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Trends in plant protection technology for arable farming

Below, important trends in forage harvesting are presented, which will also be reflected by the machine and implement programme shown at the Agritechnica 2007. This preview cannot replace a trade fair visit. It only provides pre-information and does not claim to be complete.

The draft of a framework directive presented by the EU Commission contains a bundle of measures aimed at the improvement of plant protection equipment technology. The manufacturers of plant protection equipment must observe numerous requirements in order to meet the needs of agricultural practice as well as the demands of environmental, user, and consumer protection.

Nozzles

On field sprayers, flat jet nozzles are used whose spray angle ranges between 110° and 120°. For very wide booms, nozzles having a spray angle of 80° and a target area distance of up to 80 cm are used in some cases in order to reliably avoid soil contact. Conventional extended range nozzles provide a fine to medium-sized range of droplets. These nozzles are still used for herbicide application in sugar beet, for example. In this case, the high drift potential must be considered. Air injector nozzles, which produce coarse to very coarse droplets, allow drift to be reduced by up to 90% as compared with conventional nozzles. Today, drift reduction is particularly relevant for practical plant protection because the regular distance from stretches of surface water and terrestrial habitats required for plant protection products can only be reduced with the aid of drift-reducing plant protection equipment (coarse-droplet injector nozzles). Additional air assistance also enables drift to be reduced, though only in tall crops. During band spraying, drift reduction of more than 90% was proven. The sprayers currently listed as "loss-reducing equipment" for crop cultures as well as viticulture and fruit cultivation can be called up on the internet on the homepage of the BBA (*www.bba.de*).

Agricultural computers

Today, large sprayers are generally equipped with control systems which maintain a constant application rate. The operating elements, the display, the monitor, and the multi-functional lever are designed very differently so that farmers can choose from a wide variety of systems available. Often, the control equipment differs with regard to the measurement of the volume flow to the nozzles because not only flow meters, but also pressure sensors are used. Flow meters measure the volume flow directly and require a certain amount of care due to their design (moving parts). Pressure sensors show the nozzle output indirectly using the nozzle parameters. For the application of liquid fertilizer, however, the calibration factor must be changed.

It is important for the user to check the most important parameters, such as the application rate and the speed during operation. In addition, the programming of the sprayer must be as easy as possible. If possible, the control equipment and the remote control system of the sprayer should form a compact unit. Even in twilight or in the dark, it should not be difficult for the driver to operate the sprayer. Here, lighted switches and displays provide more safety. For the case of a failure of the electronic system, the sprayer should be equipped for emergency operation so that application can be completed. This emergency function should include at least manual pressure adjustment and allow the sprayer to be turned on and off.

Some manufacturers offer automatic, DGPS-aided switching of boom sections. The sprayer stores the treated area internally so that the boom sections are switched off and back on when the sprayer avoids obstacles on the field or treats wedges, which avoids double treatment or gaps. Newer control systems also provide the possibility to vary droplet sizes based on weather data in combination with twin-fluid nozzles or the switching of several nozzles. This allows a certain drift behaviour to be realized.

The current trend is favouring ISOBUS-capable electronic equipment. In the future, the new agricultural BUS system (LBS) will provide a uniform, implement-independent interface between the tractor and the implement. Implements equipped with the BUS system are already on the market. Their future-oriented advantage is the use of the common interface by several implements (sprayer, fertilizer spreader, slurry tanker, sowing machine). Meanwhile, the development is continuing in the direction of GPS-aided application including the documentation of field-related data and plant protection measures. Transportable storage media, such as USB sticks, facilitate data transmission between the farm PC and the tractor.

Spraying boom

In mounted sprayers, the booms are generally folded as a package (horizontally or vertically) because lateral folding can lead to problems with the cab in some cases. In trailed sprayers, boom widths continue to increase. Meanwhile, hydraulic folding is standard. Often, one can choose between conventional and package folding. While the latter is very compact, the advantages of the conventional design lie in simple construction and higher folding speed. If the booms of mounted sprayers are folded laterally, one should make sure that distance from the tractor cab remains sufficient even during curve rides. Field sprayers must be equipped with a pendulum system for the

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compensation of boom movements (obligatory for working widths of more than 10 m). These suspensions are designed either as a central or a trapezoid pendulum. Both designs are equally suitable for boom guidance parallel to the ground. Central pendulum suspension systems, which feature a pendulum divided by an articulation, allow automatic slope adaptation to be realized easily. For this purpose, only the lower part of the pendulum is fixed. Thus, the boom now follows the sprayer frame instead of gravity. Nevertheless, it can still make pendulum movements. Especially if the inclination of the slope varies, this automatic slope compensation provides advantages as compared with hydraulic or electric systems, which must be operated by hand. If the sprayer is equipped with an electric system, one must make sure that the servomotor can be positioned reproducibly.

Horizontal boom movements have great influence on distribution quality. Here, the oscillation frequency of the boom movements plays a particular role. Therefore, the manufacturers designed the boom suspensions as horizontal pendulum suspensions and equipped them with appropriate suspension and damper elements.

Filling, emptying, and cleaning of plant protection equipment

For easier sprayer operation and in order to avoid operating errors, the operating elements for filling, emptying, and cleaning are concentrated in one place, preferably on the left side of the sprayer, in a so-called operating centre. The filling of the sprayer can also be monitored by a computer so that the water flow shuts off automatically after the set water quantity has been reached.

If the sprayers are easy to empty after spraying and if the technical residual quantity is kept to a minimum, the problems of residual quantity disposal and sprayer cleaning can be solved more easily. Components which enable sprayers to be cleaned properly on the field belong to the legally required minimum equipment of field sprayers. Thus, an additional water tank is required which must contain at least 10% of the rated volume of the spray liquid container or the 10-fold quantity of the dilutable part of the technical residual quantity. This must enable the pipes to be rinsed while the spray liquid container is full and allow for the interior and exterior cleaning of the sprayer. In addition, the sprayer must be equipped with an interior cleaning system for the container and a connection for exterior cleaning.

In some sprayers, interior cleaning is controlled automatically by the on-board computer, which guarantees efficient, water saving cleaning of the sprayer. The interior cleaning equipment consists of one or several special nozzles which are generally installed on the upper side of the container. Slowly rotating nozzles which produce a hard water jet achieved the best results in comparative tests.

For *mounted sprayers*, generally 21 m booms are sold today. On smaller farms (primarily in southern Germany), however, sprayers with a working width of 15 m still have large market shares. Mounted sprayers reach working widths of up to 28 m and a container size of up to 1800 litres. Even though the containers feature a compact design, the commonly used tractors often need additional front ballasting in order to conform to the road traffic regulations when the container is full. Generally, mounted implements are equipped with block fittings (boom section, main switch, and control valve in one fitting block). For valve actuation, both magnets and electric motors have proven themselves. With regard to reaction times, motor valves are virtually no longer inferior to magnet valves. The disadvantages of the latter are high electricity consumption and the strong heating of the magnets. Motor control valves only consume electricity during direct operation. In block fittings, the spray pressure is generally indicated by a manometer in the fitting block. A pressure sensor and a display in the cab, however, are a better solution. The dissolved fitting design, which has been common in trailed sprayers for quite some time, is also establishing itself in mounted sprayers. The remote-controlled boom section valves are arranged behind the container on the boom carrier and are thus very close to the nozzles. This provides the advantage of a very small pressure drop between the valves and the nozzles and, hence, significantly better lateral distribution. In addition, the residual quantity is reduced significantly.

In *trailed sprayers*, 27 m booms are predominant. However, these sprayers can also have working widths of up to 51 m and container sizes of up to 12000 l. In large sprayers, often several pumps are used. In this case, one pump each supplies the spray nozzles and the agitator. Modern trailed sprayers often have bulgy, strongly rounded containers, which have small flat bottom areas and a low centre of gravity. This guarantees a small technical residual quantity and makes it easy to empty the sprayer even on sloped fields.

The operating, measuring, and monitoring elements relevant for the spraying process can be operated from the driver´s seat and are easy to read. In general, nozzles are switched based on fixed boom sections. Switching by means of compressed air or electric motors allows for greater variability including even the switching of individual nozzles. If the spray liquid pipes are designed as a circulation system, constant liquid circulation in the boom and even concentration in the entire liquid circuit are provided. This design also guarantees that the full concentration of the plant protection product is available at all nozzles immediately when spraying begins, which is important when the product is changed.

More and more often, trailed sprayers are moved at high driving speeds in road traffic. The manufacturers offer sprayers designed for speeds of up to 50 km/h and equipped with suspended axles. Double pivot steering or an articulated drawbar enable the sprayer to follow the vehicle tracks precisely.

Self-propelled sprayers are meanwhile offered by virtually all renowned manufacturers. Large sprayers in this category have container sizes of up to 9000 l, working widths of up to 42 m, as well as 3 axles and can be optimally adapted to the conditions of use. Maximum area capacity, easy operation, good manoeuvrability, and the greatest possible evenness of weight distribution on the wheels are of particular interest for contractors and large farms. The purchasing price of these self-propelled sprayers is approximately twice as high as the price of comparable trailed sprayers.

The Dammann DT 2000H Highlander can control the Western corn rootworm in high maize crops, too