Agroecological Classification and Geographical Distribution of the Common Buckwheat, *Fagopyrum esculentum* M. in the East Asia

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To obtain more information about the distribution and ecological characters of buckwheat (genus *Fagopyrum*) as a food material, and also to collect seeds of cultivated and wild buckwheat, as genetic resources and breeding materials, the authors have carried out the research since 1970 mainly in Japan and in Nepal.

In the present paper, ecological characters and geographical distribution of the common buckwheat are mainly reported.

Agroecological classification of the common buckwheat

The authors studied effects of the sowing time on some characters of the buckwheat planted at the University Farm in Ina, Nagano Prefecture, such as flowering time, plant height, number of leaves, number of flower clusters and seed yields. About 300 cultivars of the common buckwheat collected from all over Japan were used. Main cultivars representative of agroecological districts of Japan were also examined for their photoperiodic responses under three outdoor conditions, 10 hrs, 24 hrs and natural day length, from July 4 to Sept. 9 and Aug. 10 to Sept. 15, respectively.

Based on the results of these examinations, the cultivars were classified by their responses of flowering and yielding into summer, autumn and intermediate agroecotypes.

The cultivars which showed that the flowering time was largely influenced by day length and vegetative growth period was greatly prolonged under long day condition were classified as the autumn type. While, cultivars relatively less responsive to day length and temperature were classified as the summer type.

The autumn type, as a result of the prolonged growth, produced great number of leaves, flower clusters and flowers under long day condition. If the number of flowers produced by a plant could be an indication of a potential seed yield of the plant, the cultivars of the autumn type must have larger yield under long day condition. As it is evident from the yielding habit shown in Fig. 1, however, the potential yield of autumn type cultivars was not realized under long day

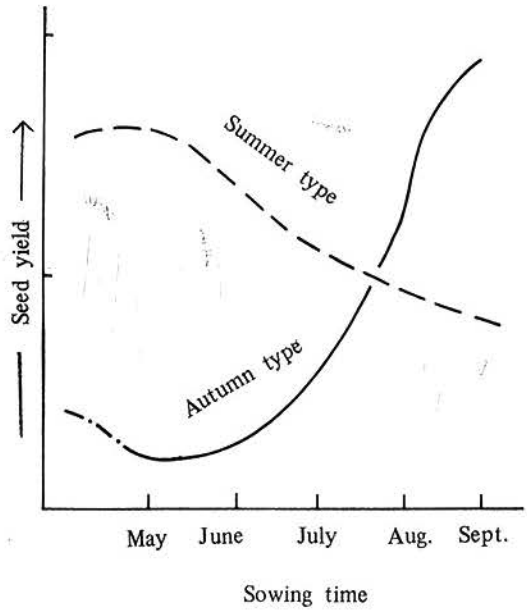

Fig. 1. Relationship between sowing time and seed yield in two agroecotypes of common buckwheat.

during early period of growth and under high temperature at flowering stage.

The authors postulate the possible cause of that low yield based on careful observations. The great number of flowers bearing abortive pistils were produced in summer season. This might be chiefly due to high sensitivity of pistil to temperature at the stage of its development. Moreover, vegetative sink might be very dominant during the period of flowering and early stage of seed set, as plant growth was indeterminate under long day condition. Apical dominance seemed to play a significant role in limiting seed set. Furthermore, it occurred that the grain in the lower part had already ripened in accordance with the indeterminate growth, while flowering was still going on in the upper part. Consequently, the plant often had severe shedding whereas it contained considerable amount of green and damp materials in its harvest. On the contrary, vegetative growth was retarded and development of pistil, seed set and maturing were achieved successfully under short day condition.

On the other hand, little variability in the length of vegetative growth or in the yield of seed was found in the summer type irrespective of sowing time and day length.

Considerable variation was recognized in the seed shape and it was divided into A, B and C types. Seeds of A type are usually small in size, relatively large in the ratio of its length to width, and round-shaped rather than triangular in cross section. The type C is usually large in size, relatively small in the ratio of its length to width, and triangular in cross section. The B type has intermediate shape between round and triangular.

It is interesting that the close relation was found between the agroecotypes, classified by flowering time, yielding habit, or the shape of seeds. The summer type was classified as the C type, while the autumn and the intermediate types corresponded to the A and B types, respectively. However, the agroecotypes classified by yielding habit are not always in full consistent with the agroecotypes classified by flowering time.

Geographical distribution of agroecotype of the common buckwheat

Agroecotypes thus classified based on the seed shape and the responses of flowering and yielding to growing time were found to have a close relation to geographical distribution and agronomical characteristics of cultivars.

The relationship between the agroecotypes of cultivars and their geographical distribution in Japan is shown in Fig. 2, 3, 4 and 5. It can be seen from Fig. 2 that the geographical distribution of cultivars is closely related to the variation of agronomical characteristics. Namely, the cultivars collected from lower latitude areas tended to flower somewhat later, and to be taller in plant height with larger number of leaves, branches and flower clusters. For example, flowering dates of local varieties show a change of about 1.03 days earlier or later with a difference of 1° latitude to northward or to southward, respectively, at the same altitude.

In addition to the change of the mean value of characters which is given in Fig. 2, a gradual increase in variances was recognized with lowering latitude as given in Fig. 3.

As shown in Fig. 4, 5 and 6, summer type cultivars were cropped in high latitude areas because growing season is shorter under lower temperature and longer day length than in the lower latitudes. Similarly, early maturing cultivars with low photoperiodic response have to be grown in mountainous cool highland. Moreover, in the region extending from a part of the middle latitude to the low latitude, where double cropping is usual, the cultivars of the summer type are grown as a preceeding crop, because temperature is low and day length is long at the early stage of the buckwheat growth and thereafter temperature become higher and day length become longer.

Even in the same region, however, cultivars which are highly sensitive to day length are grown when the buckwheat is cultivated as the succeeding crop. For example, after tobacco or soybean, buckwheat cultivars with

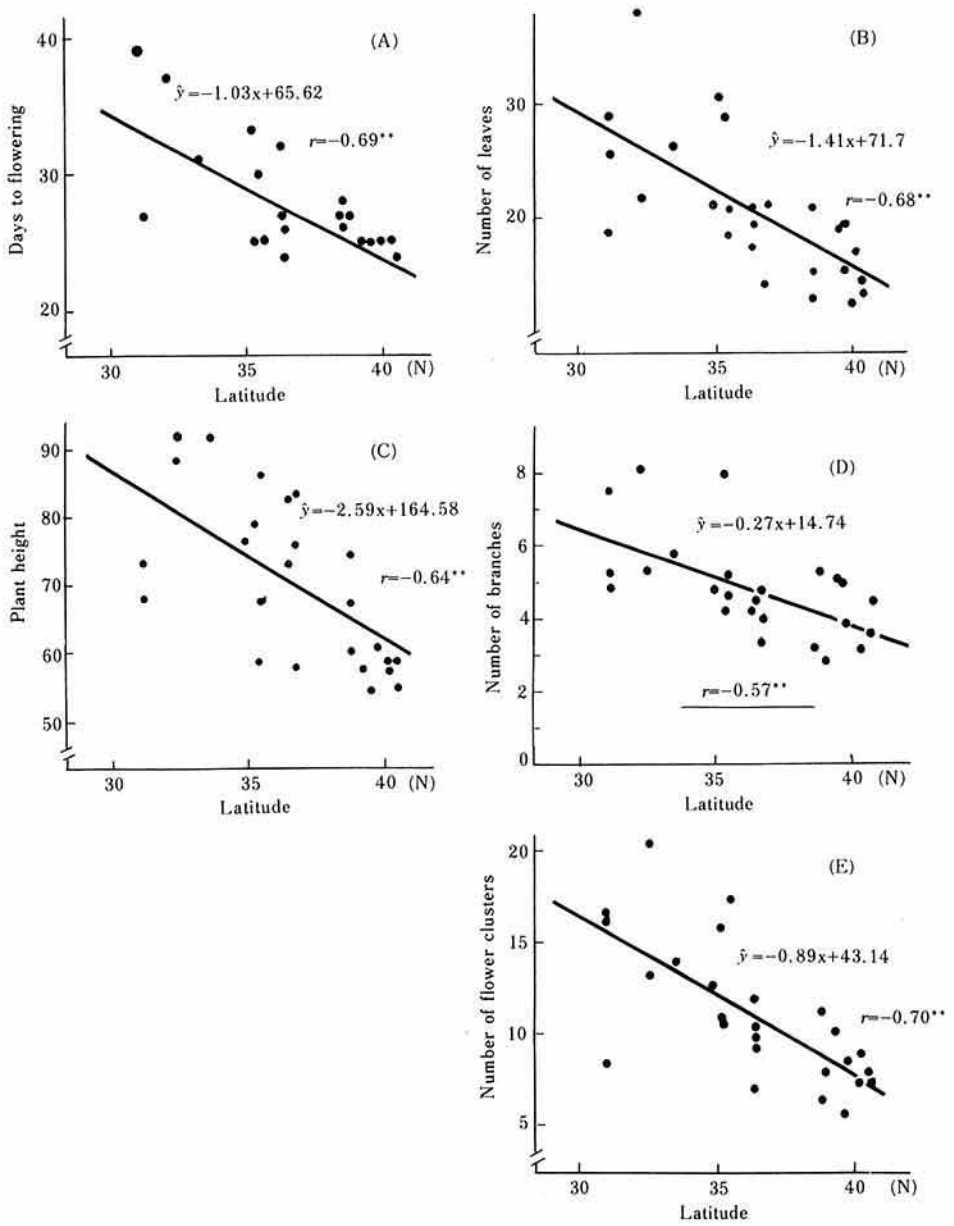

Fig. 2. Correlation between latitude and days to flowering, plant height, number of leaves, branches and flower cluster.
** Significant at 1% level

high photoperiodic response might be sown in the late summer. While, in the place where summer vegetables were planted, early maturing buckwheat of the summer type was cultivated as a preceeding crop.

In Kagoshima and Kochi prefectures, where multiple cropping is practiced, there is a variety named "sando soba" which literally means three times buckwheat, a kind of the summer type. This variety can be sown at any time in southern region where temperature is high.

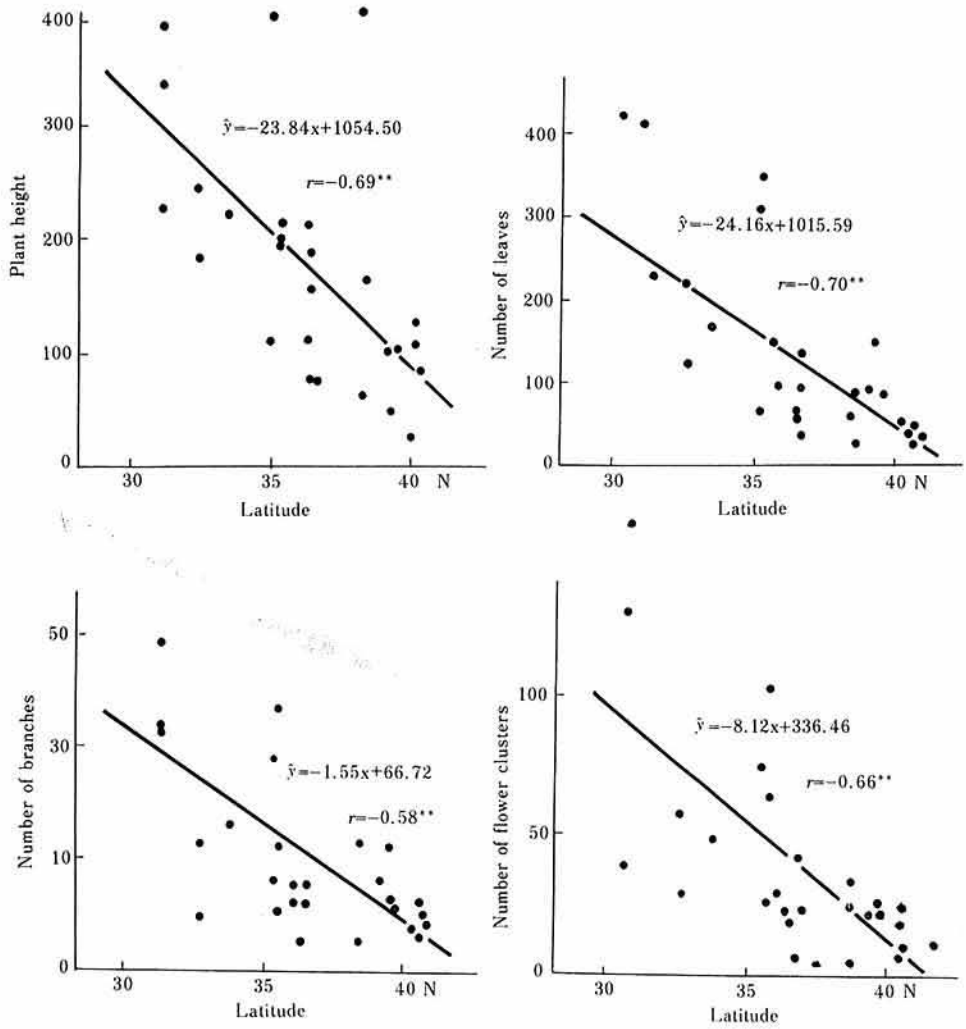

Fig. 3. Correlation between latitude and variances of some characters.
** Significant at 1% level

Agroecological type of the common buckwheat in Nepal

In 1975, a study on geographical distribution and agronomical characteristics of buckwheat (genus *Fagopyrum*) was carried out in Central Nepal. The main study areas were located between the latitude of 26°10′ and 29°10′.

The common buckwheat was found widely cultivated from the low latitude as Terai Plane near India (about 100 m above the sea level) to the mountainous regions (about 2000 m). Relations among the latitude and length of growing period, yield and some morphological characters were examined. It became clear that the length of growing period and yield of the buckwheat varied with the elevation. The growing periods of the common buckwheat both in the higher and the lower area were longer than that in the intermediate.

Furthermore, it is interesting that higher

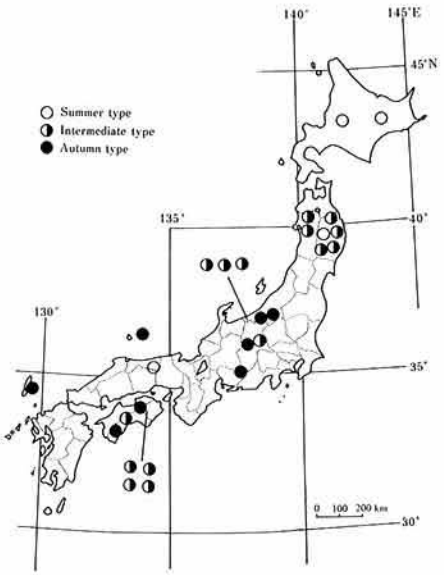

Fig. 4. Distribution map of agroecotypes classified according to the flowering time.

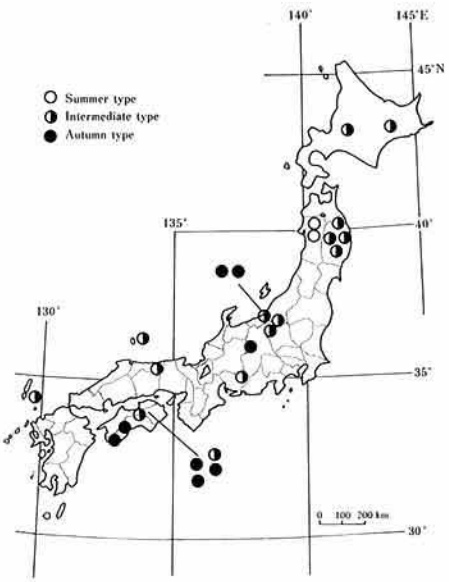

Fig. 5. Distribution map of agroecotypes classified according to the seed yield.

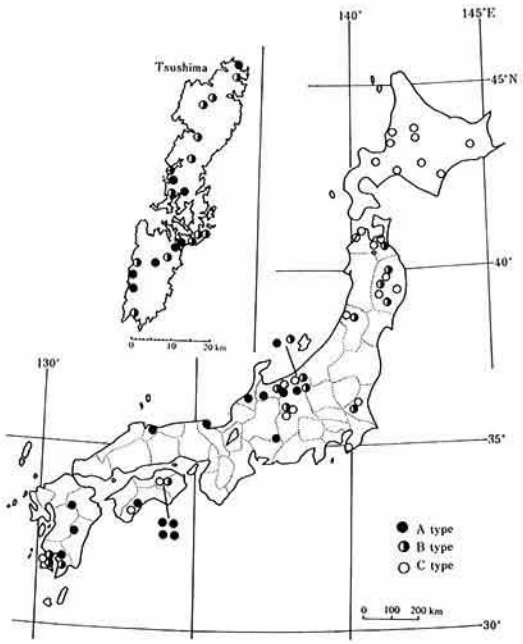

Fig. 6. Distribution map of agroecotypes classified according to the shape of seeds.

yield is obtained in the intermediate latitude where the growing period is 60–85 days.

Numerous cultivars collected in Nepal were planted in the Experimental Farm of Shinshu University and the authors attempted to make a comparison of some agroecological characters with Japanese cultivars. The cultivars originated in Nepal had longer period of vegetative growth, being highly sensitive to day length, and pistils were extremely sensitive to high temperature. Plant height, number of leaves, branches and flower clusters were larger than those of Japanese cultivars. However, few seed set was found in the cultivation from June to August.

In the place where temperature was moderate and the day length was short during the period of buckwheat cropping in the low altitude, variety with high responsiveness to day length brought high yield. It may be supposed that cultivation environment like cool hilly area in Nepal is one of the most suitable ones for growing the buckwheat of autumn type.

The origin of common backwheat and the differentiation of its agroecotypes in East Asia

De Candolle (1883) assumed that the range from Central Asia to North-eastern Asia was the original home of the common buckwheat. While, the recent study by S. Nakao (1960) indicated that the original place of buckwheat was the mountainous area in south-western China near the Himalayan region. This area was called the "arc center" by him, as the place of primary or secondary origin of many crops in Asian continent.

The authors may agree approximately with Nakao's opinion, based on their investigations on genus *Fagopyrum* in Nepal and studies on historical records of buckwheat cultivation in Asian countries as well.

According to the assumption above mentioned, the process of diffusion and differentiation of the common buckwheat may be summarized as follows. The common buckwheat was diffused from the "arc center" located in south-western China to north-eastern countries of Asia. The primary agroecotype might be regarded as an autumn type adapted to the climatic conditions of the low latitude. Through cultivation under different conditions such as long day, cool and short growing season or dissimilar cropping practice in earlier season with long day length, its derivatives as summer agroecotype would have originated.

In so far as the authors' studies on morphological characters and cropping patterns including buckwheat it may be concluded that the establishment of the summer type occurred in northern Asia, especially northern part of China, North Korea and Manchuria. And then, it seems that the different ecotypes of the common buckwheat have been cultivated extensively in these countries.

It may be said that the common buckwheat was introduced to Japan after many years through the trade routes from Korea to south-western districts of Japan, and has been cultivated extensively in different environmental regions.

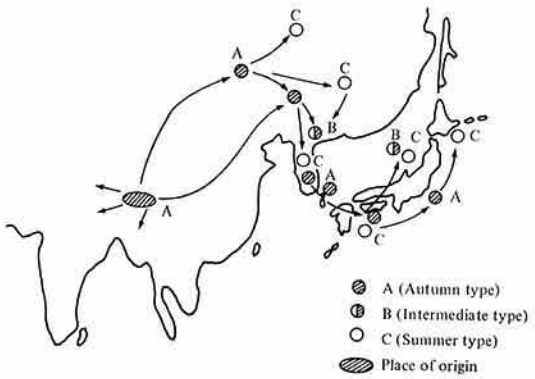

Fig. 7. Distribution arcs and differentiation of agroecotype in common buckwheat.

The process of the differentiation in agroecotypes is shown in Fig. 7.

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