The Effect of the Yamase on Cool-Summer Damage in Tohoku District

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Abstract

The cool summers that influence Japanese agriculture so deeply, are brought about by a meteorological phenomenon called yamase. The yamase is a cool, moist air current originating in the Okhotsk Sea High. The yamase blows in the northern part of the Pacific Ocean side of Japan every year in early summer. The occurrence of cool-summer damage depends on a combination of factors: the time the yamase develops, its duration, and the growth stage of paddy rice. This appearance of abnormally low temperatures may seem limited to northern Japan (especially its Pacific side), but this phenomenon is teleconnected with heat waves in the U.S.A.. The higher the Japanese reliance on foreign-produced food, the more serious the influence of the yamase will be, at least in this respect.

Key words: Natural disaster, Cool-summer damage, Yamase

1. Introduction

The greatest monetary losses due to unusual weather conditions are caused by storm and flood. This is true for agriculture as well as urban areas. But if we ignore general disasters for a moment and limit ourselves to the field of agriculture and more specifically to crops, cool-summer damage becomes especially conspicuous, not only because of the tremendously large amounts of money involved, but also for the vast areas affected.

Except in Hokkaido, the most important summer crop in Japan is paddy rice. During the cool summer of 1993, 90% of the cool-summer damage in Iwate Prefecture, was suffered by paddy rice, while in Aomori Prefecture the rate was 85%.

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2. Meteorological characteristics of yamase

The yamase is a cool, moist air current originating in the Okhotsk Sea High. Its horizontal extent is about 1,000 km, while its air layer is about 1 km thick. When such a thick cool and moist air current flows close to the earth surface, it characteristically exhibits diurnal variation under the influence of surface energy and is also affected by local topography (Bokura, 1975). This is probably why the yamase has been generally thought to be a local phenomenon. However, as may be judged from the fact that its horizontal extent is 1,000 km, it actually affects a lot of territory and lasts at least a few days at a time. Although the yamase is a phenomenon of the lower layer of the atmosphere, it is also affected by the upper atmosphere.

Especially, the meandering path of the prevailing westerlies is an important factor in the development of the yamase. The bottom surface of this cool and humid air current is affected by the sea surface on its route; on the other hand, since its top surface undergoes radiative cooling, this layer sometimes causes drizzle accompanied with fog and stratus clouds (Bokura, 1986 and 1990) (Fig. 1).

The thickness of the yamase is often 1,000 meters over the ocean (Fig. 1, ①) and it becomes 1,500 meters when it crosses the Ou Mountains (Fig. 1, ②). In 1993, so many of these cool and humid air currents were more than 1,500 meters thick (Fig. 1, ③) that their influence extended to the Japan Sea area and caused low temperatures over all of northern Japan.

Fig. 1. Schematic illustration of the yamase

From this, the following observations may be made:

- 1) The yamase blows in the northern part of the Pacific Ocean side of Japan every year in early summer (Bokura, et al., 1983).
- 2) The Japan Sea area is little affected because it is on the lee side of a 1,500-meter-class mountains range (Bokura, et al 1982).
- 3) The occurrence of cool-summer damage depends on a combination of factors: the time the yamase develops, its duration, and the growth stage of paddy rice.

3. Yamase and cool-summer damage

These observations have been proved during many years of cool-summer damage. As for 1), on the Pacific side of the Tohoku District there are areas so frequently visited by the yamase that they are commonly called "cool-summer damage areas." As for 2), although the latitude is the same, the Pacific side suffers serious yamase damage, while the Japan Sea side is comparatively lightly affected and, since feudal times, has been known for its rice production.

To illustrate this, Fig. 2 shows the paddy rice situation index in the Tohoku District.

The difference between the Pacific side and the Japan Sea side is quite remarkable in the three northern prefectures of the Tohoku District and is demonstrated clearly by the paddy rice situation index of Iwate and Akita Prefectures, which are at virtually the same latitude. The third observation may be understood from the fact that there are two types of cool-summer damage: one due to delayed growth, the other due to floral impotency. If the main cause of the yamase is the appearance of the Okhotsk Sea High, it may be considered a quite common summer weather pattern around the Japan isles. Cool-summer damage means mainly the continuation of low temperatures, in bad years for as long as three months. If low temperatures continue for more than two months, crops are not only stunted in their growth (cool-summer damage due to delayed growth), but their heading or flowering time is also affected (cool-summer damage due to floral impotency). Moreover, sometimes a mixture of the above two types is seen. This was the case in 1993. If low temperatures appear in the growing period, when paddy rice is especially sensitive, even about a week can make a critical difference.

Fig. 2. Paddy rice situation index in Tohoku District.

According to meteorological data accumulated for over one hundred years, the frequent cool-summer damage northern Japan suffered in the 1980s followed a stable rice-growing period in the 1960s and 1970s, and the cool summer of 1993 occurred toward the end of the cool summer period (Fig.3).

From a strictly Japanese point of view, this appearance of abnormally low temperatures may seem limited to northern Japan (especially its Pacific side), but this phenomenon is teleconnected with heat waves in the U.S.A. (Fig. 4) and is caused by a general hemispherical circulation of the atmosphere.

Fig.3. Temporal variation of the mean temperature in summer and paddy rice yield in Aomori Prefecture. Number is shown cool-summer damage year. 19.5 °C is thought to be the limit for cool-summer damage.

Fig. 4. The heat waves in the U.S.A. teleconnected with cool-summer damages in northern Japan brought about yamase. Temperature is shown mean temperature in July in the US Southeast. The vertical lines show the cool-summer damage years in Fig.3.

4. Conclusion

The higher the Japanese reliance on foreign-produced food, the more serious the influence of the yamase will be, at least in this respect. The ability to forecast cool summers in northern Japan will therefore become even more important.

Despite the cool summer weather and societal upheavals of the past twenty years, the farmers of northern Japan have worked hard to counter the effects of cool-summer damage by establishing mutual support systems and switching to crops other than rice.

In some areas, they are already reaping the fruits of their labors.

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