Herbicides Used in Japanese Citrus Orchards

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Herbicides used at present

The herbicide usage in citrus groves in Japan is rapidly increasing these few years, although the practical use by commercial citrus orchards is estimated at 20-30 percent of the total acreage.

Table 1. Common herbicides for citrus groves in Japan

Herbicide	Dose		Herbicidal effect	Duration of effect	Damage to citrus	
	per 10 a	per acre			via foliage	via root
Sodium cyanate	3-5 kg	27-45 lb	quick action	10 days or less	severe	no
Paraquat	0.5-0.3 *l*	0.16-0.32 gal	distinct, grasses are especially susceptible	30-40 day	severe	no
Diquat	0.3-0.5 *l*	0.32-0.54 gal	strong, broad leaves are especially susceptible	20-30 day	severe	no
Wydac	2-4 *l*	2.2-4.3 gal	powerful	30-50 day	no	no
Sodium chlorate	3-5 kg	27-45 lb	only for use in noncrop-land	long	severe	slight*
Amitrole	0.25-0.5kg	2.2-4.5 lb	suitable for the control of broad leaf perennials	long	bleaching of new tissues	die-back of shoot
Dalapon	0.25-0.5kg	2.2-4.5 lb	effective for the control of perennial grasses	long	small leaves and necrosis	die-back of shoot
Bromacil	0.2-0.4kg	1.8-3.6 lb	definite, surfactant is needed for contact foliage use	60 days or more	no	almost no
Diuron	0.15-0.3kg	1.3-2.7 lb	strong, surfactant is needed for contact foliage use	50 days or more	no	almost no
Simazine	0.15-0.3kg	1.3-2.7 lb	only for pre-emergence use	long	no	no

* in the case of planting a year after the treatment

Currently, the best known herbicides in Japanese citrus are, as shown in Table 1, sodium cyanate, paraquat, diquat, wydac, sodium chlorate, amitrole, dalapon, bromacil, diuron, simazine and others. Among them, bromacil and wydac are the most popular and useful for growers.

Normal rate for bromacil is 2-4 kg/ha (1.8-3.6 lb/ac), adding with certain surfactant. 2 k*l* par ha (220 gal/ac) of water is generally used. The definite effect of bromacil is loved by many growers, and moreover it is almost harmless to satsuma trees, the leading and main citrus variety in Japan, both from root and foriage absorption. On the other hand, some windbreak trees and other citrus varieties often suffer from severe damages by the application of bromacil. Some trees of *Pinaceae*, *Cryptomenaceae*, *Podocarpaceae* are injured and *C. natsudaidai* Hayata is frequently very weak.

Wydac, a Japan made herbicide, is an emulsion which contains 25% of dichloropropion-anilide and 5% of NAC (Sevin or Denapon). The herbicidal effect is strong

and quite harmless to citrus trees, *via* foliage or *via* root. Most windbreaks are also tolerent. General application rate of 20-40 *l*/ha (2.2-4.3 gal/ac) is relatively expensive at present. Wydac usage in Japan is increasing year by year.

Among foliar-acting herbicides, paraquat is the most popular one. The effect appears very quick and clear, and this is quite attractive for growers. But its drift on citrus leaves causes a severe damage, therefore, great precaution is needed. The device is rather difficult on the slope of the hillside plantings, because the skirts of trees are not short, and the tops of lower row are quite near to the upper terrace ground. Common dose of paraquat is 1.5-3 *l*/ha (0.16-0.32 gal/ac). Recently, the sparse spray of higher concentration (common dose in 60 *l* water) is sometimes recommended for the safety of citrus trees. Diquat is often comparable to paraquat, and the dose is 0.3-0.51 (0.32-0.54 gal).

Sodium cyanate is tested in the earlier years, but the duration of its effect proved to be too short under the humid climate conditions. Sodium chlorate is used only in the preplanting land and should be used more than one year before the planting. Simazine is good only for pre-emergence use in the orchards of clean soil management.

The control of perennial weeds with amitrole, dalapon, or 2.4-D are tested, but are not recommended for growers' use yet, because of the possibility of damage. In the experiment of recent year, DBN granule showed promising result for spotting application onto annual weeds in citrus orchard.

Peculiar usage of herbicide

Under Japanese conditions of high precipitation, weeds and grasses are needed as a favorable ground cover to protect soils from erosion. Weeds are not always the "enemies" of citrus, but sometimes they can be the "friends" of fruit trees.

The most important time for applying herbicides in citrus is late July, when the rains of early summer are over. Native weeds and grasses should be controlled generally during August to early September to eliminate the competition for soil moisture in the dry weather. At this time, the most dominant grass in almost all citrus growing areas is large crabgrass (*Digitaria adscendens* HENR.) Grown-up grasses are very tall (60-100 cm or more) and tolerent. Thus, the herbicides in Japanese citrus groves are requested to have rather strong killing effect.

Herbicides are sometimes applied in early spring, mainly because of the convenience of cultural practices in orchards.

Spring weeds will increase generally as the spring proceeds and will get its maximum around middle April. As the spring weeds fall away in May to June, summer grasses come up and grow on. One example of herbicide application schedule is twice a year; early April and late July.

In summer application, the duration of effect is requested about 40-50 days or more. So, residual herbicides are preferable in this season. In spring application, however, grasses and weeds must recover their vigor before the rains begin in early June. Consequently, leaf-absorbed compounds are often preferred to soil-acting herbicides.

Much attention has been paid in the screening tests of herbicides in Japan, since the liaison experiments between national and prefectural stations started in 1964. Accordingly, the screened herbicides exerted intense killing effect against grown-up weeds and at the same time they were almost harmless to citrus trees.

In the last five years (1964-1968). more than 60 herbicides were tested in citrus growing areas. They are 13 inorganic compounds, 4 quartary ammoniums, more than 7 amide compounds, 5 benzoic compounds, 9 uracils and urea compounds, 3 carbamates, 4 triazin compounds and other miscellaneous chemicals. Among them, in addition to the herbicides in Table 1, terbacil, cypromid, linuron and several propanil compounds are noticed for their interesting activities.

Expectation to the futuro

Position of herbicide usage in citrus production paractices will add its importance year by year in the future. Labor shortage is becoming severe in Japan, owing to the decrease of agricultural laborer population and to the increase of labor cost. Among the pre-harvest production costs, labor, fertilizer and spray materials are the biggest three, while the rate of labor cost are rapidly increasing in these years. Among laboring hours, harvesting and hauling need the most, hours, but next to that, especially in the case of citrus growing, weed control and cultivation is the biggest problem. The rate of agricultural workers to total workers was 82% in Japan of 100 years ago, and now, by 1967 the rate is reported to have decreased down to the line of 20% (or more exactly 19.3%). Under such circumstances, the researches on herbicides must be planned very thoughtfully. The cost of chemical weed control in citrus is averaged about 20,000 yen per ha ($ 22 per acre).

Among the problems in future, the control of resistant weeds, containing many perennials, might be very important. Examples of the most common perennials in Japanese citrus orchards are; false grape (*Cayratia japonica* Gagn.), bindweed (*Calystegia hederacea* Wall.), curled-dock (*Rumex japonicus* Houtt.), nutgrass (*Cyperus rotundus* L.), etc.