Pesticide Applicator Used by the Granular Boom Type Blow Head

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The most famous pesticide applicator in Japan was the knapsack type power duster with the boom type blow head except the power sprayer in 1968.

The dust application, however, is causative of pollution so that the neighbors and operators suffer from headache by inhaling the toxic dust. The effective rate of deposit to the crop in all the applied dust is about 20 to 30 per cent in an unfitting atmospheric environment.

On the contrary, the applied granule of herbicides gradually dissolves on the paddy surface and suppresses the growth of weeds. The systemic insecticides are absorbed by the root and circulate in the plant by osmosis and cause high mortality without bringing on the drift hazard due to the wind. Consequently, the granule application is safer to the operator and neighborhood than the dust application.

Structure and capacity of the granule applicator

The popularization of the knapsack type power applicator in Japan was about 1.0 million in 1968 and the production in a year is about 0.02 million. This type is convertible to the duster, mist sprayer and granule applicator by the simple exchange of each attachment.

The applicator of granule as shown in Fig. 1 consists of the engine, blower, granule tank, adjusting shutter, mixing device of air and granule, delivery pipe and the boom type blow head that is described elsewhere in this paper.

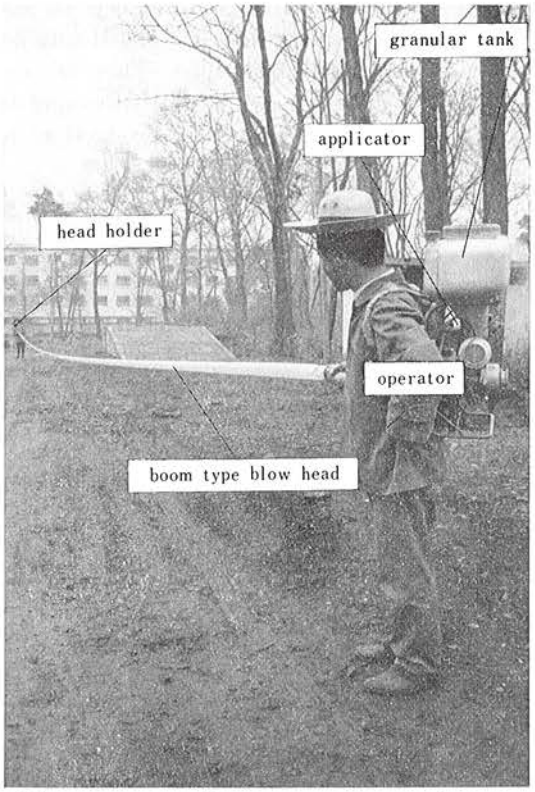

Fig. 1. Knapsack type power granular applicator

The granule in the tank is delivered to the mixing chamber situated in the bottom part of the tank and is mixed by the air flow from the blower, and gets to the inlet of the boom type blow head.

The discharge rate of granule is adjusted by the shutter that differentiates the area to pass the granule or the air flow as explained by M. Ariyoshi in 1970.[1] All centrifugal type blowers are made of aluminum alloy, and are driven by a two-cycle gasoline engine with the displacement of 30 to 40 cc. The revolution per minute is about 7,000 to 7,500 to decrease the weight of the knapsack. In the middle part of the blower casing, there is a small hole which is connected through a pipe with the mixing device in the bottom of the tank. Therefore, the velocity and flow rate of the air, size of the particle and specific gravity of the granule must suit with each other in the mixing device. When the granule does not agree with the design of the mixing device, the discharge rate per minute becomes irregular or the discharge is stopped to make a bridge of a concave space in the bottom of the tank. The discharge rate per minute should be set within the range of the travelling speed made by the following formula (1). The excessively large discharge rate per minute and the excessively high travelling speed V, which are given by the swath width L and the applying rate Q determined by the applicator and the pesticide, make the worker unable to walk in the foot path or paddy field. On the other hand, the excessively small rate causes the waste of the applying time as explained in the formula (2).

For the applicator, the applying rate per acre is 27 lbs, the discharge rate per minute is 2.0 lbs, and the swath width is 66 ft or 99 ft by using the boom type blow head, so that the work is carried out perfectly. The working acreage per 4 to 5 hours in one day in the paddy field is about 5, and the applying acreage per pest control work is about 15. The applying work can be done by only two persons: one drives the applicator (the weight of the knapsack is about 20 to 30 lbs. empty), and the other holds it by the end of the head, so that labor saving and the high efficiency are excellent.

Device of the boom type blow head

Fig. 2 illustrates four types of the granular boom type blow head in 1970. The mixtures of the granule and air are caught by the

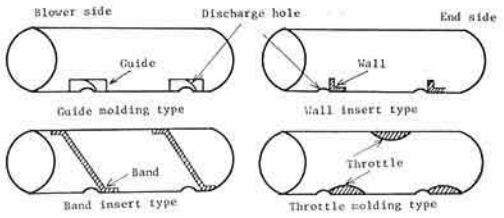

Fig. 2. Granular boom type blow head

guide, insert and throttle, and discharged from each hole situated in the bottom of the boom. Thus, the granule is distributed evenly in a straight line from the boom type blow head of 66~99 ft swath width. This head of the plastic tube can be folded in a long band and wound on to a reel because of the thin tube of 0.1 mm.

On the application, as soon as the head holder expands the tube from the applicator to the other side near the field and the operator fixes the end of the tube on the applicator and drives the blower, the head (i.e. the tube) rises up horizontally on the paddy field and discharges the mixture of granule and air to the rice from each hole opened at some intervals.

Some parts of the applied granular insecticides are deposited on the leaves and exterminate immediately the insects but others drop on the paddy surface and put in motion the control effect by osmosis. The fine granule is more easily deposited on the leaves to bring on the high mortality than the coarse granule.

On application at the field, it is essential that the operator and head holder walk about at a constant speed, holding the head in a horizontal position on the rice crown. The speed is as follows:

$$V=7.26\times10^{2}q/LQ(\text{ft/ sec})$$
$$=4.95\times10^{2}q/LQ(\text{MPH}) \quad \ldots\ldots(1)$$

then,

q: discharge rate (lbs/min), L: swath width (ft) Q: (lbs/acre), V: travelling speed

On the other hand, the applying time per acre T (except supply and turning at the end of the field et al.) is

$$T = Q/q(\min) = 4.95 \times 10^2/VL(\min) \quad \ldots\ldots\ldots\ldots (2)$$

Under this formula, the more the speed and the larger the swath width are, the less the applying time becomes. The limit of the speed in the paddy or the foot path is 1.3 or 1.9 ft/sec, and the swath width is 66 or 99 ft in this knapsack type.

Evenness of distributed granule and formulation of chemicals

Many studies concerning the evenness of granule application have been conducted since 1967 by using insecticides and herbicides and the formulation of granule was discovered as coarse (10–48 mesh), fine (48–150 mesh), and a mixture of granule and dust.

On the other hand, the wall insert, band insert, and guide molding types et al. have been developed from the boom type blow head. But in the early period of the new formulation, some blow heads distributed it uneven for insufficient inserts, and the other heads were left over it inside of the boom.

The formulation of granule of too light weight and fine particle concentrates its distribution at the end of the boom to cause the photo-toxicity to crops by herbicides or insecticides, because it is blown away to the end of tube by high speed air blow and is discharged out of the last hole.

In 1970, the Institute of Agricultural Machinery (IAM) published the report titled "Mutual Improvements of Boom Type Blow Head and Granule Formulation". The blow heads used were of four types as shown in Fig. 2 and granules were of 10 formulations as shown in Table 1.

The testing methods were authorized by IAM in Japan, based on the OECD testing code of granule fertilizer, and the testing devices consist of a travelling carriage with the frame, sampling boxes of 50 × 100 × 15 centimeters in size (surface area is 0.5 sq m) which are placed on line with the boom type blow head. The wheel-barrow moves with the carriage at the end of the head.

The carriage is operated by an electric motor at the speed calculated by the formula (1), and the granule is discharged down to the boxes at the discharge rate, 27 lbs/acre, which farmers have actually adopted in the fields.

After that, the weight of the granule in

Table 1. Tested granules

Granule	Diameter (mm)	Specific gravity	Angle of repose	Name of pest*
Diazinon	0.3–0.8	1.40	37.6	Borer, leafhopper
MCC	0.5–0.8	1.00	33.8	Barnyard grass
MPP. MCP	0.3–0.8	0.78	43.6	Borer, leafhopper
MIP. SPANON	0.4–1.0	0.81	37.1	Borer, leafhopper
KITAZIN P	0.6–1.7	0.99	34.3	Rice blast Leaf spot withering
CNP	0.3–0.8	1.01	34.3	Barnyard grass
2, 4PA. ATA	0.08–0.6	1.15	35.2	Leafhopper
BPMC	0.08–0.4	1.09	33.9	Borer, leafhopper
Diazinon	0.08–0.4	1.33	36.9	Borer, leafhopper
SMI. NAC**	—	—	48.2	Borer, leafhopper

* Names are representative examples

** Formulation is mixture of fine dust and granule (2 : 1)

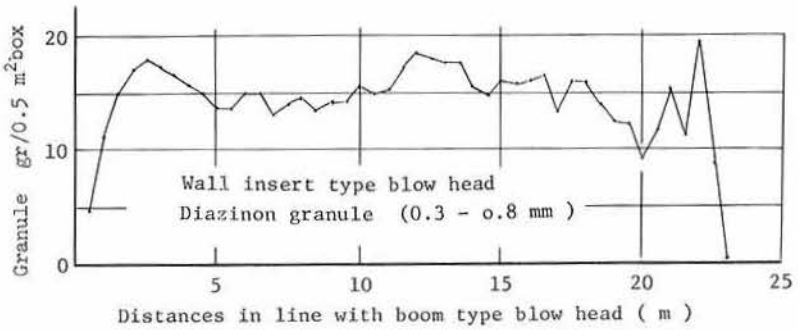

Fig. 3-1. Distribution of coarse granule

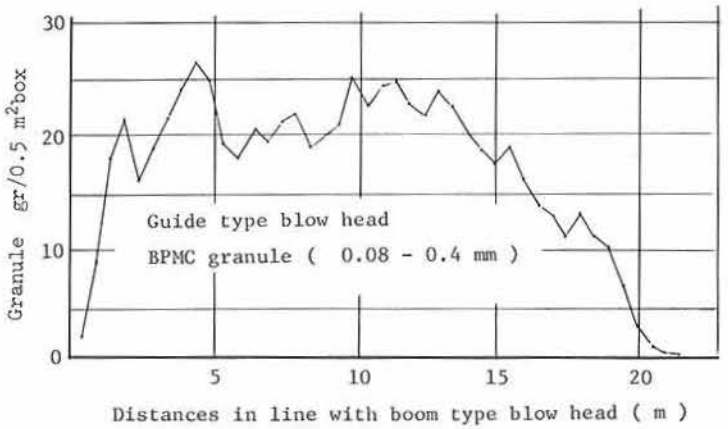

Fig. 3-2. Distribution of fine granule

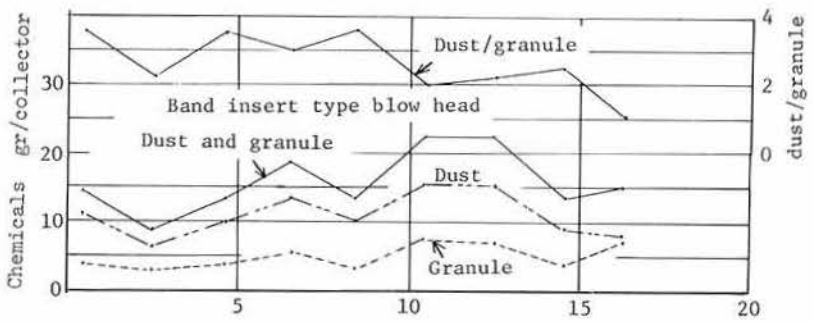

Fig. 3-3. Distribution of mixture dust and granule (2:1)

each box is counted out by the balance, and the evenness of the distribution is calculated by the following formula (3):

$$C.V.=\frac{\sqrt{(x-\bar{x})^2/(n-1)}}{\bar{x}}(\%) \quad \text{.....(3)}$$

then,

x: weight of granule in a box,

$\bar{x}$: average of x,

n=the number of boxes (in this test, n=40 for 66 ft swath width, n=60 for 99 ft swath).

This C.V. value is authorized as standard and it should be less than 60 per cent: if the value obtained by using a blow head with confirmed granule or the value by using granule with a confirmed blow head is over 60 per cent, the head or the granule is not regarded suitable for real use.

As the results of the test, the combination of the fine granule and the throttle molding type blow head used was not sufficient for even distribution. Its maximum value per 0.5 sq m was four times more than the mean value gained by the use of 2, 4 PA. ATA, and its minimum value was 0.08 times as much as the mean value by Kitazin P. But the other heads and granule, selected from 40 data, were both practicable as indicated in Fig. 3.

The dust and granule mixture was not suitable for the throttle molding type. However, the other head can apply it evenly as indicated in Fig. 3 and shows the merits that will be utilized for the insecticides (to granule) and fungicides (to dust) in the same work.

Conclusion

The study on the connection between the boom type blow heads used by the knapsack power type and fine granular formulation would serve the development of pest control technique for rice farming, but the formulation and boom heads are not always constant with the tendency of their improvements.

It seems that mutual studies are most important and necessary to diffuse this technique. The granular application will develop to a low volume such as 18 or 14 lbs/acre, and the swath width of the head will expand to 165 or 330 ft for a large size field to maintain even distribution. According to the diffusion of this blow head, labor saving and high efficiency will be recognized by all farmers who work in the paddy field.

Reference

1) Ariyoshi, M.: Knapsack Type Power Applicators in Japan, *JARQ*, **5**(2), 1970.