Development of Application Equipments for Soybean Pest Control in Japan

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Soybean plants growing in the warm region of Japan are apt to suffer from diseases and insect pests. Particularly, soybean is a crop liable to show serious damages by insect pests. Yield-decrease and quality-deterioration occur without a sufficient pest control. To get stable yield-increase with good quality, it is regarded as essential to make a sufficient application of agricultural chemicals to pods during the middle to late growing season. However, at this season soybean plants are at the stage after flowering, with thickly crowded leaves and stems, so that it is quite difficult to exert a full control-effect to leaves and pods located deeply inside the plant mass, when application equipments and application techniques prevailing in paddy fields are directly used.

For example, in case of liquid application, sprays made above the plant canopy by means of line nozzle or boom nozzle, or swath applications made from farm-roads or field bunds by using wide swath nozzle resulted in poor deposits of chemicals on pods. Similarly in case of dusting, the applications made above the plant canopy by means of single-hole blow head, multiple-hole blow head, or boom type blow head showed only an insufficient control effect, like the case of liquid sprays. Furthermore, a method of application, in which nozzles and blow heads are kept inside of soybean inter-rows was not practical because it required longer working time and higher labor intensity.

Therefore a study to develop application equipments adaptable to soybean fields with a high effectiveness and high efficiency was carried out. As a result, power applicators with blow-up blow heads were developed. The new applicators are of a new type, which blows up chemicals from the bottom by using a blower, contrary to the old type, which applies chemicals from the top of the plant canopy.

In this paper, structure and principle of application of the newly developed equipments will be presented, together with characteristics of application to soybean fields.

Structure of power applicator with blow-up blow head

Three models of different types, knapsack, walking, and riding type, were developed for different farm sizes. The knapsack type is adaptable to relatively small fields, the riding type to group pest controls in big fields, and the walking type to fields of intermediate size. Any model is equipped with blow-up blow head, but other types of nozzles or blow heads can also be used.

1) Knapsack type power applicator[2)]

A blow-up blow head is attached to it, and by adopting dusting-mechanism for a dust, or by using mist-mechanism for a liquid, it can be used for both chemicals. The application is made by blowing up a chemical obliquely to right and left sides from a portion close to the plant base in the inter-row space of soybean fields. The structure is composed of a blow head, a guide plate, a discharge port, a nozzle pipe for liquid, a divider rod, etc. (Fig. 1). The operator walks in inter-row space, holding the blow head close to the soil surface. To facilitate the operator to walk in inter-row space of thickly grown soybean fields, a blow pipe connecting a blower and a blow head serves to divide the leaves and stems of plants. To support against the resisting power applied to the blow pipe in dividing leaves and stems and the repulsion of high speed air stream generated by blowing, a wheel is attached under the blow head. This wheel acts to keep a relative position of blow head to pods at constant.

As the operation is an application to the inside of plant mass, the exposure of the upper half of the operator's body to a chemical is of a less extent. When the blow head is drawn behind the operator as shown in Plate 1, he can work quite safely without an exposure to chemicals.

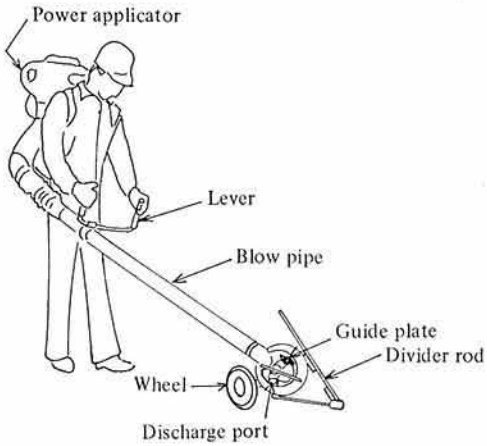


Fig. 1 Blow-up blow head (Bu-3)

Plate 1. Backward application for blow-up blow head

2) Riding type power applicator[3]

This is a 4-wheel and high clearance type, as shown in Fig. 2. It runs in inter-row space, covering two rows of soybean plants between the right and left wheels, to apply dust or liquid chemicals. It has two blow-up blow heads for dust or liquid application and a boom nozzle at the rear of its body for liquid application. In addition, boom type blow head can be equipped in place of the blow-up blow heads for dust application. A reciprocating pump is used for pumping liquid chemicals. To operate the pump and the running gear, a 4-cycle gasoline engine (7 p.s.) is mounted. In addition, a 2-cycle gasoline engine (8 p.s.) is used to operate a centrifugal blower. The operator can handle these apparatus at the front part of the body. As the blow heads are placed at the rear of the body, the exposure of the operator to chemical is less.

Five different methods of application can be made by combining different kinds of chemicals, nozzles, and blow heads to be used. For soybean plants before flowering with less luzuriant growth of leaves and stems, dusts or liquids can be applied by using boom nozzles or boom type blow head, while for the plants at the middle to late growth stage after flowering with thickly grown leaves and stems, dusts or liquids can be applied by the blow-up blow heads. Furthermore, in case of aiming at more effective application to leaves, stems, and pods, a simultaneous spray of liquid by boom nozzles and blow-up blow heads can be done.

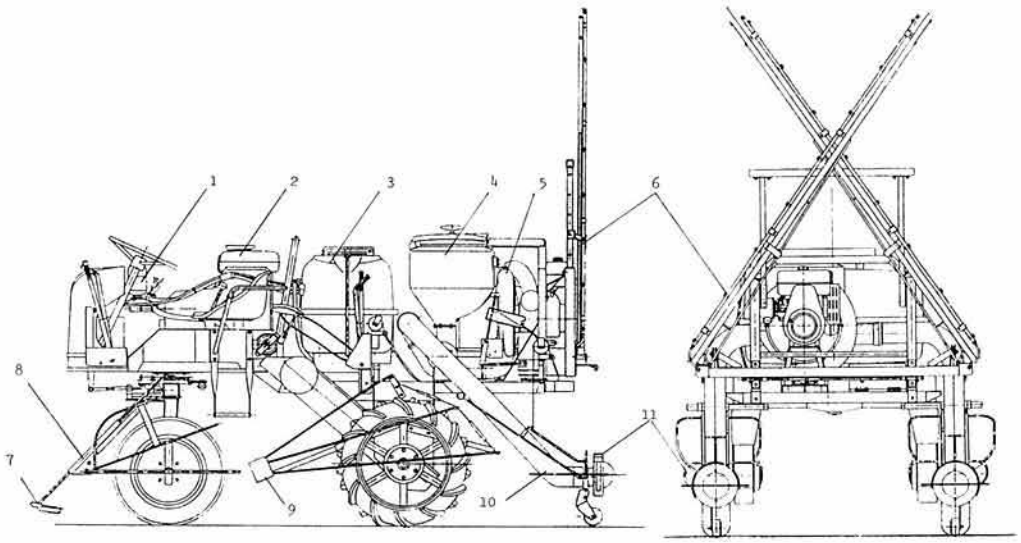
3) Walking type power applicator[4]

As shown in Fig. 3, it is composed of a self-propelled carrier which runs on inter-row space of soybean fields, a boom, and a side wheel attached to it across the distance covering one row of the crop. The operator walks behind the carrier and dusting or spraying is made by a blow-up blow head obliquely behind the operator.

The structure is composed of a blow-up blow head, a pump, a tank for chemicals, a centrifugal blower, a two-cycle gasoline engine (3 p.s.), a self-propelled carrier, etc.. In addition, a boom and side wheels are attached at one side of the carrier in order to reduce rolling of the carrier and to give a straight drive of the carrier.

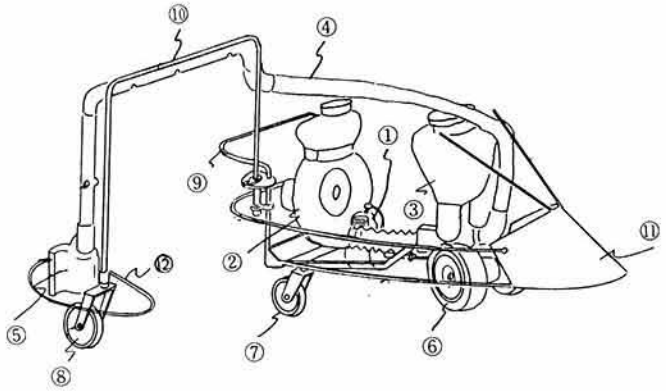
Performance of application

Distribution of dust deposits shown by the use of a blow-up blow head of the knapsack type power applicator was compared with that shown by the customary over-canopy dusting of a multiple-hole blow head at the field condition of about 1 m height of soybean plants. Figs. 4 and 5 indicate the dust deposit distributions, as expressed by mean values of dust-coverage ratios at the top, medium, and lower portion of plants



1 Liquid pump
2 Engine
3 Liquid tank
4 Dust hopper
5 Centrifugal blower
6 Boom nozzle
7 Raise-up rod
8 Divider for front wheel
9 Divider for rear wheel
10 Blow pipe
11 Blow-up blow head

Fig. 2. The riding type applicator (BU-T2)



1 Engine
2 Centrifugal blower
3 Chemical tank
4 Blow pipe
5 Blow-up blow head
6 Drive wheel
7 Rear wheel
8 Side wheel
9 Handle bar
10 Boom
11 Divider
12 Divider for blow head

Fig. 3. The walking type applicator (BU–Wl)

and front and back surface of leaves. The blowing up of dust from the bottom by the blow-up blow head caused a higher deposit efficiency, less drift of chemical, and more amount of deposit to the middle and lower portion of plants, where pods are growing, than the blowing down from the top by multiple-hole blow head. The amount of dust deposit on the back surface of leaves by the former was more than 3 times that of the latter. Thus, it is clear that the blowing up is effective in applying chemicals to back surface of leaves and pods. From the results of insect

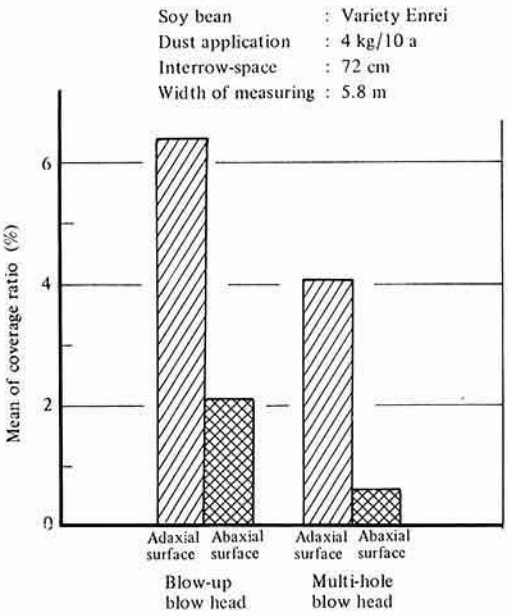


Fig. 4. Dust deposit on both surfaces of leaves

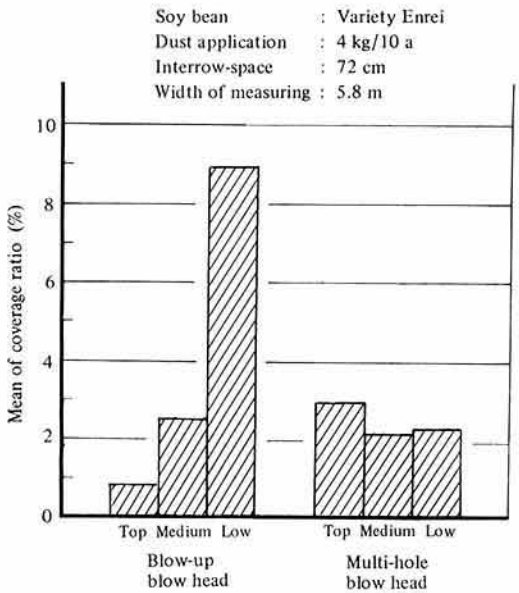


Fig. 5. Dust deposit on leaves at different height (top, medium and low)

control experiments[1] (such as for stink bug, etc.) carried out at various places, it was shown that the reaching distance of chemicals was 2–3 rows to both right and left of the blow head in dusting and 1.5–2 rows for liquid spray, i.e. 2–4 m of effective swath width.

Comparison of distribution pattern of liquid deposit on leaves and pods by the blow-up blow head of the riding type power applicator and the customary blowing-down boom nozzle was shown by mean coverage ratios in Fig. 6. In addition, the result of the simultaneous spray by the both

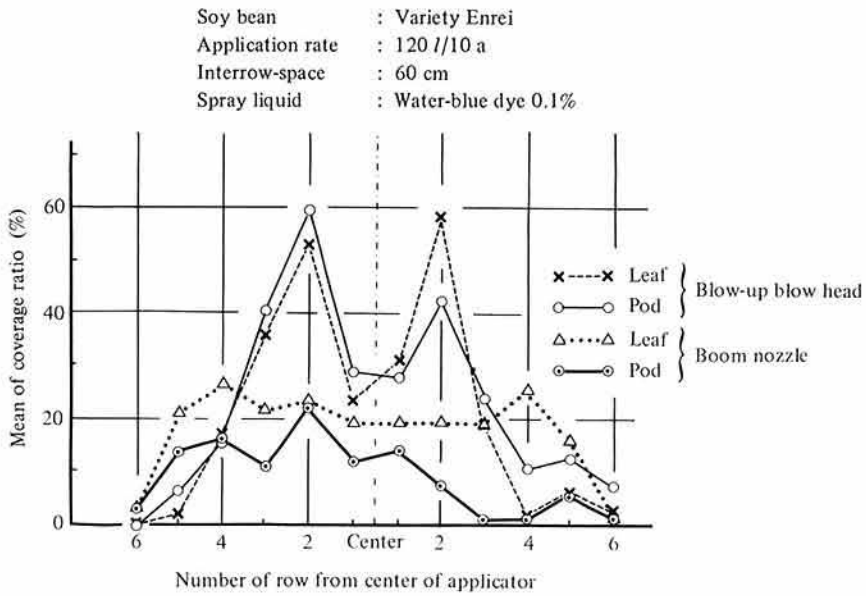


Fig. 6. Distribution pattern for the riding type applicator

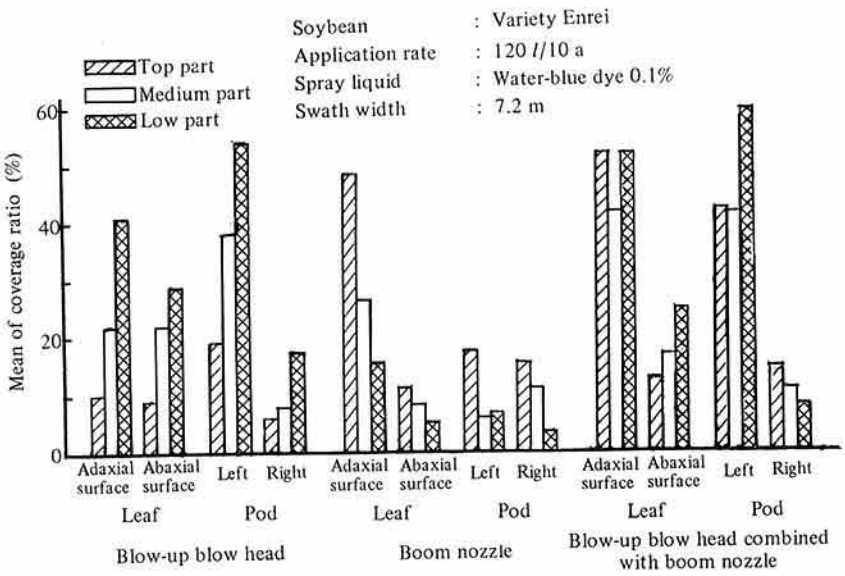


Fig. 7. Deposit on different parts of soybean plants by the riding type applicator

methods is given in Fig. 7. The mean coverage ratio on leaves was the highest with the simultaneous spray. That on pods was low with boom nozzle but was high with the blow-up blow head and the simultaneous spray. The blow-up blow head showed a better deposit on back surface of leaves than the boom nozzle. The deposit by the blow-up blow head was in the order of lower>middle>top portion of plants, whereas that by the boom nozzle was top>middle>lower portion, and the simultaneous spray showed more deposit on top and lower portions than the middle portion of the plants.

In general with the liquid spray, the blow-up blow head is more effective than the boom nozzle for the insect control of pods, while the simultaneous spray by combined blow-up blow head and boom nozzle is the most effective for leaves and pods.

Dusting by the riding type power applicator gave the same results as the case of spray, showing remarkably better deposit than the customary multiple-hole blow head. Particularly, control-effect on pods can be expected. The effective swath width of the blow-up blow head was about 6 m for liquid spray, and about 8 m for dusting.

Performance of blow-up blow head of the walking type power applicator was also similar to that of the above two types, and the effective swath width is about 3–5 m.

Rate of work and serving area per spell of application

Extent of area which can be served by an applicator depends on its rate of work. The rate of work of the knapsack type power applicator with blow-up blow head is 20–25 min/10a, taking its field efficiency as 60%. This time is shorter than that required for the application by a power sprayer combined with line nozzle. The knapsack type power applicator with blow-up blow head needs 1–2 workers i.e. less than half that for a power sprayer requiring 3–4 workers, thus enabling labor-saving operation. Extent of area to be served by the former is estimated at 2–3 ha per one applicator by taking number of working days for each spell of application as 3, a daily working time as 4 hr, and an actual working rate as 80%.

The riding type power applicator offers a highly efficient operation with the rate of work of about 60 min/ha, and its serving area is about 12 ha per each spell of application. Thus, it is adapted to the use for group (collective) pest control. The walking type power applicator has the rate of work of about 10–20 min/10a, and serving area of 2–4 ha.

Reference

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