Technical Innovation in Herbicide Use

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Abstract

Granular herbicides have been used for the past 40 years in Japan and account for 86% of all rice herbicides applied. They are packed in 3 kg packages as a 0.1 ha dose on the assumption that they will be used in hand treatment like fertilizers. Trials have been carried out to minimize application labour in paddy fields. In one of them, flowable herbicides were developed in 1986 and the merit of easy application without use of tools was recognized. Another trial was made to reduce the dosage of granular herbicides from 3 kg/0.1 ha to 1 kg/0.1 ha. In yet another, The Japan Association for Advancement of Phyto-Regulators (JAPR) has carried out basic research on large granular type herbicide, provisionally called Throw-in type formulation (so called "Jumbo" formulation), in an attempt to treat 0.3 ha paddy fields within 5-6 min. by throwing "Jumbo" from levees into the field. "Jumbo" application does not require any particular equipment and is labour saving.

Key words: granular herbicides, flowable herbicides, Jumbo Herbicide

Introduction

Based on the statistics shown in Fig. 1, the weeding labour time in paddy rice culture in Japan in 1992 was only 2 hours per 0.1 hectare, (less than 4% of the 50.6 hours required prior to the introduction of paddy rice herbicides) and it accounted for 5% of the 41.1 hours of total labour time for rice culture in 1992. This situation results from the development of new herbicides and the improvement of formulation as paddy rice herbicides, as well as from the rational dissemination of these herbicides.

Especially after 1983, the weeding labour time was saved owing to the simplification of application methods, including 1) the reduction of the application frequency by the development and introduction of the one-shot herbicides, 2) the reduction of the amount of granule formulation applied from 30 to 10 kg/ha, and 3) the development of suspension concentrate formulations which can be easily applied from levees into paddy fields.

Since 1991, the Japan Association for Advancement of Phyto-Regulators (JAPR) has carried out basic research on the throw-in type formulation (so called "Jumbo Herbicide", JH) to develop a safe and easy

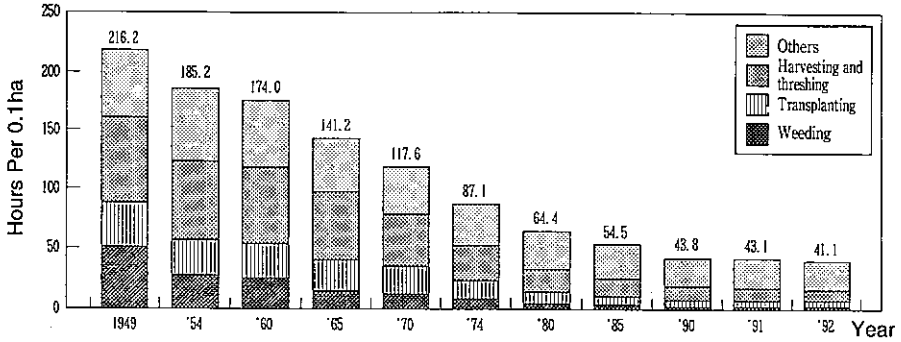

Fig. 1 Change of labour time in paddy rice culture

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application method and to save the application labour in order to reduce the rice production cost while taking account of the ageing of the farmer population engaged in rice production. The results obtained show that two kinds of JH were already submitted for registration in 1994, and the sale of these JH products started in 1995. At present, thirty products are being evaluated by JAPR.

Research progress in herbicide technology

JAPR has been carrying out research on herbicide technology based on the conditions of rice culture in Japan, which are characterized by 1) small farm size, about 95% of the total paddy field area is smaller than 0.5 ha per farm (Fig. 2), 2) increase in the number of elderly farmers, half of which are more than 60 years old, in rice culture (Fig. 3), and 3) considerations about safety of the pesticides used for farmers, crops, and environment.

As a result, JAPR made considerable progress in research on herbicide technology which enabled to reduce the amount of application from 30 kg (dose per hectare) to 10 kg using granule formulations (Fig. 4), and 2) to simplify the method of application by developing suspension concentrate formulation in combination with higher dilution (Fig. 5).

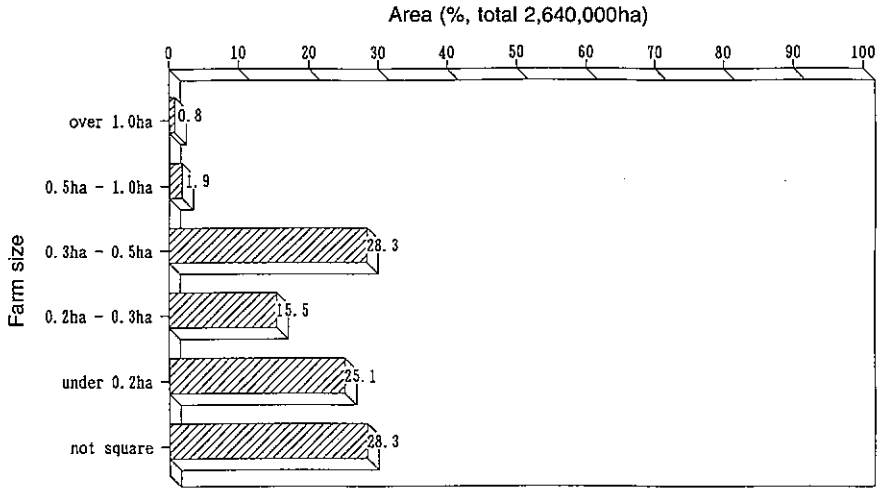


Fig. 2 Area of paddy fields in relation to farm size in Japan (1992)

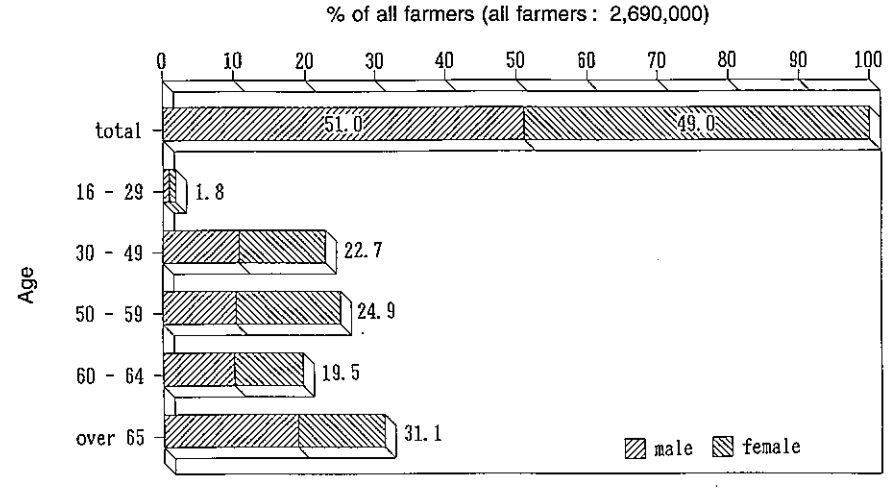
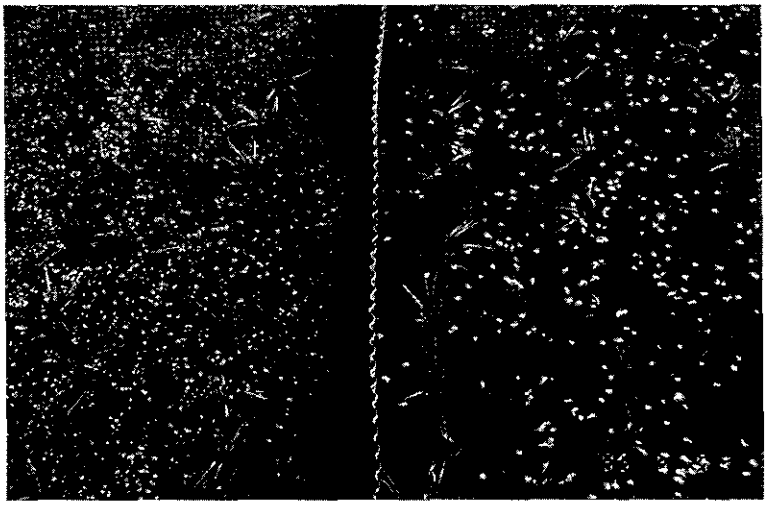


Fig. 3 Distribution of farmers engaged in rice culture by age in Japan (1922)

A

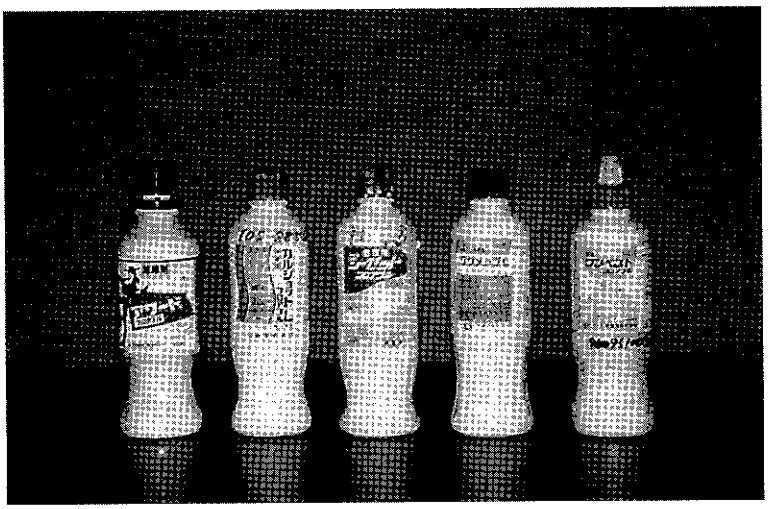
B



C

Fig. 4 Development of 10 kg/ha granule formulation (GR) and application method
A. granule formulation package type, left: 3 kg/0.1 ha (conventional), right: 1 kg/0.1 ha (new)
B. distribution of GR in paddy field, left: 3 kg/0.1 ha GR, right: 1 kg/0.1 ha GR
C. application from levees by using back-pack power granule distributor

A



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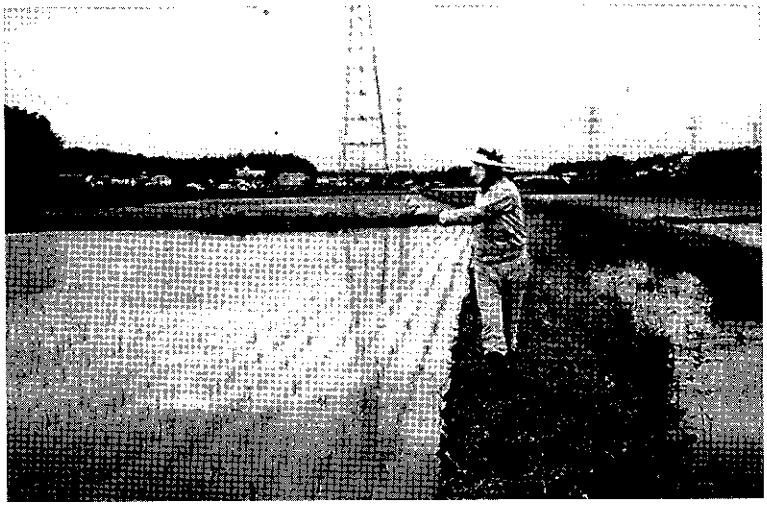

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Fig. 5 New suspension concentrate formulation and application methods
A. bottle of suspension concentrate for non-dilution application
B. bottle shaking application method from levees
C. inlet application with irrigation water

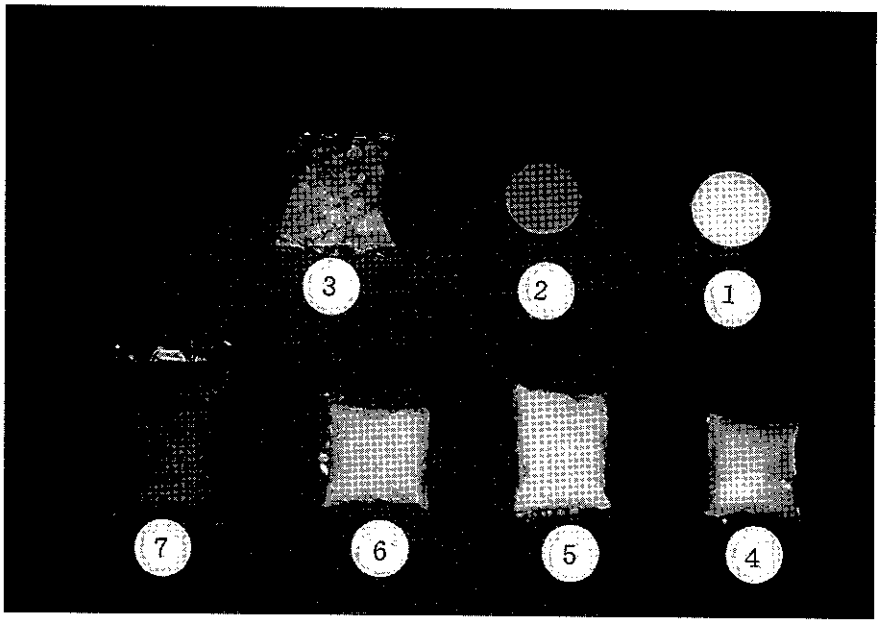

Fig. 6 Several throw-in type formulations of so-called Jumbo Herbicide (The number under each type corresponds to those in Fig. 7)

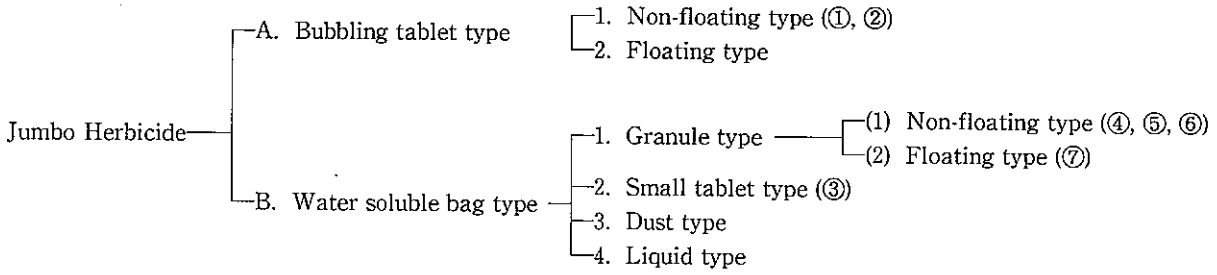

Fig. 7 Classification of types of Jumbo Herbicide (The number in the circles corresponds to those in Fig. 6)

Specification of jumbo herbicide

JH formulation can be thrown from the levees into paddy fields without the use of any machines. During the initial development stage, the application consisted of 50 g per bag/tablet (piece) with 200 pieces per hectare. Thereafter the formulation was 30-50 g and/or distribution (80-200 bags/ha).

1. Classification of formulation

As shown in Fig. 6, many formulation types were evaluated by JAPR in 1995. They are classified into two types based on the formulation characteristics as shown in Fig. 7.

The first type is the bubbling tablet type (A, Fig. 7) and the second type is the water soluble package bag (WSB) type (B, Fig. 7).

The bubbling tablet type is again divided into two types: floating on water or not floating. The water soluble package bag type is also divided into four types based on the formulation in WSB such as granule, tablet, dust and liquid. The granule type with WSB further, includes non-floating and floating types.

2. Degradation and diffusion of JH formulations from the application point

Uniform diffusion with rapid degradation is important to obtain effective weed control. The degradation and diffusion patterns of the representative four JH are described as follows.

1) Bubbling tablet (non-floating type) (Fig. 6-① ②, Fig. 7-① ②)

Fig. 8 shows the initial diffusion state of a bubbling tablet of the non-floating type at the application point 5 minutes after application. Fig. 9 shows the distribution pattern of the concentrations of the active

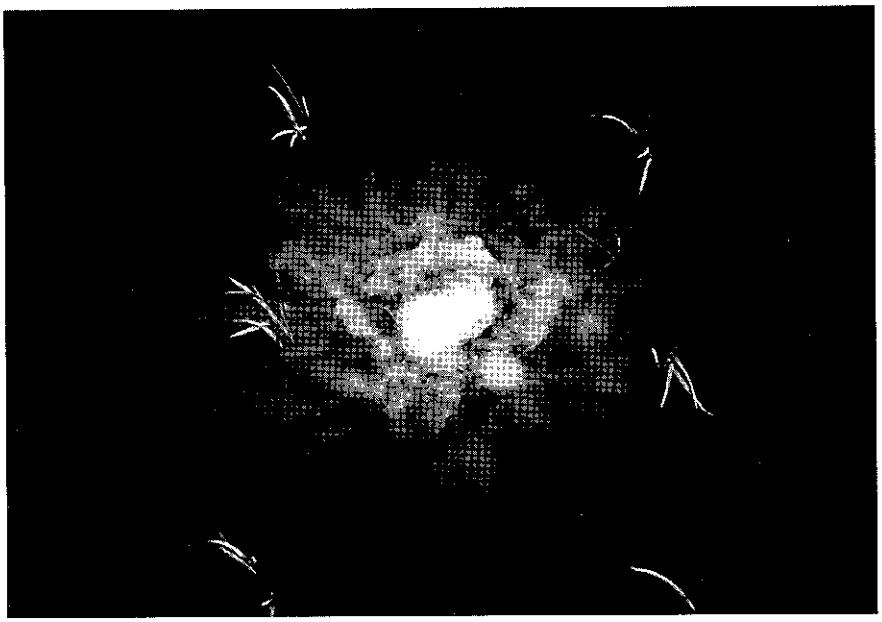

Fig. 8 Diffusion of a bubbling tablet of the non-floating type Jumbo Herbicide (5 minutes after application)

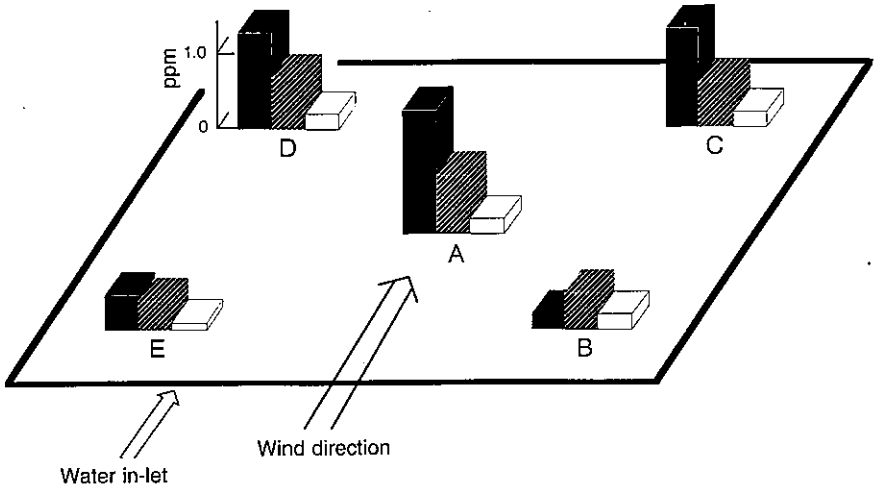

Fig. 9 Disribution of active ingredient concentration in the surface water in the bubbling tablet non-floating type of Jumbo Herbicide with Quinoclamine (ACN) 6 (■), 24 (▨) and 72 (□) hours after application (plot size: 50 m² with 7.1 m × 7.1 m)

A: application point. B, C, D and E: four corners in the plot (Koura *et al.*, 1994)[1)]

ingredient (Quinoclamine, ACN) in the water in this type. ACN at the application point (A) and four corners (B+C+D+E) in the experimental field (50 m^2 with 7.1 m by 7.1 m) was uniformly distributed within 72 hours. In the same experimental field, ACN was more rapidly degraded in the water than granules uniformly applied at the rate of 30 kg and 10 kg (Fig. 10). These results indicate that JH is effective and safe.

2) Water-soluble bag type
   (1) Granule WSB of the non-floating type (Fig. 6-⑤, Fig. 7-④, ⑤, ⑥)
   The granule in a bag started to diffuse uniformly in the water 5 minutes after application as shown in Fig. 11-A.
   (2) Granule WSB of floating type (Fig. 6-⑦ Fig. 7-⑦)

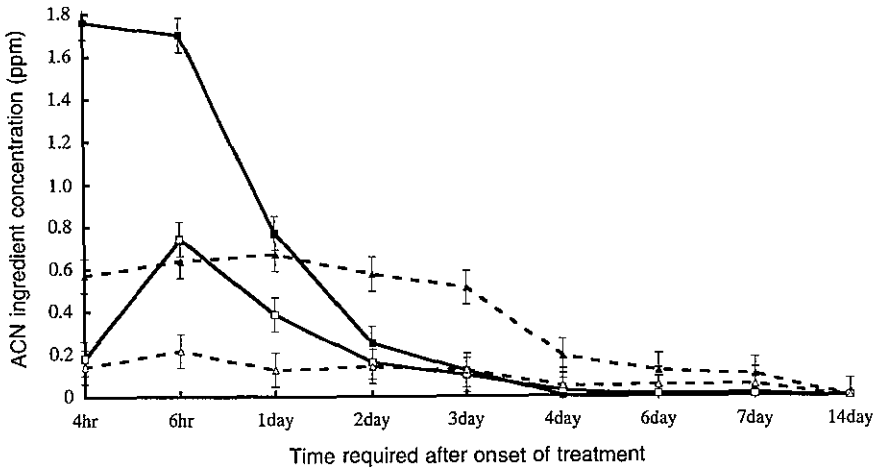

Fig. 10 Changes in active ingredient concentration in the surface water with time after application in the bubbling tablet type Jumbo Herbicide, Quinoclamine (ACN) JH (—) and conventional ACN granule (···) with 10 kg/ha (△) and 30 kg/ha (▲). —■— and —□— corresponds to A and B-E (average value of B, C, D and E) in Fig. 9, respectively (Koura *et al.*, 1994)[1]

Table 1 Comparison of labour load between Jumbo Herbicide application by hand (JH) and conventional granule application by back-pack power distributor (PD) from levees of a paddy field (Takeshita *et al.*, 1994)[3]

	Work efficiency-1 work time per 0.1 ha (min/0.1 ha)		Work efficiency-2 work area per min. (0.01 ha/min.)		Work intensity-1 heart rate (heart rate/min.)		Work intensity-2 energy metabolic rate (RMR*)		Work intensity-3 energy consumption per 0.1 ha (kcal/0.1 ha)	
	JH	PD	JH	PD	JH	PD	JH	PD	JH	PD
Male A (62 years old)	1.5	1.9	6.7	5.3	119	136	3.8	4.8	7.3	11.0
Male B (38 years old)	1.3	1.7	8.0	6.0	113	135	2.8	4.2	5.9	10.3

Note.
1) Experimental field is 0.3 ha (100 m by 30 m).
2) * : Parameter of work intensity to indicate how much energy is consumed in work with the metabolic rate and calculated by the following equation.

$$\text{RMR (Relative Metabolic Rate)} = \frac{\text{metabolic rate at work} - \text{metabolic rate at rest}}{\text{basal metabolic rate}}$$

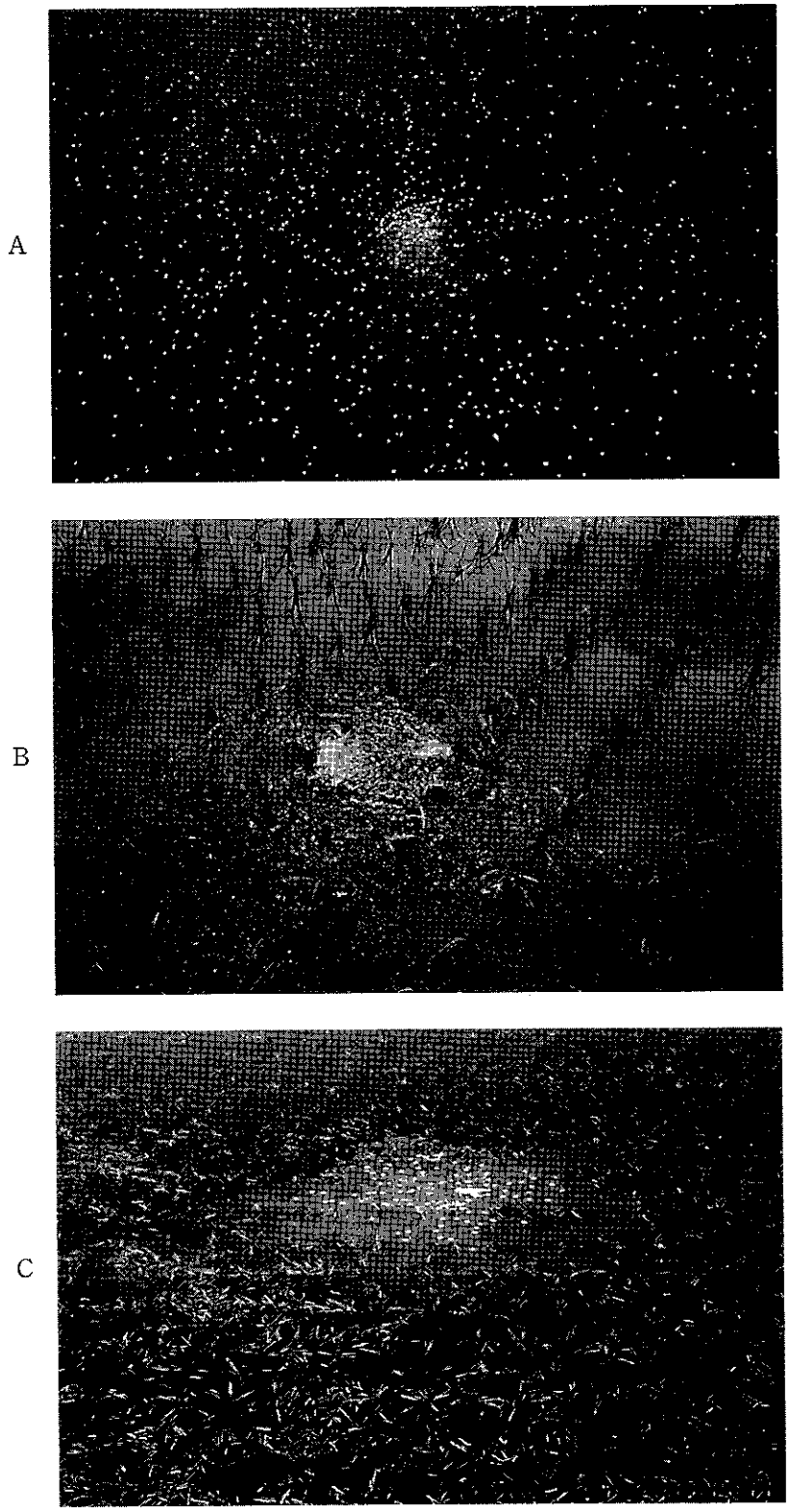

Fig. 11 Diffusion of WSB type Jumbo Herbicide.
A. granule WSB floating type (5 min. after application)
B. granule WSB floating type (30 sec. after application)
C. small tablet WSB type (3 min. after application)

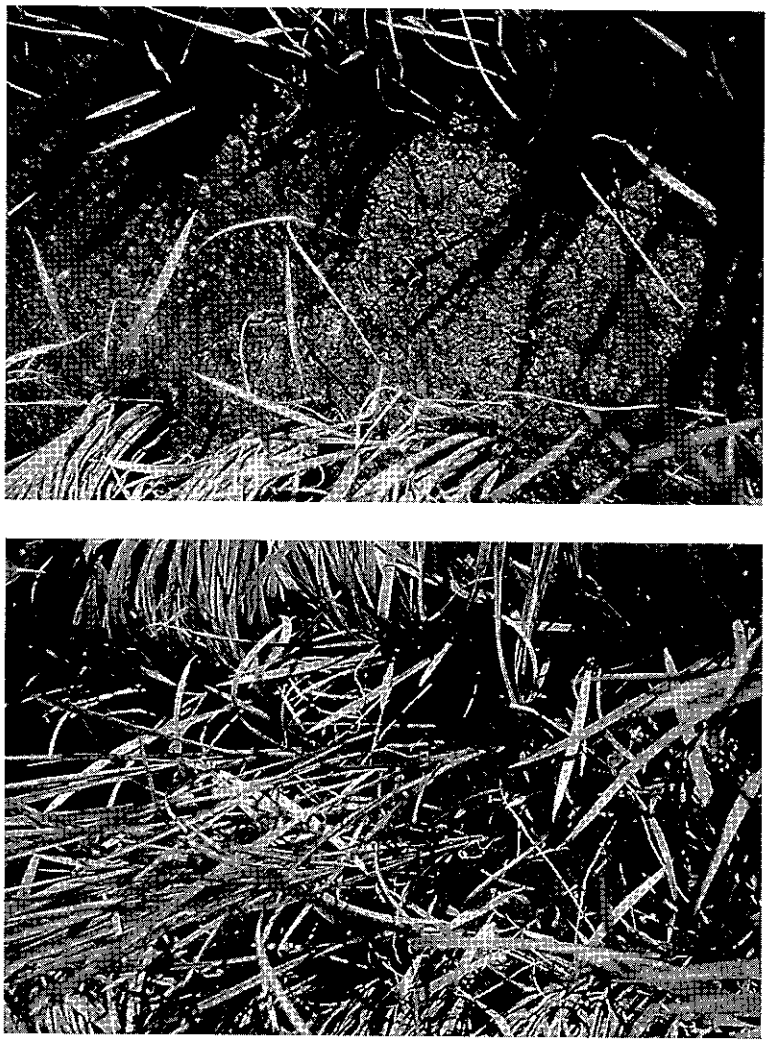

Fig. 12 Weed cover in the plots treated with Jumbo Herbicide (A) and not treated (B) 45 days after application (50 days after application)

Granule particles diffused and floated rapidly in the water 3 minutes after application as shown in Fig. 11-B, and the diffusion ended about 7 minutes after the application.

(3) Small tablet WSB type (Fig. 6-③, Fig. 7-③)
One hundred small tablets per bag floated in the water 3 minutes after application over a distance of 4 to 5 meters from the application point (Fig. 11-C).

Conclusion

All weeds were completely controlled in the plot treated with WSB type JH 45 days after application (50 days after transplanting), while abundant weeds occurred in the untreated plot as shown in Fig. 12. Table 1 indicates the difference in labour load between JH application by hand and conventional granule application by back-pack power distributor, from levees of the experimental paddy field with a size of 0.3 ha (100 m by 30 m) in both cases. It appears that JH technology is characterized by a higher working efficiency in terms of working time and area, and lower work intensity in terms of heart rate, energy metabolic rate and energy consumption than conventional application methods.

In conclusion, JH technology is 1) a simple and labour-saving method of application which enables farmers to apply herbicides without the use of machines (Fig. 13), 2) an environmentally safe method of application under definite limits of concentrations of active ingredients.

Fig. 13 Jumbo Herbicide application from levees by hand

Further investigations are needed to improve JH technology in future.

References

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Discussion

Taylor, M. (Australia): 1. When using these formulations, have you evaluated the presence of herbicide residues in foliage, grain and straw at the point of application versus the balance of the paddy ? 2. Do floating solid formulations present a problem of blowing downwind onto the levee in windy weather ?

Answer: 1. There are no problems. 2. No problems are observed if the wind velocity does not exceed 5 m/sec.

Boonrat Nanta (Thailand): Is there any local crop damage close to the application point ?

Answer: There is no toxicity close to the application point.

Duong Van Chin (Vietnam): Can we use the "jumbo" type of herbicide for direct seeding ?

Answer: We will study this aspect in future. Control of algae and aquatic weeds is being currently tested.