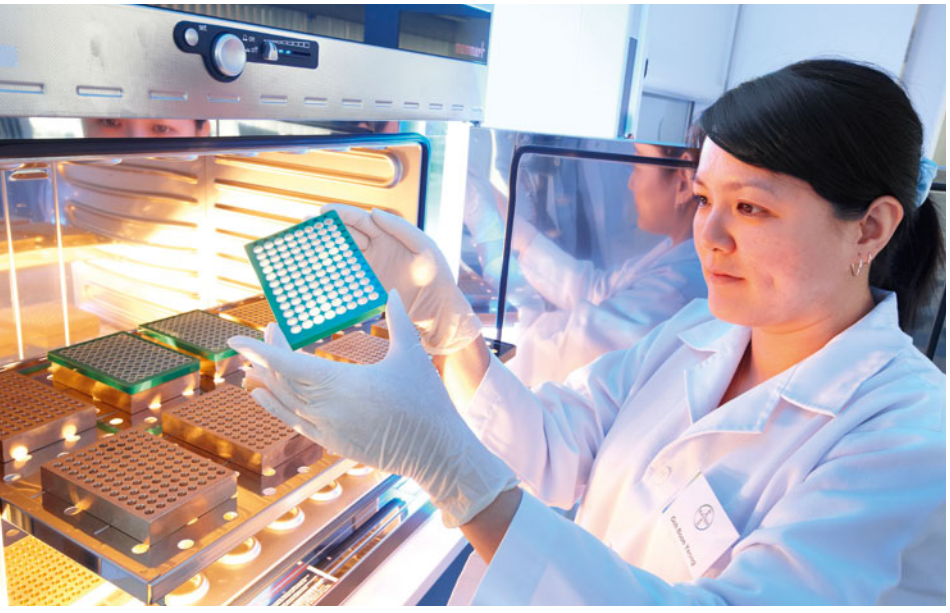
But it was a long road leading up to that point: as much as ten years ago, Bayer researchers in Japan turned all their attention to new variations of sulfonanilides, which had already proven effective as herbicides. Their basic structure comprises two carbon- and nitrogen-based rings linked by a chain containing carbon and oxygen. Each ring has two additional molecular side groups. To find new, highly effective substances, the Bayer researchers altered various parts of the molecule, developing a total of about 1,000 substances in the process. For instance, they changed the bridge between the molecular rings, and switched the halogens fluorine, bromine and iodine on the side groups with one another, replacing them with hydrogen atoms or molecular groups containing carbon. In Bayer CropScience's greenhouses in Frankfurt, the different variations of the active substance had to prove their ability to combat a few typical rice weeds. "Four out of five substances failed to clear this first hurdle," reports Rosinger. Active substances that did manage to pass these initial tests were then tested on additional weeds. What sounds simple was no easy task: "Finding a herbicide with such a broad range of applications that it is useful to as many rice farmers as possible is an extremely difficult task," explains Coralie van Breukelen-Groeneveld, global project leader at Bayer CropScience in Monheim. The reason is that the weeds growing in rice fields in Asia vary greatly from country to country and the level of infestation is dependent on climate and local conditions, i.e. the rice varieties planted and the irrigation methods used. What's more, every region has its own method of cultivation: rice farmers either sow the seeds directly by hand, machine or airplane, or they transplant seedlings by hand or mechanically from a nursery box.

After just a year of screening, the researchers knew they had already found the ideal molecule: the active substance triafamone. "All other active substances, some of which differed from triafamone by only a single atom, had either a significantly narrower spectrum of activity or were less selective," the biochemist relates. The process was extremely fast, and surprisingly unequivocal: "It was like winning the lottery. What are your chances of getting all six numbers right?" Rosinger says. Further greenhouse and field testing, first in Frankfurt and then worldwide, confirmed this initial success and showed that the substance even combats weeds which are resistant to other herbicide classes.

"We also were able to demonstrate in numerous studies that the acute toxicity is rather low and the product poses no health risks if it is used as recommended," says van Breukelen-Groeneveld. "If released into the environment, the herbicide decomposes rapidly into metabolites." This has been proven in innumerable tests with flooded rice fields, different soil types and water management. The herbicide decomposes both chemically and by microbial action. "In most paddy soils, triafamone has a half-life of less than ten days," van Breukelen-Groeneveld says.

Farmers are thrilled with the results in their fields

Triafamone today has advanced far beyond the trial phase: the herbicide has already received approval in South Korea and will be available there starting in 2015. Market launches are scheduled to follow soon in China, India and Japan. "Whether it's in granule or liquid form,



Persevering researchers: the work on new crop protection agents by Bayer employees such as Martina Mücke (photo above) and Goh Boon Yeong (below) includes tests on the efficacy and safety of potential active ingredients, for example with biochemical analyses of rice plants and weeds.

triafamone can be mixed with other Bayer herbicides to help expand the spectrum of activity and prevent resistance," Rosinger explains. The Bayer researchers are not the only ones convinced of the advantages of their multi-talented product. "Farmers are already delighted with the results in our demonstration plots. More than anything else, the active substance makes their work considerably easier," van Breukelen-Groeneveld says. For example, triafamone can be applied in all weather conditions and at any growing phase, even before the first weeds sprout from the ground, for instance during the first round of fertilization or directly during planting.

For Japan, Bayer researchers have even developed a machine that can plant the seedlings and apply herbicides in a single step. Similar systems are to follow for China and India. "Also just one application should be enough," Shirakura emphasizes. That saves valuable time. But despite all of these innovations, "rice still does not grow all by itself," says the researcher, who like so many people enjoys rice as part of a healthy diet.

Bruce Tolentino

"The challenge of climate change"

Dr. Bruce Tolentino is Deputy Director General of the International Rice Research Institute (IRRI) in the Philippines. research *spoke with him about rice as a staple food and the challenges of the future.*

How important is rice?

Rice is the staple for half of the world's population – some 3.5 billion people, especially in Asia. Rice consumption is also growing fast in the rest of the world, particularly Africa.

How healthy is rice?

Rice is very nutritious, but polished rice contains low amounts of iron, zinc and vitamin A. Rice is usually eaten in combination with other foods such as fish, meat, and vegetables. However, the poorest cannot afford much more than rice. Thus micronutrient deficiency is a serious problem among the poor, especially women and children. So the IRRI is working on rice varieties with higher iron, zinc, and vitamin A contents. Diabetes is also associated with rice-based diets so work on rice varieties with a low glycemic index is also ongoing.

What are the biggest challenges in rice farming?

The impacts of climate change – floods, drought, salinity and heat, and the increased volatility and unpredictability in weather. Moreover, the population in developing countries continues to grow as our natural resources dwindle.

What needs improvement?

R&D needs greater public funding to enable earlier results, especially from research on rice varieties that can better tolerate extreme weather, as well as methods to help farmers cope with climate change, including "alternate wetting and drying" (AWD), which reduces water use and methane emissions.

www.research.bayer.com/rice
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