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24.28 metric tons per hectare per year

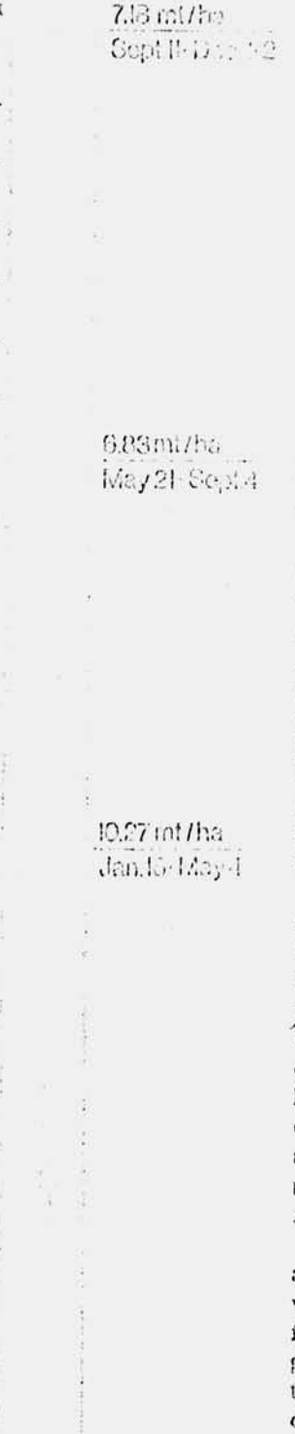
mt/ha

7.18 mt/ha
Sept 11-Dec 12

6.83 mt/ha
May 21-Sept 4

10.27 mt/ha
Jan 15-May 4

World record yield



In the last 10 years scientists have made many changes in rice-growing practices in the tropics. If you put together all the latest technology, how much rice can be produced in one year? Or, to put it another way, what is the maximum yield potential of the new varieties? The answer to both questions is at least 24 mt/ha. That's the figure that IRRI agronomists claimed as a world record last year.

The record yield was made in three transplant crops in cooperative experiments at Central Mindanao State University in Mindanao, Philippines. The crops were in the ground for 316 days. Thus 49 days were available for preparing the land between crops.

The first of the three crops was an experimental selection, IR593-3-17, which was transplanted on January 16. On May 4 it was harvested and it yielded 10.27 mt/ha (rough rice at 14% moisture). The second crop was IR20 which was planted on May 21 and harvested on September 4. It yielded 6.83 mt/ha. The third crop was IR593-3-17 again. It was planted on September 11 and harvested on December 22. It yielded 7.18 mt/ha. The total: 24.28 mt/ha.

Before each crop, at least 7 days were available for land preparation. The crop planted in January received 140 kg/ha of nitrogen, the crop planted in May, 120 kg/ha; and the crop planted in September, 80 kg/ha. In addition, each of the three crops received 60 kg/ha of phosphate and of potash (based on other experiments, however, IRRI agronomists consider application of phosphate and potash unnecessary for rice production except in a few soils).

The nitrogen was in the form of ammonium sulfate. All the fertilizer was broadcast before the last harrowing for each crop except 20 kg/ha of nitrogen which was applied at panicle initiation. Weeds and insects were carefully controlled. The trials were replicated four times.

In the same experiment the highest three-crop total from a single variety or selection came from IR593-3-17 which yielded 23.55 mt/ha. IR20 produced 23.22 mt/ha in three crops and IR8 produced 22.81 mt/ha.

An annual yield of 24 mt/ha is out of the reach of rice farmers. But the experiments show that three crops a year can be produced with adequate time to prepare the land between each crop. The farmer must have irrigation water available throughout the year, however.

CSD-2541 Res.

By inventing a new type of threshing surface, IRRI agricultural engineers have developed a low-cost thresher that is light enough to be carried into the rice field. And, unlike other threshers, it works even with wet or high moisture paddy. For the many farmers in developing countries whose fields do not have access roads or whose fields are wet at harvest time heavy conventional threshers are difficult to bring into the field.

The new threshing surface is like a spinning table top studded with threshing blades. Nearly 80 percent of the threshing surface is in use at any time. The threshing surface in conventional threshers is a revolving drum on which threshing blades, bars, or fingers are mounted. Only 30 percent of the threshing surface can be used at one time.

In the IRRI table thresher the threshing surface also acts at a radial fan for winnowing the grain. Thus the new type of threshing surface has permitted the development of a paddy thresher that is simple to construct and light in weight in relation to its output. It has only two moving parts.

Three manufacturers — two Philippine and one Australian — are about to put the thresher on the market. The

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The paddy table thresher is light enough to be carried into the field by four men. It threshes 1 metric ton of paddy in 2-1/2 hours.

estimated selling price, including engine, is US$400 to $450. Other companies are expected to start manufacturing the thresher in the future.

The table thresher has an output of 350 to 400 kg/hr of rough rice with four men feeding it. The machine weighs 170 kg and has lifting handles which allow it to be carried into the field by four men. A wheel attachment is being designed so it can be pulled by one or two men or drawn by an animal or vehicle.

The sheet metal housing has four feed openings. The operators place bundles of rice in the openings and held the panicles (grain heads) against the threshing surface. As the blades strike the panicles, the grain is thrown against the inside of the sheet metal housing and falls onto a slowly moving screen. The grain goes through the screen leaving behind pieces of straw, passes through a stream of air which removes light impurities, and then rubber flaps sweep it to the grain outlet. No further grain cleaning is necessary even if the grain has a high moisture level.

machine shops that can do welding, metal cutting and bending, and metal lathe work can build the thresher. The machine requires no castings or sheet metal stamp[illegible] --operations which call for special equipment and [illegible]ques. The materials required are standard items [illegible]h as angle and flat irons and sheet metal. The only imported parts a manufacturer in a developing country would have to buy are the engine and two ball bearings. Any 2-1/2 or 3 hp aircooled gasoline engine is suitable for the thresher.

The thresher, including engine, can be packed into a crate that measures about 0.5 x 1.5 x 1.5 m. The compact package means that manufacturers can economically ship it to foreign customers.

Weed killers for direct-seeded rice

IRRI scientists have found two low-cost chemicals that suppress weeds in direct-seeded rice without killing the rice plant, too.

Weed control in rice grown from pre-germinated seeds planted directly in the field is both more critical and more difficult than in transplanted rice.

In the competition between weeds and rice for light and nutrients, transplanting sturdy seedlings into the field gives the crop a head start on weeds which are just germinating. In direct-seeded rice, the weeds and rice start growing at the same time so the crop has no advantage.

Weed control in direct-seeded rice is more difficult because, if the rice is broadcast, laborers cannot move through the field to hand-weed without pushing under some rice plants. In addition, weeders cannot easily distinguish between young grassy weeds and young rice.

Since handweeding is impractical in direct-seeded rice, chemicals are the obvious alternative. But chemicals that work in transplanted rice (See "2,4-D kills grasses, too." IRRI Reporter. Vol. 6, No. 1) do not necessarily work in direct-seeded rice. In transplanted rice, herbicides are applied a few days after transplanting. At that time, the weed seeds just starting to germinate, but the rice plant is several weeks old, so it is less susceptible to chemicals than the newly sprouted weed seeds. In direct-seeded rice, the rice plants and weeds are the same age so chemicals must be highly selective or both will be killed.

In tests of several chemicals, benthiocarb (Saturn) applied at 1.5 kg/ha of active ingredient 6 to 8 days after seeding was highly successful. Toxicity and weed control in IR72 were evaluated 28 to 56 days after seeding. Benthiocarb showed no toxicity at either date and gave complete control of barnyardgrass (Echinochloa crus-galli) and water lily (Monochoria vaginalis). The control plot yielded only 3 mt/ha largely because of an unusually high infestation of barnyardgrass that resulted from adding 2 kg/ha of barnyardgrass seed to it (and to all other plots as well). The plot treated with benthiocarb yielded slightly over 6 mt/ha.

Another chemical, CP53619 (Machete), applied at 1 kg/ha of active ingredient 6 days after seeding also gave excellent control of weeds. This chemical caused some toxicity to rice plants, but IR72 produced extra tillers which made up for the slight damage.

The cost per hectare of either treatment was good compared to the cost of hiring labor to hand-weed transplanted rice.

While inadequate weed control is an important barrier to the widespread use of direct-seeding in the developing countries, the discovery of effective herbicides does not mean that the traditional practice of transplanting is about to go into obscurity. To successfully use direct-seeding, the farmer must be able to

Direct seeded plot treated with benthiocarb. Left is free of barnyardgrass and broadleaved weeds. Control plot is at right.

carefully control the water level in his fields.

In these experiments on weed control, IRRI agronomists sowed pre-germinated seeds on mud. The soil was kept saturated (wet, but with no surface water) for the first 5 days after sowing. Before herbicide application at 6 to 8 days after seeding, the soil was flooded to 2 to 3 cm. Then the water level was raised to 5 cm and kept there until the crop matured.

This type of control of water is difficult for farmers with irrigated fields if the water supply is not reliable, and it is impossible for farmers with rainfed paddies. Experiments are currently under way to determine if direct-seeded rice can produce satisfactory yields with less precise water control.

Brown planthoppers find an ally

Diazinon has been applied to IRRI's experimental fields since 1965 to control rice stem borers, whorl maggots, and brown planthoppers. It did a good job until early 1969, then it seemed to lose its punch late in the season. As a result, brown planthoppers -- insects that strike during the rice plant's later growth stages -- did unexpected damage.

IRRI scientists have determined that in fields that have received applications of diazinon year after year, an agent, which is apparently a bacterium, builds up and accelerates the breakdown of diazinon.

The scientists established the link between diazinon application and diazinon breakdown in tests in which diazinon was mixed with a sample of water from a field that had been treated repeatedly with diazinon, and the mixture was incubated for 5 days at 25 C. In this mixture the added diazinon was degraded much faster than in a mixture of diazinon and water from an untreated field. This showed that a degrading agent must have been present in the water from the treated field.

The scientists used several tests to determine whether the agent was chemical, biological, or both. All the tests provided evidence that the agent was biological.

-- Sterilizing water from a treated field to eliminate biological organisms and then incubating the water with diazinon resulted in a much less rapid breakdown of added diazinon.

-- Incubating water from treated fields with diazinon at various temperatures showed that at 25 C and 30 C degradation was rapid while at 0 C and 40 C the insecticide was stable. A chemical agent should be very active at 40 C.

-- Enrichment techniques -- techniques used to increase populations of microorganisms -- resulted in very rapid breakdown of diazinon.

Although diazinon is hydrolyzed under acid conditions, pH was ruled out as a cause since all tests were conducted near neutrality.

Should farmers who have been applying diazinon to their fields for several years give it up? No. Diazinon is not broken down rapidly early in the season so it is effective against early insects such as whorl maggots and stem borers. At late crop growth stages and after several applications (2 kg/ha at 20-day intervals is the normal rate), degradation goes on rapidly. In addition, the plants are older so they absorb more diazinon from the paddy water. The combination of degradation and absorption makes diazinon ineffective in late growth stages even if applied as often as every 5 days. So insects that attack the rice plant late in the season are not well controlled.

If diazinon appears to be ineffective late in the season, IRRI entomologists suggest applying MIPC or Furadan granules to the paddy water or spraying carbaryl on the leaves.

Sterile rice

IR8 performs no miracles for farmers in La Trinidad, Philippines. When IR8 is planted in La Trinidad, four-fifths of each panicle is sterile (bears no grain). Why? La Trinidad is nearly 1,300 m above sea level. Although it is well within the tropics (16°N) the temperature is generally too low for IR8 to bloom. Local rice varieties in La Trinidad are not as sensitive to cool temperatures.

Until the development of high-yielding, photoperiod-insensitive varieties, temperature was rarely considered as a limit on where a variety could be grown in the tropics. The sensitivity of most varieties to day length was far more important. But as high-yielding varieties have been developed that are little affected by day length, more and more areas have areas have started planting them. This has made the temperature limitations of the new varieties more critical.

IRRI physiologists recommend planting IR8 only in areas that have a maximum temperature of at least 22 C (72 F) during the flowering season. This rules out certain high altitude areas and some seasons in some areas on the fringes of the tropics.

In experiments in growth chambers, the scientists found that IR8 would not bloom (shed pollen) at temperatures of 21 C or less. The optimum temperature is 30 C.

The scientists also examined the effect of fluctuating temperatures, such as occur when the daytime temperature is high enough for IR8 to bloom, but the nighttime temperature is too low. They found that if the nighttime temperature was 21 C (just below the minimum necessary) the daytime temperature would have to be 32 C for at least 30 minutes to cause 50 percent blooming. Two hours at 32 C would result in maximum blooming.

At a daytime temperature of 27 C, after a nighttime temperature of 21 C, 50 percent blooming would occur only after 60 minutes.

At La Trinidad, the daytime temperature during the flowering period often does not rise above 21 C, accounting for the high sterility in IR8.