2.
The Application of Seed Treatments

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ENGINEERING RESPONSES TO CHANGING REQUIREMENTS IN THE UNITED KINGDOM

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ABSTRACT

In the past two decades, the practice of seed treatment has undergone many changes. Seed treatment plants have become fewer and bigger. Machines are much more sophiscated, providing more accurate dosage, better distribution and a faster work rate. As a result, the dusty but easy to distribute powder formulations of the 1960s have given way to the cleaner liquid and flowable formulations of today. These are usually applied without dilution. A major development was the 'Rotostat', which treats seed in batches. Each batch then becomes a sales pack, avoiding the need to handle treated seed. The process of improvement is expected to continue and be augmented by better methods of assessment of overall loading and distribution.

INTRODUCTION

The last 20 years has been a period of rapid change in the practice of crop protection. Nowhere is this better exemplified than in the field of seed treatment and especially cereal seed treatment in the United Kingdom.

In the late 1960s the practice of seed treatment was already more than 30 years old, and the original barn floor and shovel technology had been replaced by machines. Since then, further developments have been made. This paper will examine the main forces driving these changes and the responses required of the engineer.

SEED TREATMENT IN 1967

Both powder and liquid seed treatments were in use, with powder predominating because of its easier distribution on the seed. However, the loss of powder during seed handling, which caused low ultimate load and contamination of the atmosphere was a recognised problem. Overall powder loadings 10% of theoretical were found (Lord et al, 1971). Liquids had the opposite problem, with difficulty in distribution. Coefficients of variation over 300% were found. (Calculation from Jeffs et al, 1968). Retention of active ingredients in liquids was good, although the overall load was often low because of metering inadequacies. The solvents used as a base gave hygiene problems for seed treatment plant workers.

There were more than 400 seed treatment plants - many of them situated in towns. Their dust extraction systems discharged directly to the atmosphere without adequate dust collection. They employed over 600 seed treatment machines typically of 4 t/h capacity, about half of which were sold by the agrochemical companies. (Internal ICI document). Bagging and weighing - in hessian bags - was manual, and the only mechanical aid was a sack barrow.

Active ingredients in general use included organic mercury in its volatile alkyl form, lindane, aldrin and chlorfenvinphos.

SEED TREATMENT IN 1987

The current scene is different in very many respects. The reasons for the changes are firstly the attitude of society to human welfare and the quality of the environment, embodied in the Health and Safety at Work Act of 1974. Secondly, the accession of the UK to the EEC which resulted in a greatly changed set of rules and regulations for the seed trade. Thirdly, increasing competition both between agrochemical companies and between seed companies.

Seed Treatment Plants

There are now only about 130 units operating, several of them producing in excess of 10,000 tons of cereal seed per year. They use automatic bag placing and palletising machines, with a greatly reduced work force enjoying a much safer working environment, and they have long since discarded the sack barrow in favour of the fork lift truck. They often work in shifts - sometimes 24 hours per day - and are generally situated away from populated areas. They demand seed treaters of high capacity - typically 15-20 tons per hour.

Active Ingredients

Organo-mercurial fungicides are still used, but are now mostly of the aryl type. These non-volatile compounds require a much higher standard of distribution on the seed. Other fungicides have appeared, notably for control of loose smut (Ustilago spp) and barley mildew (Erysiphe graminis). Some of these require more accurate loading on the bulk and also on individual seeds to ensure efficacy, whilst maintaining safety to the crop. The highly persistent organo-chlorine insecticides have now been banned. Some new insecticides have appeared but there are, as yet, no pyrethroid seed treatments.

Formulations

Powders are comparatively little used today. Although seed treatment plant contamination can be controlled, the lack of adhesion remains a problem. Stickers, including water, have not been adopted.

Liquids are now widely used. They are generally water based, although some insecticides are solvent based.

Flowable formulations, (or suspension concentrates) known in the late 1960s, are now frequently employed where an active ingredient is insoluble in water. They are applied neat or diluted. They generally have high, and temperature dependent, viscosity which can cause metering problems. Flowables are inclined to form hard deposits inside machines, particularly if the seed is dusty.

Slurries, ie, wettable powders mixed in the seed plant with water, are not used for UK cereals.

Machinery

Of the machines available in 1967, only one is still available today. The independent machinery manufacturers have all but disappeared in favour of machines supplied and serviced by the agrochemical companies as part of their overall service to the seed trade. Machines are frequently adapted to cater for new products. Output today is typically 10-20 t/h with twinning of machines often practised to increase production.

SPECIFICATION FOR CHANGE

The following requirements for change had been clearly identified by the early 1970s.

* Improve the distribution of liquid insecticides to avoid phytotoxicity or lack of protection (Jeffs et al. 1968).
* Improve the distribution of liquid mercury because of change to non volatile aryl types.
* Improve adhesion of powders to avoid loss in handling and improve safety in the seed plant.
* Apply larger volumes of flowable formulations.
* Increase the rate of work.
* Improve the ease of cleaning - particularly when using flowables.

There were also problems associated with the flow of seed in hoppers and weighers when freshly treated with flowable formulations.

THE ENGINEERS' RESPONSE

Principles

The main elements of a seed treater which the engineer can influence to meet the specified improvements in performance are as follows:

a) Seed Metering

It is necessary to meter the seed to provide the right seed/chemical ratio, and greater accuracy should therefore be sought. Weight metering is consistent with current practice in specifying application rates and also with trading and agronomic practices. Volume metering can avoid recalibration, eg, if denser seed types require proportionally less chemical.

b) Chemical Metering

This is required for the same purpose as seed metering. It has also been too imprecise in the past, particularly with flowables. Powder should, ideally, be metered by weight and liquids by volume to follow the recommended application rates.

c) Application Chamber

This is sometimes designed to achieve uniform coverage immediately the seed and chemical come into contact. Alternatively, the initial contact may be random, with reliance placed on redistribution in a mixing process. Rotary atomiser machines use the former system and revolving drum types the latter. Both had limited success with liquids (Jeffs et al. 1968), but were very poor with flowables. Auger machines are usually a combination of both systems with a degree of initial distribution, followed by mixing. They were the only machines used for powders in 1967.

d) Control System

In the past, complex systems were not required, although volume seed metering drums needed some means of sensing the presence or absence of seed in the input hopper, so as to turn the drum and also run the chemical dispensers only when seed was present. Weight seed metering systems usually drove the chemical applicators directly, and would only work when seed was flowing.

e) Receiving Hopper and Weigher

Although not strictly part of the machine, hoppers are important. For example, too steep a converging section encourages separation of powder. Seed freshly treated with flowable needs a larger dribble orifice in the weigher.

TYPES OF MACHINE

Several types of machine have enjoyed a long history of use but, in response to the changing needs of the industry a completely new principle was developed in the early 1970s. The main types are briefly described below:

1 Drum Mixers

Of all the machines available in 1967 only the drum mixer is now sold and that, in small numbers. Most remaining units are on mobile seed processing plants, where their lightness and simplicity are useful. However, not all products are authorised for use in drum mixers.

2 Rotary Atomiser Machines

Early examples used very simple weight metering systems, with the seed weigh pan directly driving liquid metering 'spoons'. Later, volume seed metering drums were used, with liquid 'cups' arranged on a coaxial wheel. 'Spoons' and 'cups' tended to develop deposits when used with flowables, and had poor speed response characteristics, so metering pumps were adopted, with greater success. Orifice metering for seed was tried but was too variable, and was replaced by gravimetric flow control.

Virtually all rotary atomiser machines have been adapted by the addition of mixing augers, which considerably improves their distribution capabilities with flowables.

3 Auger Mixers

None of the early machines are now available, principally because they were not backed by an agrochemical company to keep them up to date. A number of 'Plantector' machines have survived in use, but have undergone the following changes :

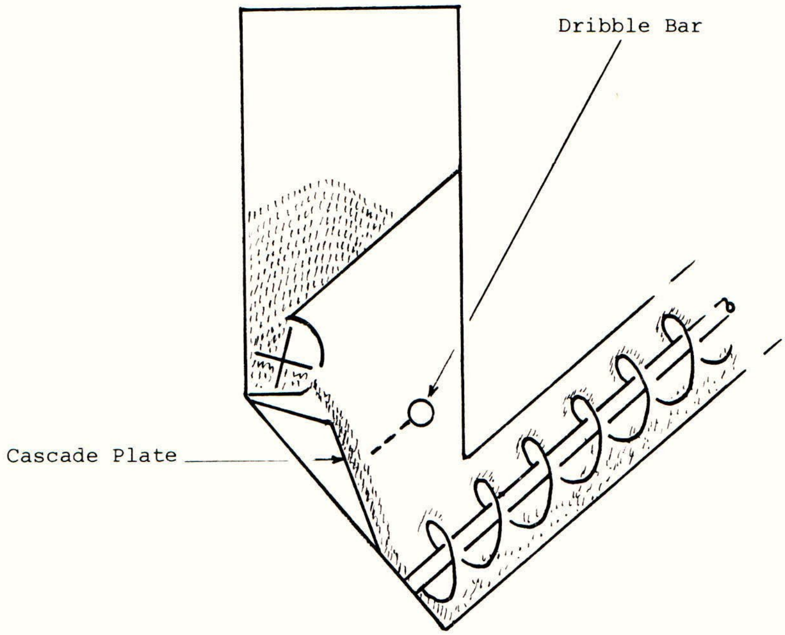
a) Metering pumps were fitted - particularly for high volume flowables. These have either a mechanical clutch or are separately driven so that they can be disengaged when not required.

b) Access to the auger barrel was improved to allow more complete cleaning.

c) For flowables a dribble bar was arranged across the spray chamber. The seed flowed in contact with a cascade plate so that any liquid passing through the seed curtain was immediately removed by seed. This gave sufficient initial distribution for 'Milstem' - a flowable introduced in 1971 which did not require a high standard of distribution (Fig. 1.).

d) For conventional liquids, a spray nozzle, or sometimes a rotary atomiser with a conical version of the cascade plate, was fitted in the spray chamber.

Fig.1. 'Plantector'



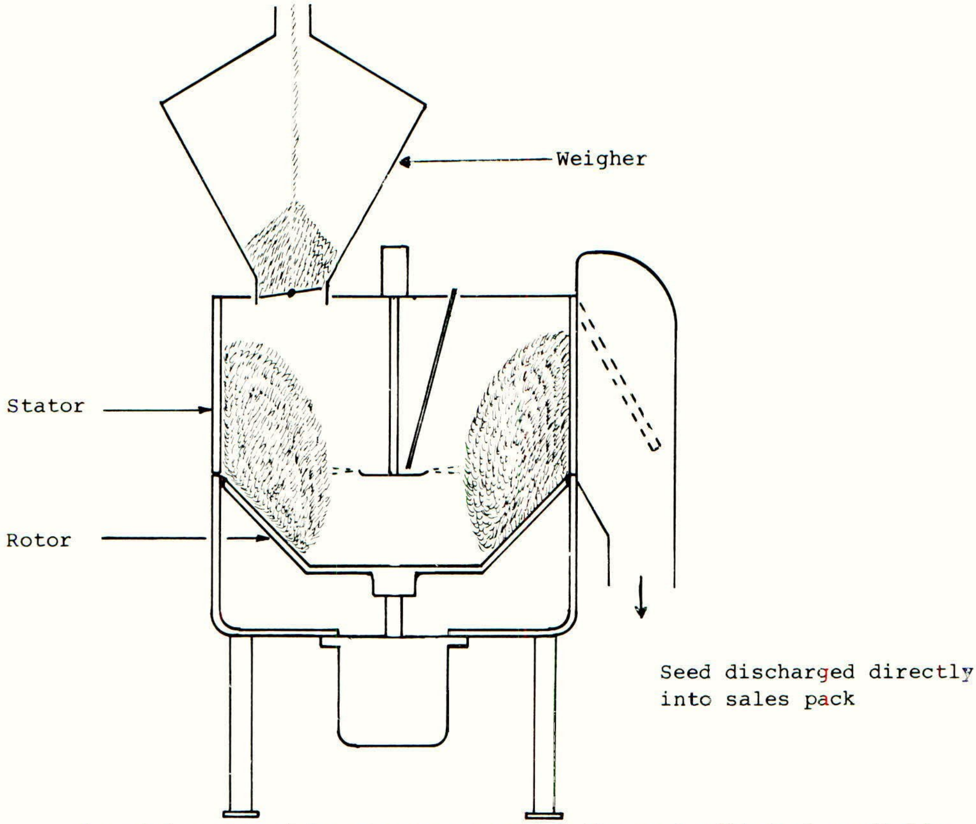
4 'Rotostat'

In the early 1970s, the development team at ICI was motivated to develop equipment to overcome as many of the limitations of existing machines as possible. Despite all the modifications to the 'Plantector' it became clear that this principle could not be developed to the necessary extent and a completely new start was the only possible approach. The development programme resulted in the 'Rotostat' machine (Fig. 2) which was announced in 1973 (Elsworth and Harris, 1973) and the first machine was installed that same Autumn.

The 'Rotostat' adopted a novel mixing principle and a batch mode of operation which was contrary to all large scale seed treaters in operation at that time. A continuous process is difficult to control accurately due to changes in the instantaneous flow rate of seed and chemical.

The 'Rotostat' completely overcomes the problems with hoppers and weighers by inverting the accepted sequence. The accurate weighment of seed is made before treatment, normally 50 kg with allowance for the addition of chemical. After treatment, the batch is discharged directly into a bag to form a single sales pack.

Fig. 2 'Rotostat'



The mixing principle adopted is one of the most efficient available and imparts a firm rubbing action which is very beneficial to uniform coating. The mixer is constructed of a static cylinder - the 'stator', with a rotating dished base - the 'rotor'. Seed is dumped from the weigher onto the spinning rotor and forms a hollow ring or torus. Individual grains move round the torus and also round a cross section of the torus, in a multitude of shear planes. Liquid chemicals are sprayed from a rotary atomiser, suspended in the centre of the chamber over a period of several seconds. A short period of mixing is then allowed before a door in the stator is opened and the seed is rapidly ejected into a bag. The whole operation is interlocked and automatically controlled and the cycle time is 15 seconds which gives an output of 12 t/h.

Some advantages of the batch system are that the seed and chemical treatment can be accurately measured before coming together in the mixing chamber. With appropriate design of control system, multiple chemicals in liquid or powder form can be applied simultaneously and selection is by simply flicking a switch. Valuable seed is not wasted when changing varieties or treatment because there is no treated seed held between the treating process and the weigher. The mixer is virtually self cleaning and can be easily checked by the operator. Two potential disadvantages identified in the early days were capital cost and complexity. However, because the 'Rotostat' is a free standing machine requiring no discharge hopper or platform and has its own built in weigher, the cost for new plants is actually lower than for continuous machines which need all the extras. The complexity lies mainly in the sequence control system which is necessary for the batch process. However, over the life of the machine, successive advances in control technology have been incorporated, and reliability is now high.

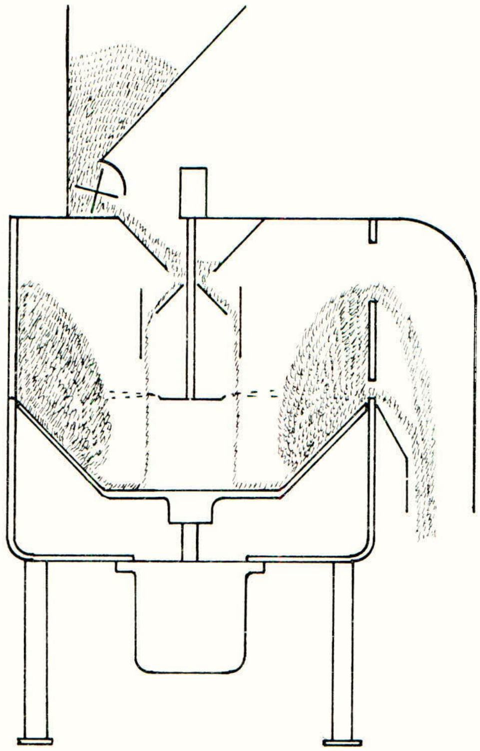
In the early 1970s 12 t/h was an acceptable production rate but in 1987 this is less often so and many recent installations have been of twin machines with automatic bag placers. Individual components of the system have been developed over the past 15 years and these include a purpose designed weigher, special simple pneumatic dosing pumps, full electronic controls with facility for up to 6 liquids and 2 powders and the ability to fill 'big bags' as well as those of standard 50 kg. The machine has always had facilities for maintaining a negative pressure in the mixing chamber, but today this is usually tapped into the seed plant extraction system.

The latest development is in response to the increasing use of bag placing machines. This is a modular concept in which the mixing unit is mounted on a platform. It allows improved access to both 'Rotostat' and bag placer. The control unit and liquid dispenser are positioned at floor level convenient to the operator. The 'Rotostat' is linked to the bag placer to ensure that discharge does not take place without a bag in position.

5 'Centaur'

For installations which required updating rather than complete replacement, the 'Rotostat' was not ideal due to its free-standing character and size. In 1978, a new model was developed to meet the requirement for continuous flow operation and compact design to allow it to slot into the space occupied by a 'Plantector' or similar obsolescent machine. The 'Centaur' (Fig. 3) uses the same mixing principle as the 'Rotostat' but with the volumetric continuous seed feeder from the older 'Plantector'. Hence the name. The seed, liquid and powder chemicals can be metered in synchronism or independently for calibration. Each has its own drive motor so that clutches are not necessary. The mixing chamber has been modified to provide continuous operation using a weir to control the level of seed in the chamber.

Fig 3 'Centaur'



A small continuous bleed is also provided from just above rotor height which provides complete self cleaning. As seed is metered by volume, the production rate is dependent upon bulk density. Fourteen t/h can be achieved with wheat.

When 'Ferrax' seed treatment was introduced in 1984 a more exacting standard for accuracy of dosage and distribution became necessary. This was because the triazole active ingredient, in common with other triazoles, has a progressively higher plant growth regulating effect as the rate is increased beyond the normal loading. Some machines could cope with this requirement, some were boarderline, and drum mixers were found to be inadequate. In the case of the 'Centaur', it was felt necessary to improve the standard in both respects. In the case of distribution, many potential modifications were tested and the most effective was to introduce a period of mixing after loading the seed and chemical into the chamber, thus approaching the 'Rotostat' cycle. This finding confirmed the soundness of the batch treatment principle. Modifications of existing machines have now been completed but it is doubtful if further machines will be produced because the changes remove the cost advantages the 'Centaur' had over the 'Rotostat'.

In order to improve the accuracy of overall loading, an affordable flow meter capable of working with flowable formulations was sought. None was found so a simple and effective design was specially developed. This is based on a free piston working within a cylinder with the seed treatment on both sides. The incoming flowable from the pump displaces the piston which in turn forces the product into the machine. At the end of the stroke, sensors change a set of valves to reverse the piston. The time taken for one stroke is compared to a set time which is calculated from the seed input rate. Errors may be used either to drive an alarm, alerting the operator to make adjustments manually, or to actually make the adjustment directly via a servo motor. A number of 'Centaur' machines now have this modification.

THE PRESENT POSITION AND FUTURE PROJECTIONS

The UK seed treatment machinery is dominated by the 'Rotostat' and the newly modified and improved 'Centaur'. It is anticipated that the 'Rotostat' will continue in its leading position as the process of seed treatment continues to get more exacting.

A very fruitful partnership exists between seed and chemical companies with the latter supplying machines and service to support their respective products. This is effected by a multidisciplinary team with all the necessary commercial and scientific disciplines, including the engineer. Therefore a strong incentive has evolved to keep machines up to date. There is one notable area of conflict which will have an increasing impact upon the design of machinery. Seed treatment plants require higher rates of work but these mitigate against the requirement for improved accuracy of loading and distribution. There is usually a trade-off between throughput and accuracy, and commercial pressures tend to lead to higher work rates even if quality is sacrificed. Improved methods of measuring seed loading are already coming into use and further extension of this must follow. It will then be possible to monitor the performance of each seed treater to ensure that the efficacy of the chemical product is maintained on the farm.

In general, great strides have been made towards meeting the required changes identified in the early 1970s. These have resulted from the steady improvement in the performance of seed treaters and in the view of the author, this process will continue. The seed treatment plant of the future will be more like a chemcial factory than an agricultural plant, with efficiency a high priority. Capital expenditure will continue to rise as today's processes give way to new ones and key personnel of high calibre will be needed in order to achieve the full benefits.

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RECENT ADVANCES IN SEED TREATMENT TECHNOLOGY IN HUNGARY

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ABSTRACT

The soils and climate of Hungary are favourable to the production of a wide range of agricultural and horticultural seeds. Seed production and marketing are carried out by several specialist institutions. The seed treatment technology employed varies with the tradition, level of mechanisation and financial strength of the organisation, but there is a trend towards the adoption of the most up-to-date technology. Since 1962 Hungary has specialised within the CMEA for the development and production of seed treatment machines and these are manufactured in large variety and numbers by the Debrecen factory to meet the needs of the Hungarian and neighbouring agriculture.

INTRODUCTION

Hungary's soil and climatic conditions are suitable for the production of a large variety of agricultural and horticultural seeds. There is a lengthy tradition in the organised production and processing of seeds which are well-known and appreciated in many countries through the extensive export trade.

Seed production plays a significant role in Hungarian agriculture and is regulated by a strict system of legal provisions. The management of the process varies according to the type of seed, broadly as follows:

1 Maize

Throughout Hungary hybrid varieties are grown which, of course, require new seed each year. There are thirteen large scale state farms which produce hybrid seeds. The whole production is centralised and supplies 130,000 t annually of which 35,000 t are used domestically and the rest exported.

2 Sugar Beet

Treated or pelleted seed is produced by the sugar factory of SELYP for 100,000 ha of crop and treatment is compulsory.

3 Cereals

This is by far the largest category of seed and half a million tonnes are produced annually. The seed production company contracts with growers and processes their production in its eight seed processing plants. At present seed treatment is not compulsory but 60-70% of seed sold in Hungary is treated. Consideration is being given to make treatment compulsory to reduce the losses due to fungi which each year reduce yields by 0.5 to 1.5 t/ha. Some seed production houses, for example, the combinat at Bóly, sell exclusively treated seeds. However, farms themselves produce half the cereal seed used so no official data is available on the proportion which is treated.

4 Sunflower

Only hybrid seeds are sown and treatment is compulsory. The majority of seed for the 400,000 ha sown is produced by the state farms at Bácsalmás, Bóly and Baja.

4 Alfalfa and Clover

The turnover of seed is relatively small, as these perennial crops require renewal only every 4-5 years. 80,000 ha is grown. Seed production is partly central, partly on the farm and treatment is not obligatory.

5 Vegetables

These present a varied picture, some being treated, some not. Seed sold in small packets is not treated to avoid health problems and a significant quantity is exported - also without treatment.

LEGAL FRAMEWORK

The legal framework is provided by the Sowing Seeds Act. This regulates who is allowed to produce seed and is supervised by the Institution for the Production and Qualification of Plants and also the local county Agricultural and Food department. A company must apply for a permit which will only be granted if it has the necessary technical, professional and personal qualifications. Product is continuously monitored and the seed is officially sealed. Where it is obligatory the seed treatment is closely specified and monitored.

SEED TREATMENT TECHNOLOGY

Almost every farm in Hungary used to have its own seed treatment machine and the remnants of this system still exist. The current trend, however, is for seed supply to be centralised. This results in more demanding specifications for the treatment machines which must now be heavy duty with accurate metering, excellent distribution and hygenic operation. They have become organic parts of the processing lines, coming after the cleaning, sorting and classification but before packing. The machines in use include those by Gustavson, Heid, Röber, Gompper as well as those produced in Hungary by the Debrecen factory.

Liquid seed treatment is universally used in Hungary because of the limited adhesion of powders and resulting loss of chemical and pollution of the environment. Frequently the liquid treatment is applied with a sticking agent of natural or synthetic origin. Generally the chemicals are a mixture of one or two fungicides which may be mixed with insecticides. They are of the 'Buvishield' family produced by the Budapest Chemical Works. No organic mercury compounds have been used in Hungary for several years. A recent and rapidly growing development is the use of encrustation in which a multi-layer coating, including fungicides, nutritive materials and adhesive is applied. This may require drying after application.

HUNGARIAN SEED TREATMENT MACHINES

The production of agricultural and food processing machinery represents 9-10% of all machinery produced in Hungary. Seed treating machinery is a particularly important part of this sector of industry and since 1962 Hungary has specialised within CMEA (Council for Mutual Economic Assistance) for the development and production of all such machinery. This means that practically all CMEA countries obtain their seed treaters from Hungary.

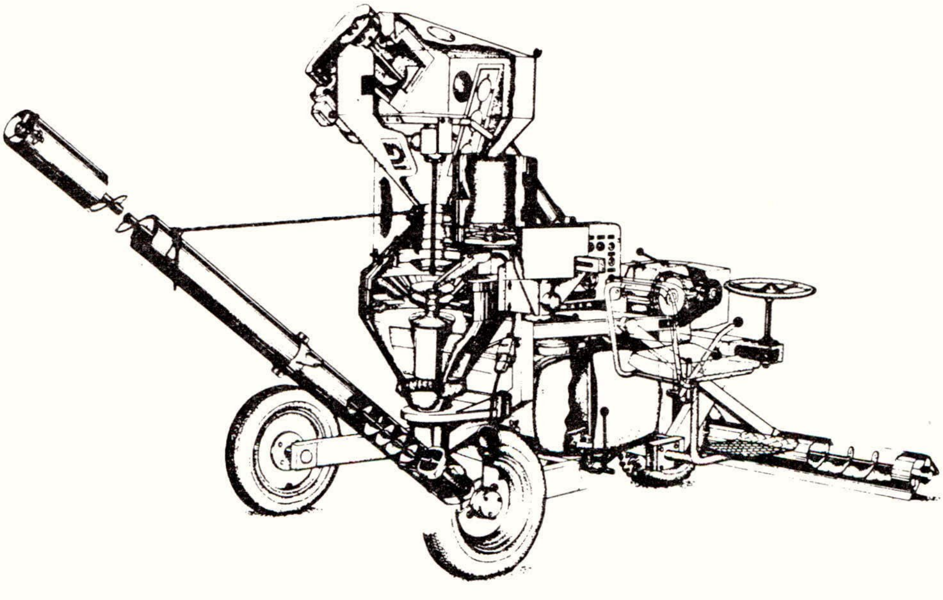
The business began at the Budapest Agricultural Machine Factory but in 1976 the Debrecen Agricultural Machine Factory took over the responsibility. Now approximately 2,000 machines per annum are produced for domestic and CMEA use.

Orders from the various customer countries are collected and checked by the relevant working commission of CMEA and are passed to the Debrecen factory for execution. The many and various requirements for different sectors of agriculture cannot be fulfilled by a single type of machine. This is further emphasised by the different technologies in use in different countries, and the range of seeds from grass to maize and peas and also the constant stream of new chemical products on the market.

CMEA experts have collaborated to produce standards for seed treatment machines which define not only the main parameters but also the methods of testing them.

Currently the Debrecen factory is producing several types of seed treater, all of which have been developed by the factory itself. The best known machine is the Mobitox Super, (Fig 1).

Fig. 1 Mobitox Super Self Feeding Seed Treater



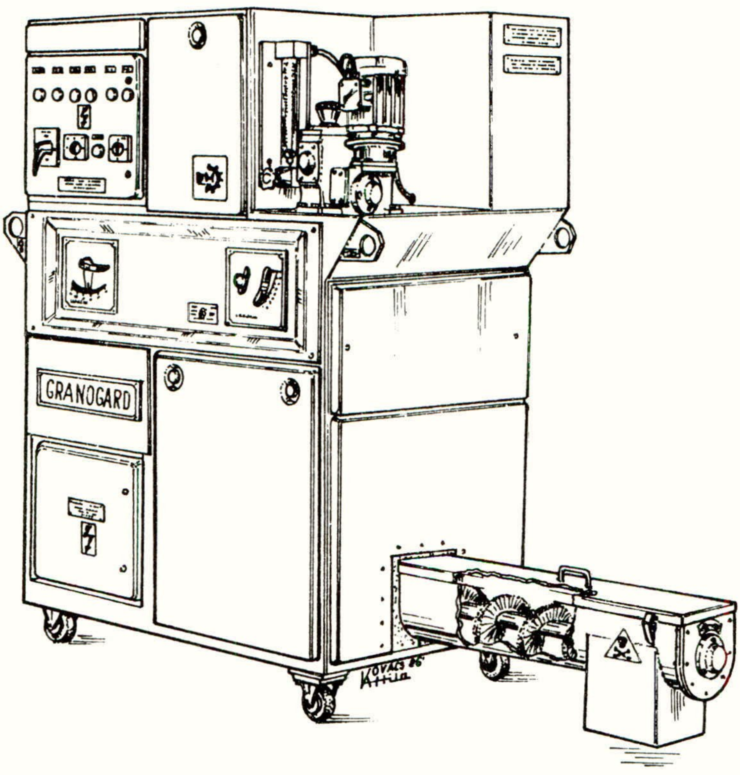
In the past 10 years the factory has produced about 20,000 units of this design. Its design is unique because it was developed for special requirements, namely, medium sized processing plants where seed is stored in large heaps on the floor of barns. The machine is a self propelled structure which has a pick-up type feed auger at the front end. In operation the machine picks up seeds from the heap, treats them and then loads them into lorries or trailers or into sacks. Its maximum output is 20 t/h.

Generally the Mobitox Super is used to treat maize or cereals using liquid or powder treatments or a combination of both. The rate of movement into the heap of seed is automatically controlled and the seed metering and chemical supply are synchronised. To ensure good operator hygiene air extraction and filtering equipment is buit in.

Many thousands of this machine are operating in the Soviet Union, several hundreds in Hungary and Bulgaria and a few dozens in Czechoslovakia and other countries.

The machine specifically designed for the largest seed processing plants is the Granogard, (Fig. 2).

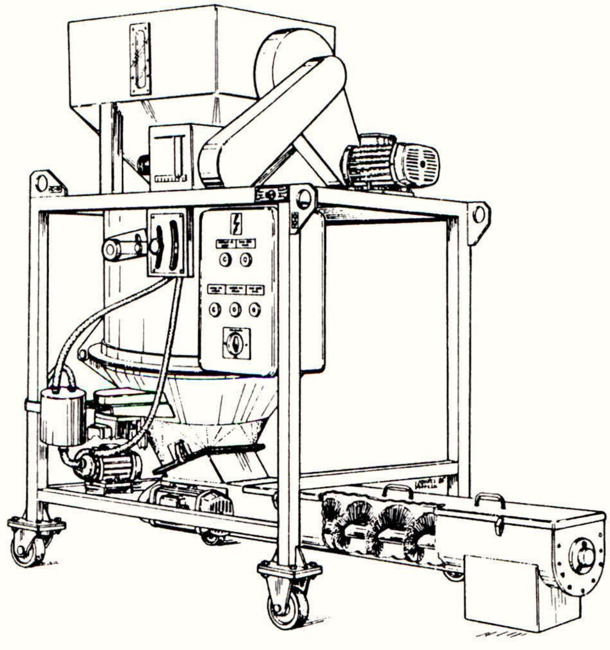
Fig. 2. Granogard Seed Treater for Larger Scale Processing Plants



Located in a machine line, its output is variable between 6 and 15 t/h. It is suitable for the treatment of cereals, maize, industrial seeds, sugar beet and others. Powder treatment, wet treatment with slurry and even film coating can be carried out in the machine. The operation of all major elements such as seed and chemical feeding and metering are synchronised and interlocked. An important feature is that the machine is totally enclosed in a steel casing beneath which a pressure below atmospheric is maintained to ensure that no dust or vapour escapes into the atmosphere.

The seed treatment machines, Gramax and Gramax-P are the result of recent development and can be used successfully as independent machines or installed in a processing line.

Fig. 3 <u>Gramax-P Modern Medium Output Seed Treater</u>



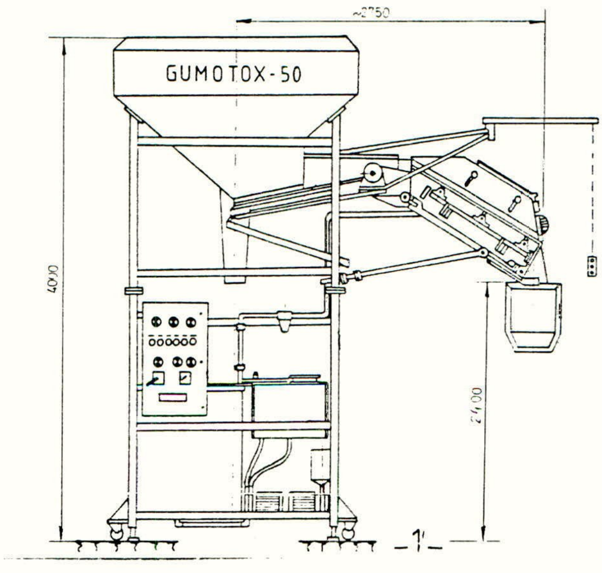
The output of the Gramax type treater is 2-6 t/h and it is excellent for the treatment of a wide range of seeds. Cereals, maize, vegetable and other small seeds are treated using wet methods, slurry treatment or film coating. The Gramax-P model will also apply powders. These machines have well designed simple structures and handle and treat the seeds gently to avoid damage.

Hungary also produces a range of potato treating machines and these are in use domestically and in other countries of CMEA. The Gumotox-S is a machine of special design. The tubers are passed through parallel rotating spongy cylinders which are in contact with one another and wetted by the treatment chemical. A machine contains two pairs of cylinders offset a little in relation to each other. The tubers receive an excellent smooth coating as they pass through the rollers. Other elements include feeding and discharge belt conveyors, complete liquid systems with tank, pump, filter and metering controls. The output is 10 t/h and is automatically controlled electrically. Many thousands of this type of treater are working in the Soviet Union, hundreds in Hungary, Czechoslovakia and Poland.

For plants producing large quantities of tubers the Gumotox-60 is the preferred machine. Its output is 60 t/h. It has a large storage hopper for receiving the potatoes from which they are conveyed onto treating belts. The treatment chemicals are sprayed through hydraulic nozzles onto tubers as they rotate on the belts. The machine has its own liquid system with preparation and discharge tanks, pump, powder metering and suspension preparation equipment. All is completely controlled with electrical automation.

The most recent development is the Gumotox 50 potato treating machine (Fig. 4). The machine is designed to treat with solutions and suspensions a the last unit of a processing line with tuber cleaning and sorting. The operation of the machine is fully synchronised with potato metering between 25 and 50 t/h, liquid chemical metering between 2 and 10 l/min. The main sub assemblies of the machine are its hopper, feeding conveyor, treatment chamber, liquid chemical system and electrical control system.

Fig. 4 Gumotox 50 Potato Tuber Treater



CONCLUSION

Seed treatment is considered in Hungary to be the most effective and economic method of plant protection. Both agricultural producers and agricultural machine manufacturers understand and appreciate its importance. Those engaged in the development and manufacture of seed treating machinery are making every effort to answer the challenges arising from both the agronomists and the chemical manufacturers. This is being done by the adoption of new methods, new machines and novel technical solutions to problems.

THE BAYTAN FLOWABLE DELIVERY SYSTEM - A CLOSED SYSTEM FOR THE METERING OF LIQUID SEED TREATMENTS

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ABSTRACT

This paper reviews some of the problems encountered in handling liquid seed treatment in a commercial seed plant. It describes the development of a dedicated delivery system for Baytan flowable which overcomes these problems and provides a reliable supply of product to a seed treater.

INTRODUCTION

Baytan (triadimenol & fuberidazole) has been in use for a number of years as a dry powder seed treatment. There is a preference for a liquid product which does not lead to airborne dust and loss of product during subsequent seed handling. It was not possible to make a satisfactory true liquid formulation of Baytan as the active ingredients are insoluble in water and formulation with organic solvents leads to phytotoxic effects. It is therefore produced as a water based flowable suspension.

The aim of the development of the Baytan flowable delivery system was to promote the production of accurately treated seed using this formulation. The system seeks to achieve this firstly by providing a consistent and reliable supply of Baytan flowable at a suitable volume to the seed treater and secondly, by preventing the operation of the treater if that supply is not available.

FACTORS AFFECTING LIQUID AND FLOWABLE SUSPENSION DELIVERY

A high value product requires application at an accurate rate both from the point of view of the economic cost of over-treatment and the loss of performance from under-treatment. Early experience with the then current commercial seed treatment machinery highlighted a number of areas which were found unsatisfactory.

Metering pump accuracy was not always as good as expected. This was caused in part by the suction lift involved in lifting the product from the container, thus reducing the volumetric efficiency of the pump.

Diaphragm metering pumps operating without any damping produced pulsed outputs causing uneven application to seed.

Not many seed treaters had adequate safeguards to prevent the production and packing of untreated or poorly treated seed resulting from failure of product delivery to the treater.

Using product from an open container allowed contamination with grain and dust. When left to stand in a partly used condition, flowable product on the sides of the container above the liquid level dried and cracked into flakes. These flakes then also became a contaminant.

A flowable product consisting of suspended solids has an opportunity to separate during prolonged storage necessitating agitation prior to use. The agitation of large containers is not always practical.

In the case of Baytan flowable, the formulation was found to cause some sticking of the pump valves. The balls were found to stick to their cages intermittently causing a reduction in output. Any solid contaminants, including flakes of dried product, reaching the pump valves also caused a reduction in output.

With certain flowable formulations, using low volumes, product was found to combine with seed dust and stick to parts of seed treater mixing chambers. This was caused by the speed of drying of the product and also the abundance of seed dust formed from particles of seed coat, in particular of barley seed.

EQUIPMENT

The requirement was for a closed packaging system which would prevent external contamination from dust, grain or debris and prevent self-contamination due to dried flaked product. A method of dispensing from such a package to a metering pump module, incorporating solutions to the above mentioned aspects would complete the system.

Dispenser Pack

A collapsable pack was chosen to exclude air and initial tests were done using a wine box type of pack. This type of pack proved unsatisfactory due to the irregular way the pack collapsed, creating isolated pockets of product when flow had ceased from the outlet. This wastage is not acceptable when dealing with a high value pesticide.

The next development was to revise the shape of the collapsable pack to give more regular collapsing and better draining. A flat pillow shape was chosen because it gave good collapsing and was easy to manufacture. By hanging it from one edge and fitting the outlet to the opposite edge, with the bottom corners sealed off, very efficient drainage was achieved.

The pack is constructed using a metalised polythene laminate material for the bag with a foil type seal on the spout. A suspension tube is fixed in the top of the bag and this retains it in a double walled cardboard box (Fig. 1).

Using the pack in a hanging position gave the opportunity to provide a positive head of product at the inlet valve of the metering pump to improve metering accuracy.

An additional benefit from the use of a flat pack shape is that when stored flat any sedimentation is limited to the pack thickness and is easily agitated when the pack is raised to the hanging position.

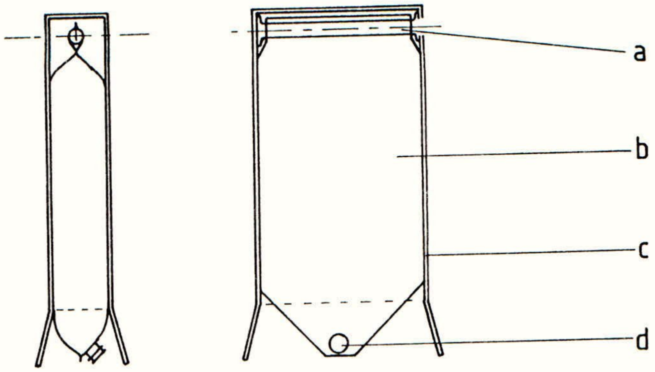

Fig. 1. Dispenser pack: (a) plastic suspension tube; (b) bag; (c) box; (d) spout with foil seal.

Pack Coupler

A connector was needed to link the pump feed tube to the pack outlet. A self sealing design was necessary to maintain the closed system. A coupler was successfully produced to meet this requirement which breaks the foil pack seal only after it has sealed itself to the pack spout. The displaced pack seal is not allowed to obstruct the flow or contaminate the product (Fig. 2).

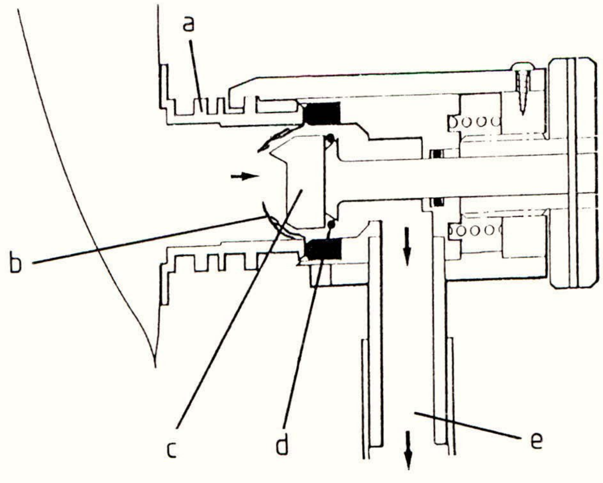

Fig. 2. Pack coupler: (a) pack spout; (b) foil seal; (c) foil cutter; (d) self sealing valve; (e) outlet.

Pack Handler

The size of the dispenser pack was limited to 10 litres because it is a reasonable size for a man to handle and it is a safe limit from the pack material and seam strength aspect.

This was too small a reservoir for a normal seed treatment operation, representing product for only 5 tonnes of seed. It was, therefore, considered necessary to provide a method of connecting several packs at once. Packs must be used sequentially while maintaining a positive head to the metering pump.

To avoid the complications of valves and possible restrictions in flow, a valveless arrangement was chosen which uses the pack weight to differentiate between full and empty packs.

The pack handler takes up to 5 x 10 litre packs of product. Once these packs are coupled, they form, together with the connecting tubes and manifold, a single, interconnected, closed system.

The packs are suspended in vertically sliding carriages which in turn are supported on pairs of springs. An arrangement of latches ensure that the packs drain and empty in sequence, rising as they do so. When the packs have risen to the empty position they can be easily replaced, one at a time, without interrupting the product supply (Fig. 3).

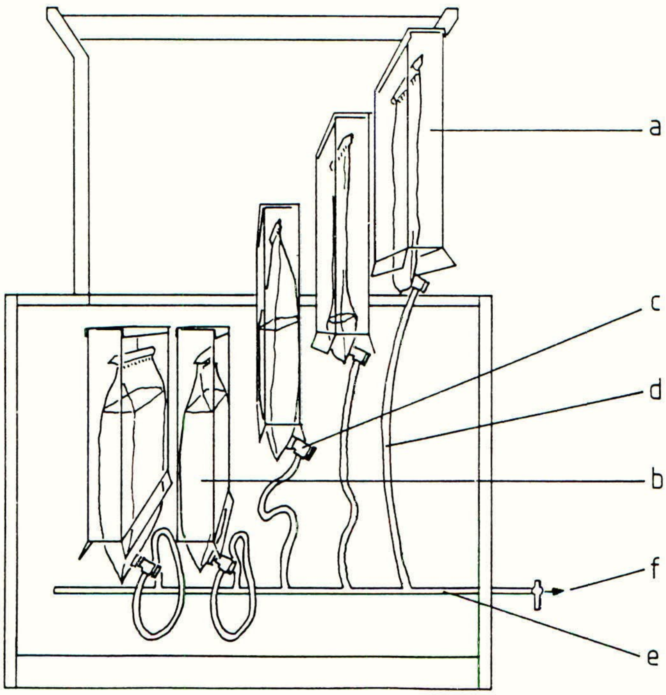

Fig. 3. Pack handler: (a) empty pack; (b) full pack; (c) coupler; (d) connecting tube; (e) manifold; (f) outlet to pump. Springs and latches are not shown for clarity.

Metering Pump Module

The metering pump module may be considered in two parts.

Liquid Metering

A diaphragm metering pump was chosen as being the most suitable type. The following conditions and modifications were specified to ensure accuracy.

The provision of a flooded feed to the inlet valve of the pump was achieved by the use of the new pack system. This maintains the volumetric efficiency by allowing the pump chamber to fill completely during the suction stroke.

Intermittent sticking of the ball valves in their cages became apparent as a reduced output which could be temporarily rectified, during pumping, by sharply tapping the outside of the valve casing. The problem was overcome by modifying the valve cages to reduce the contact area of the cage with the ball.

A pulsation damper is fitted to the pump to provide an even flow to the treater. This functions in conjunction with a solenoid valve which maintains the working pressure in the damper by closing when the pump is stopped. The immediate cut off in the flow to the treater then matches the cut off in the seed supply. An equally immediate resumption of flow is produced when the pump is restarted and the solenoid valve opened.

It was found that the build up of combined product and dust on the inside of seed treater mixing chambers could be eliminated by the addition of water. The water is supplied using a second pump head working in parallel with the first. It is mixed in the proportion 1:1 with the product just after the pump (Fig. 4).

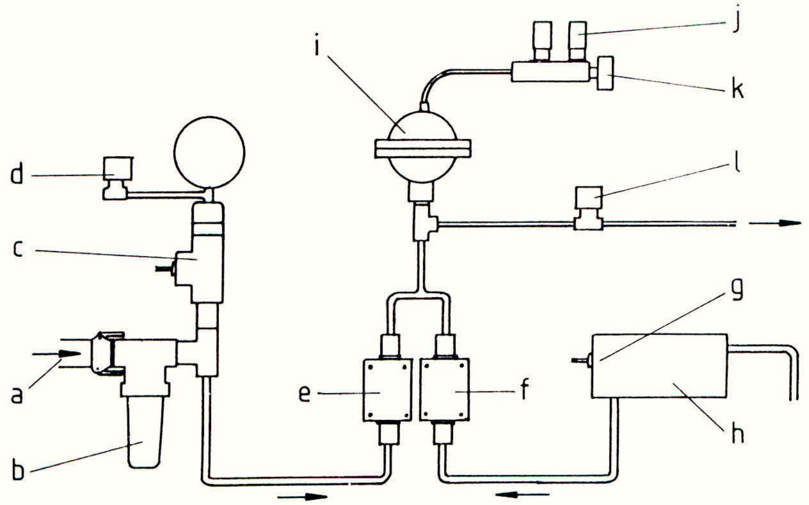

Fig. 4. Pump module components: (a) product supply; (b) filter; (c) float switch chamber; (d) air vent solenoid valve; (e) product pump head; (f) water pump head; (g) water float switch; (h) water tank; (i) pulsation damper; (j) pressure sensors; (k) pressure gauge; (l) solenoid valve.

Control and Monitoring

The pump module is electrically connected so that, when required, the pump starts and stops simultaneously with the treater. Several monitoring functions are also incorporated which when actuated, stop the pump and pass a signal to the treater, to stop it also. This prevents the inadvertent production of untreated or poorly treated seed.

Of prime importance is the float switch which monitors the presence or absence of product. This is fitted in a chamber adjacent to the pump head. Its operation is very simple but is complicated by two effects. If an air bubble is drawn into the float chamber from the pack handler it will cause the float to drop prematurely. An air vent solenoid is, therefore, used to allow such air to escape. It is opened only when the float switch drops. The other effect is that the liquid level in the float chamber fluctuates in response to the inlet strokes of the pump. This also causes premature switching of the float switch. This is overcome by increasing the volume of air above the switch. The level fluctuations are then kept above the float switch.

Monitoring of product flow is carried out by monitoring the delivery pressure of the pump. This is measured on the dry side of the pulsation damper which is at the same pressure due to its floating diaphragm. A high pressure switch is fitted to sense if the pressure rises too high, as a result of an outlet blockage. A low pressure switch senses if the delivery pressure drops, indicating a reduction in product flow. A pressure guage is fitted to check the pressure and to assist in adjusting the pressure switches.

A low water float switch is installed in the water tank. This ensures that product cannot be supplied undiluted hence causing problems in the seed treater.

DISCUSSION

The design of the Baytan flowable delivery system set out to ensure that the product was accurately and reliably supplied to the seed treater. This has principally been achieved by allowing the metering pump to operate under optimal conditions by providing it with a flooded delivery of uncontaminated product and by an electrical control system which prevents seed being treated when a fault in product supply is detected, thereby reducing the possibility of poorly treated seed being produced. Accurate control over application of a high value product is important and it has been shown that the system is superior to some conventional liquid seed treatment systems.

In addition the system has some advantages in the handling of flowable formulations. The disadvantage of water based flowable formulations is that when exposed to air they can dry and become contaminated with dried flakes of product. This has effectively been eliminated in the system by adopting a closed system which is made possible by the collapsable packs. The new packs not only make it easy to agitate the product before use but also lead to less wasted product. It was found that up to 2% of product remained in a conventional 10 litre drum compared with less than 0.5% in the new pack. This improvement is due to the pack shape and bottom emptying arrangement.

Flowable formulations tend to be viscous in order for them to be stable and consequently are best applied at high rates (frequently more than 400 ml per 100 kg seed) to obtain even treatment of seeds. By diluting the product with water the system provides a high volume of low viscosity. This has the advantage that the treatment is more easily applied in the seed treater resulting in a more even distribution of chemical on the seeds whilst at the same time enabling a more concentrated lower volume product to be supplied to the customer. A disadvantage of adding water to a flowable formulation is that the suspending agents are no longer able to maintain the active ingredients in suspension and consequently sedimentation rapidly occurs. The system minimises the amount of diluted product (usually less than 200 ml) by mixing water and product only as it is required.

The Baytan flowable delivery system provides a novel means of accurately and reliably supplying a seed treater with a flowable formulation in a form that optimises application to the seed. Patent applications have been made for the system (Morris et al. 1985a, 1985b) which has been in use for over two years with more than a hundred units currently installed.

ACKNOWLEDGEMENTS

The authors would like to thank colleagues for their assistance and support with this project. The authors are also indebted to the various companies and particularly Turner Grain and Feed Milling Limited who participated in the production of prototypes and the final equipment and the seed companies who co-operated with the testing of the equipment.

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OPTIMISING THE PERFORMANCE OF A SEED TREATER USING A ROTARY ATOMISER WITH A RANGE OF CHEMICALS, SEED TYPES AND FLOW RATES.

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ABSTRACT

The performance of a seed treater depends upon achieving a fine balance between the chemical atomiser and the design of the treatment chamber. The meeting zone of the chemical and the seed is particularly critical. Rotary atomisers are preferred to nozzles but it has been found that their performance varies with the surface tension of the chemical being applied. In addition it has been found advantageous to develop relatively simple means of optimising the coming together of seed and chemical in the treatment chamber to handle a wide range of seed types and flow rates. Two such design features are described.

INTRODUCTION

Seed treatment machines made in Hungary employ a seed treatment chamber into which a curtain of seed is introduced. A rotary atomiser is placed in the centre of the circular curtain to distribute the chemical uniformly onto the falling seed.

Rotary atomisers are preferred to nozzles because experience has shown that this type of atomiser is able to meet the constantly rising requirements being specified by the producers of seed treatment chemicals. Also, the spray pattern created by the spinning disc is independent of the fluid pressure and discs do not clog.

A well developed rotary atomiser produces a uniform spray pattern of fine droplets. There are, however, several factors which may have more or less influence upon the characteristics of the pattern. Some of these are linked with the physical characteristics of the liquid chemical being applied.

Although the size of the droplets involved at the edge of a rotary atomiser is relatively small (c 100-200 µm dia), under certain circumstances they break up into smaller droplets as they progress in the air away from the disc. This phenomena has been investigated with particular reference to the relationship between the surface tension of the liquid and the further disintegration of the droplets.

ANALYSIS

In order to obtain the most uniform coverage of the seed in the treatment zone (the meeting point of the seed and chemical), it is desirable to employ small droplets. For this reason it is necessary to examine the development of droplet size and in particular the further disintegration of droplets after initial formation.

The relationship between the surface tension of the droplet in static conditions and the external pressure acting upon the droplet is as follows.

$$p_b - p_k = \frac{2\alpha}{r}$$

where:

p_b = internal pressure
p_k = external pressure
α = surface tension
r = radius of the droplet

Pressure is exerted on the droplet in motion by air resistance and if the latter can be characterised by the formula.

$$p_d \geqslant p_b - p_k = 2\,\alpha/r$$

the droplet will disintegrate.

Here:

$$p_d = F/A$$

in which:

F = the force created by air resistance
A = front surface of the droplet

The air force acting on the droplet is:

$$F = \varphi\,\rho\,Av^2$$

where:

φ = resistance factor of the droplet
ρ = density of the medium
v = velocity of the droplet

$$\varphi = \frac{12{,}5}{\sqrt{R_e}} \qquad \text{and } R_e = \frac{vd}{\gamma_K}$$

where:

d = diameter of the droplet
γ_K = kinetic viscosity

The pressure acting on the surface of the droplet is the following:

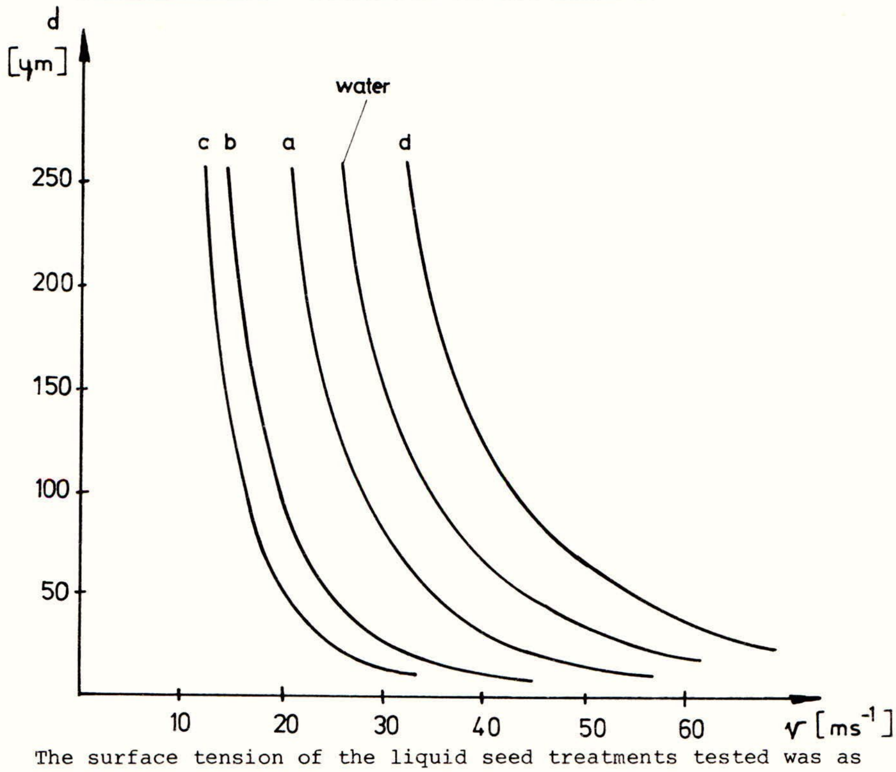
$$p_d = \frac{F}{A} = \frac{\varphi\,\rho\,Av^2}{A}$$

Hence the critical velocity (v_{cr}) needed for the disintegration of the droplet is:

$$v_{cr} = \sqrt[3]{\left[\frac{\frac{4\alpha}{d}\sqrt{\frac{d}{\gamma k}}}{12.5\rho}\right]^2}$$

By constructing the v - d curves for water and for four different commercially available agents the following relationships can be shown (Fig 1).

Fig. 1 Relationship between velocity and droplet size



The surface tension of the liquid seed treatments tested was as follows:

Material	Surface tension N/m
Water	0,0295
Seed treatment chemical "a"	0,0212
Seed treatment chemical "b"	0,0124
Seed treatment chemical "c"	0,0094
Seed treatment chemical "d"	0,04189

From Fig. 1 it can be seen that in the case of a 100 µm diameter droplet the critical velocity causing break up is approx 38 m/s in case of water, approx 43 m/s in the case of the high surface tension 'd' seed treatment liquid and approx 20 m/s in the case of the low surface tension 'c' seed treatment chemical.

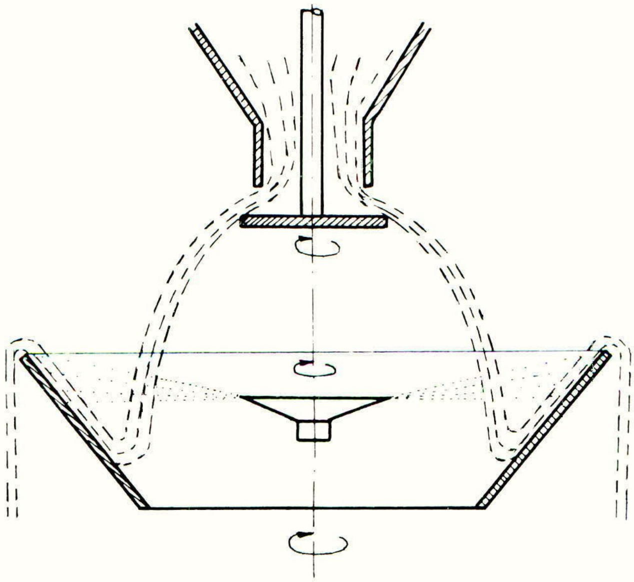
Further, it can be concluded that the 100 um droplets of seed treatment chemical 'c' break up into smaller droplets under the velocity of 20 m/s while the 200 µm droplets of seed treatment chemical 'd' break up only over 35 m/s.

Thus it may be seen that great stress is laid on understanding the theoretical questions arising in connection with the development of droplets. In practice these results can be used to fine-tune the speed of the rotary atomiser to match the characteristics of the liquid seed treatment so that optimum conditions exist in the critical treatment zone.

DESIGN CONSIDERATIONS

Seed and chemical treatment come together in the treatment zone of the treatment chamber and it is crucial to achieve the best possible distribution and most uniform loading of each seed at this first meeting. We have observed that however uniform the spray pattern of small droplets produced, some part of the spray proceeds through the seed curtain without contacting any seeds. Such droplets then hit the wall of the seed chamber and, flowing down from it, meet some of the seeds, thus destroying the uniformity of distribution. In order to avoid this we have developed a seed lifting cone (Fig.2) on which the falling seeds are propelled slowly upwards by centrifugal force and are contacted by the droplets of chemical which pass through the curtain.

Fig.2 Cone to lift the seed after initial application.

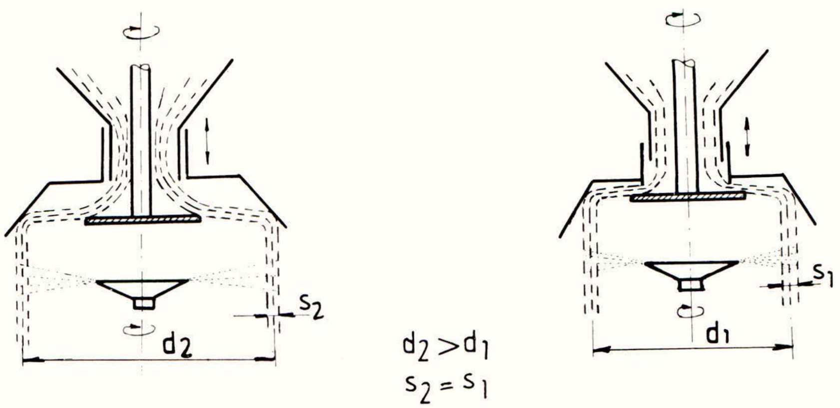


Another design feature which has been built into our seed treaters has been developed to help optimise performance with the widest possible range of seed types and rates of work. For example, it is necessary to accommodate work rates between 6 and 20 t/h.

Low flow rates of seed require proportionately small volumes of chemical and the optimum treating zone is reduced to a small diameter seed curtain. In the case of high seed flow rates large volumes of chemical are required and the optimum treatment zone requires a seed curtain of larger size. At the same time it is most desirable to maintain the same thickness of seed curtain in both conditions.

The design of the seed chamber has been developed to automatically adjust the diameter of the seed curtain in proportion to its volume. Fig.3 shows the construction of the seed metering mechanism. Seed flows down the seed pipe to reach the treatment chamber but its flowrate is regulated by a choke pipe which moves relative to the seed spreading disc. A cone shaped baffle is fixed to the choke pipe and moves vertically with it as it regulates the rate of seed flow. Since the cone angle is 45°, the seeds flying off the seed spreading disc will hit the cone at higher or lower positions and fall to create a curtain of smaller or larger diameter. Hence the thickness and density of the seed curtain remains constant and independent of the rate of seed flow. This helps to ensure that the chemical and seed always meet under favourable conditions for optimum distribution.

Fig 3 Automatic adjustment of curtain diameter with constant thickness



By two such relatively simple developments in the construction of our seed treaters we have been able to significantly improve primary loading and distribution of the chemical which are the leading factors in determining the quality of seed treatment.

CONCLUSION

The studies described were useful in the development of the seed chamber of our machines to obtain optimum primary loading and distribution. It was also clearly shown that the impact of surface tension of the liquid seed treatment chemical must not be left out of consideration. The negative effects of these changes can however be minimised by relatively simple technical innovations applied to the seed chamber of the machines.

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SHOULD VOLUME BE GIVEN MORE WEIGHT? - THE CASE FOR CHANGING THE WAY SEEDS ARE TREATED.

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ABSTRACT

This paper refers, primarily, to commercially grown cereal seeds although the principle could be applied to other areas. It deals with seed measurements in relation to application of seed treatments, seeding rates, consistency in soil placement of insecticidal and soil acting fungicidal chemicals.

INTRODUCTION

The past 10 years have shown a marked increase in the amount of Autumn sowings which now stands at approximately 90% of the cereals acreage grown in England and Wales. This shift in sowing dates has increased the workload on seed processors and farm staff at a time of year when the workload is already high and timing critical.

Farmers have been assisted in their efforts by the development of bigger capacity tractors, cultivators, seed drills, fork lift trucks and big bag bulk handling systems. All these factors have helped them drill more hectares earlier - an objective encouraged by consultants in order to achieve maximum crop yield potential. The other fundamental factor in achieving maximum yield with quality is plant population. This is achieved by controlling the numbers of seeds sown per unit area and current practice is to take 1000 grain weight which is translated into a given weight of seed per unit area, This is not as accurate as precision drilling, but is an adequate method of achieving placement of a specific number of seeds per unit area over a variety of soil and seedbed conditions.

Because seed treatments are applied on the basis of "unit of treatment per unit weight of seed" the <u>concentration</u> of treatment per unit area of land and the <u>cost</u> varies considerably using the 1000 grain weight method of calculating drilling rates. This fact, coupled with the need of the farmer using bulk seed handling systems, to have a quick, easy and accurate method of calibrating large drills, prompted the work presented in this paper.

AGRONOMIC REQUIREMENTS FOR SEED TREATMENTS

Seed treatments are divided into two main categories - 1) Fungicidal and ii) Insecticidal. Older seed treatments were specific to seed borne diseases, but modern developments have produced treatments which are multi-functional to control not only seed borne and soil borne diseases but also have a systemic effect on early attacks of foliar fungi.

Insecticidal treatments are used to prevent attack on the seedlings by a variety of fly larvae and in order to achieve this it is necessary to create a concentrated insecticide barrier within the soil immediately surrounding the seedling. The seed itself is then merely used as a carrier for the chemical.

It is generally accepted that all seed borne diseases are best controlled by a uniform distribution of treatment over the seed, but even when this is achieved the concentration of the a.i. varies with the specific weight of the seed sample when the method of treatment is by unit of treatment per unit weight of seed.

Little is known about the way seed treatments work against soil borne diseases. Whether there is any downward translocation and systemic action through the roots or whether the a.i. is absorbed by the soil moisture to create a chemical barrier around the root system, or a combination of both, is a subject for further examination.

Where seed treatments are used to control foliar diseases the systemic action is by upward translocation of the a.i. within the seedling. This movement can be initiated by direct absorbtion of the a.i. into the seed or by uptake through the root system after the a.i. has been absorbed into the soil moisture. In either case it is necessary to achieve the correct concentration if the product is to be totally effective. Placement and concentration of insecticides within the top layers of the soil is of paramount importance as an overdose would be costly and an underdose would be ineffective, especially against higher populations of the pests.

Seed treatments are available in various formulations from dry powders to true liquid solutions and dose rates are calculated to give effective control without the a.i. or the formulation becoming phytotoxic.

THE RELATIONSHIP BETWEEN SEED NUMBERS AND VOLUME

The weight of a given volume of seed is relative to individual seed weight and packing density.

Numbers of seeds in a given volume are relative to individual seed size and packing density.

Where seeds are consistently graded to specific size tolerances then the numbers of seeds in a given volume will remain constant, irrespective of weight. It therefore follows that where numbers of seeds per unit area are required, then it is possible to measure by volume. Where a quantity of a.i. is required per unit area then that amount of a.i. should be applied to the relevant volume of seeds.

Under the current system of applying treatments at a given quantity per unit weight of seed the amount of a.i. will vary according to the specific weight of the sample:

For example:

Birlane (Chlorfenvinphos) - dose rate 300 ml per 100 kgs seed
if seed specific weight 69 kgs per hectolitre = 207 ml product
if seed specific weight 82 kgs per hectolitre = 246 ml product

DEVELOPMENT OF PRACTICAL SYSTEMS AND MACHINERY

Since the basis of counting numbers by volume is dependent on maintaining seed size it is necessary to grade seeds using good, effective screening systems. This is achievable by using modern equipment.

Although one or two seed treatment machines employ a volumetric grain metering system, their potential has not been fully exploited. Calibration of continuous flow machines is usually done on a flow rate system using weight against time and calculated in "tonnes per hour". Since this is done against a sample of random specific weight any subsequent sample of different specific weight will receive a different dosage when expressed as quantity of product per weight of seed.

Accurate, continuous flow, rotary valve grain metering systems with electronic direct digital read-out have been developed for metering the grain into the treater. Chemical metering pumps and applicators are coupled either mechanically or electronically to give outputs in direct ratio to the speed of rotation of the grain metering system. This ensures stability of calibration with varying throughputs of seed, calibration being done on the basis of unit of treatment per volume of seed.

DISCUSSION

Since the farmer needs to plant numbers of seeds per unit area to achieve optimum crop yield and quality those numbers can be measured by volume. Treatments applied to a volume will ensure constant quantity of product over a number of seeds and, when those seeds are planted by numbers, then the quantity of product per unit area will remain constant. This in turn will ensure consistency in concentration and effectiveness whilst maintaining stability of cost per unit area to the farmer. The system was first tried in Autumn 1984 on approximately 3,000 acres over a variety of farm sizes and soil types. To date the system has been adopted by the first participating farmers and used by an increasing number of other farmers. It has also found favour with certain chemical manufacturers as it allows engineers to calibrate machinery without seed being available.

ACKNOWLEDGEMENT

The Author would like to thank the staff of Shell UK Ltd, Seed Treatments Department for their help and encouragement, the farmers who undertook the first trials and all staff involved in the design and manufacture of the equipment.

DETERMINATION OF THE QUALITY OF SEED TREATMENT BY SINGLE SEED ANALYSIS

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ABSTRACT

Generally the quality of seed treatment is expressed as a simple dosage parameter. It is measured by extracting the dye from a bulk sample of 50 g of grain and shows the amount of seed treatment actually adhering to the seed, calculated as a percentage of the recommended dose.

Obviously the aim of seed treatment is to place as much active ingredient on every single seed as is needed for the intended biological effect. For this reason it is necessary to evaluate the quality of seed treatment determined as the variation of pesticide dose on individual seeds.

Fluorescence of seed treatments is measured against a standard after extraction from individual seeds in an alcohol/water mixture. Based on the results of 100 single seeds per seed lot the pattern of distribution can be demonstrated and mean dosage and coefficient of variation can be calculated. The most important parameter for the quality of seed treatment is the percentage of seeds carrying the correct amount of chemical.

INTRODUCTION

The application of liquid seed treatments has increased remarkably during recent years as a result of the disadvantages of dry powders. The problems are insufficient adherence and the occurrence of harmful dust during treatment and handling of seed. For these reason the registration authorities of the Federal Republic of Germany have announced that dry powder formulations will not be allowed for use beyond 1989.

Liquid formulations adhere much better to the seed and dust is no problem. In contrast to powders, the major problem of liquids is to get a uniform distribution of the active ingredient within the seed lot (Lord *et al.* 1971).

The physical characteristics of seed treatments are responsible for the different distribution patterns. Factors like particle size and particle number are of major influence for the maximum load of a single seed and the distribution of the active ingredient.

The application of dry powders can be understood as a simple blend of two bulk goods. Since the particle size of dry powder seed treatments ranges from 20-50 um the relation between number of seeds and number of powder particles is about 1:5000. If a liquid formulation is used the volume must be atomized as a first step of the distribution process. As a matter of fact a single seed is able to retain much more of a liquid than of a powder. Therefore it is mainly a technical problem to distribute the liquid seed treatment among the seeds in order to get a likely uniform distribution.

The objective of seed treatment is to place as much active ingredient on every single seed as it is needed for the intended biological effect. The total amount of seed treatment found on 100 kg of seed is expressed as a percentage of the recommended dose per 100 kg and achieves ideally 100%.

The investigation of an aliquote of treated single seeds using the common evaluation of dosage and distribution parameters is a reliable method of characterising the quality of seed treatment of liquid formulations.

EXPERIMENTAL

Fluorescence as a measurable physical property

12 out of 25 liquid seed treatments and one out of three slurry formulations registered and traded in West Germany (Table 1) were found to contain a fluorescent dye. The amount of fluorescence is a parameter for the amount of seed treatment on a single seed (Koch & Spieles, 1985 b). A fluorescence spectrometer (Turner 111) was used to measure the fluorescence extracted from single seeds.

Factors affecting the quality of seed treatment

There are various factors influencing the results of seed treatment. Naturally the seed treatment machinery must be adapted most accurately in order to achieve optimal processing of a specific liquid formulation. Accuracy of the metering device and the technique of atomisation and mixing are of major influence on the resulting quality of seed treatment. Of course, formulation and physical properties of the chemical influence the distribution process. Seed quality is a third main factor. It is characterised by the species of grain, the seed size and the quantity of undesired particles. Dust and abrased glumes retain liquid seed treatment much better than the seed itself. This is an important reason for reduced loadings on seed batches.

Single seed analysis

The determination of the quality of seed treatment is based on single seed analysis which can be done with the help of the Fluorescence Distribution Test (Koch & Spieles, 1985 b). The procedure can be divided into a technical and a calculation part (Fig.1). It is essential to have a sample of the treated seed and the seed treatment chemical as well.

After sampling 100 single seeds out of the batch and determining their total weight every individual seed is placed together with 4 ml of the solvent (Ethanol/Aqua dist. 1:1) into a test tube. A period of 16 to 24 hours is necessary in order to get an optimal extraction of the dye. Then the concentration is measured against a standard and the individual loadings are calculated. Simultaneously the theoretical single seed target dose is calculted from the total weight of the sampled 100 seeds and the recommended dose per 100 kg. The final step is to find the percentage of seeds that actually carry the calculated single seed target dose with a maximum deviation of ± 25% (Fig.1).

The reliability of the Fluorescence Distribution Test was confirmed by gas chromatography. Both methods gave comparable patterns of single seed distribution of liquid seed treatments.

TABLE 1

Fluorescent Liquid Formulations

A. Solutions for Seed Treatment (LS)

	Product Name	Common Name of Active Ingredient
1	Aagrano GF 2000	Furmecyclox 450 g/l, Imazalil 25 g/l
2	Abavit UF	Carboxin 400 g/l, Prochloraz 80 g/l
3	Arbosan Spezial Feuchtbeize	Methfuroxam 150 g/l, Thiabendazol 25 g/l
4	Arbosan Universal Feuchtbeize	Methfuroxam 150 g/l, Imazalil 25 g/l, Thiabendazol 25 g/l
5	Etilon	Imazalil 35 g/l
6	Germisan GF	Carboxin 300 g/l, Imazalil 20 g/l
7	Germisan Spezial Feuchtbeize	Methfuroxam 150 g/l, Thiabendazol 25 g/l
8	Panoctin 35 Feuchtbeize	Guazatin 350 g/l
9	Panoctin GF	Fenfuram 200 g/l, Guazatin 200 g/l, Imazalil 20 g/l
10	Panoctin Spezial Feuchtbeize	Guazatin 300 g/l, Fenfuram 100 g/l
11	Panoctin Universal Feuchtbeize	Guazatin 300 g/l, Fenfuram 100 g/l, Imazalil 20 g/l

B. Water Dispersible Powders for Slurry Treatment (WS)

	Product Name	Common Name of Active Ingredient
1	Baytan Universal Slurry	Triadimenol 22%, Fuberidazol 3%, Imazalil 3.3%

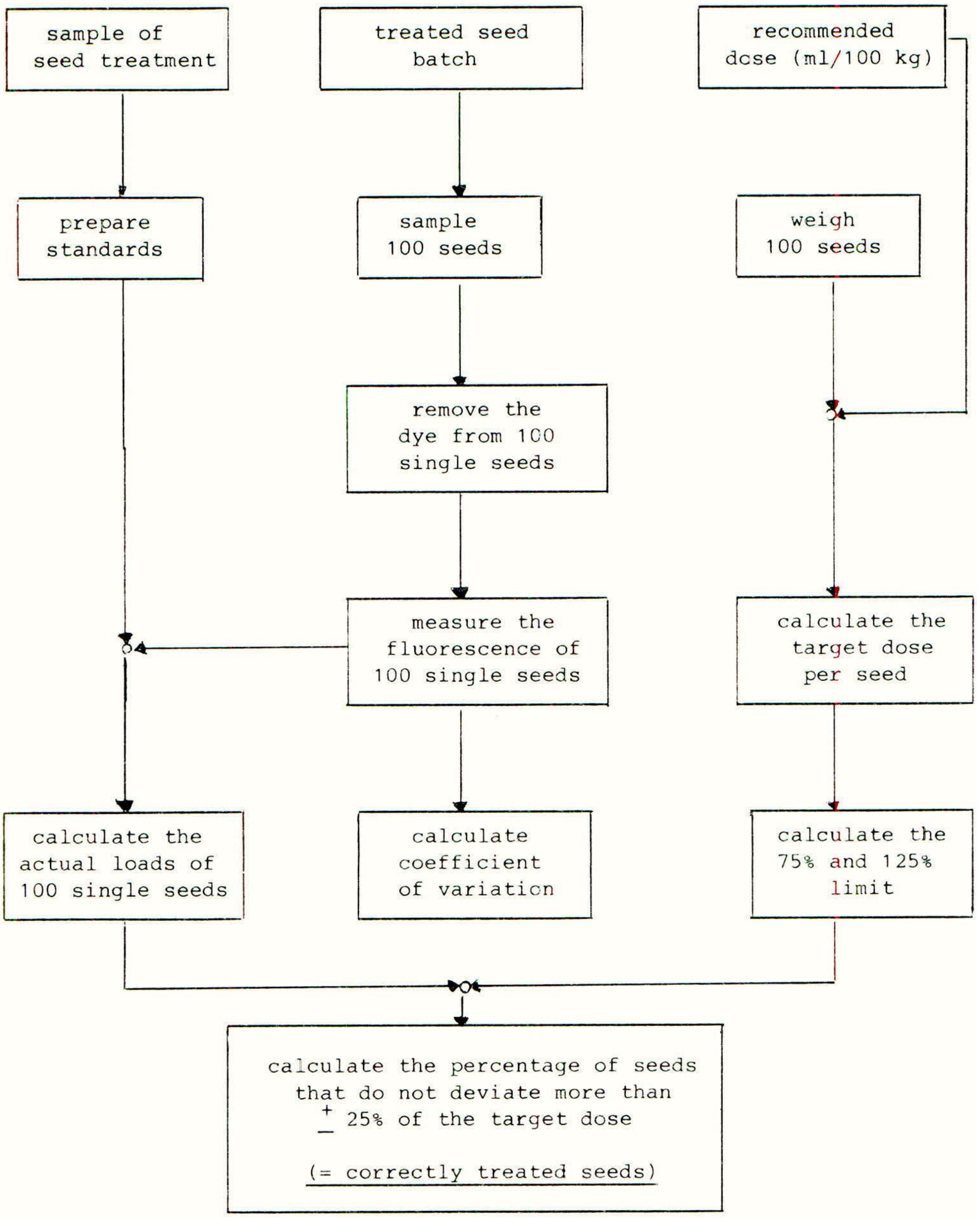


Fig. 1: Determination of the Quality of Seed Treatments

RESULTS

Quality of distribution pattern

Investigations of laboratory and commercially treated seed lots showed typical distribution patterns with coefficients of variation (v (%)) ranging from 10% to 50% and 25% to 170% (Table 2.). Half of the commercially treated seed batches show a coefficient of variation higher than 50%.

TABLE 2

Classification of coefficients of variation from laboratory or commercially treated seed batches

V (%)	Number of laboratory treated seed batches	Number of commercially treated seed batches
0 - 10	1	-
›10 - 20	17	-
›20 - 30	16	13
›30 - 40	16	21
›40 - 50	3	23
›50 - 60	-	21
›60 - 70	-	16
›70 - 80	-	9
›80 - 90	-	9
›90 - 100	-	4
›100	-	6

Quality of seed treatment

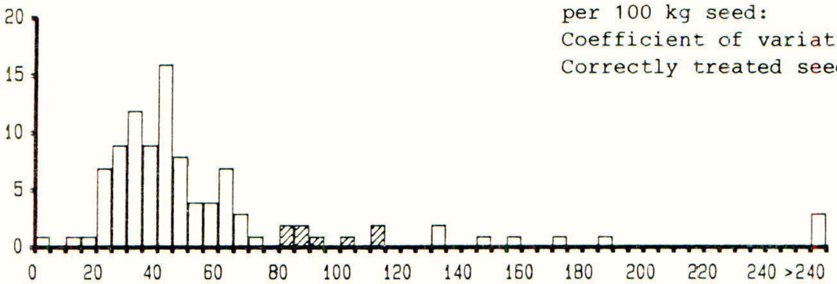
To determine the quality of seed treatment it is necessary to demonstrate the effect of total loading expressed as percentage of target dose and uniformity of distribution on the amount of correctly treated seeds. As a proposal seeds are correctly treated when their individual load does not deviate more than ± 25% from the calculated single seed target dose (Fig.1). Fig. 2 shows the frequency distribution of single seed loadings of four samples with varying percentages of target dose and coefficients of variation.

Fig. 2a shows a commercially treated sample with a total batch loading of 95% of the recommended dose and uneven distribution. 8% of the seeds are accepted to be correctly treated. Individual seed loadings range from nearly 0% to 420% of the target dose. The distribution is typically skew. Because a few seeds carry an amount greatly in excess of the target dose, many seeds are scarcely treated.

The sample demonstrated in Fig. 2b is also commercially treated. It is characterised by a reasonably good dose per 100 kg but poor distribution. 27% of the seeds are correctly treated which is assumed to be not enough. The distribution pattern shows the same skewness as Fig. 2a.

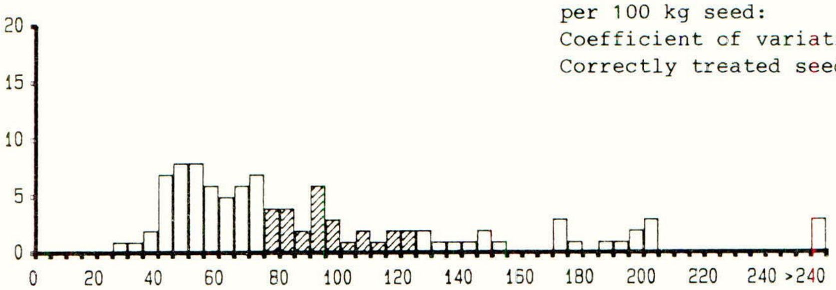
Fig. 2a

Proportion of seeds (%)



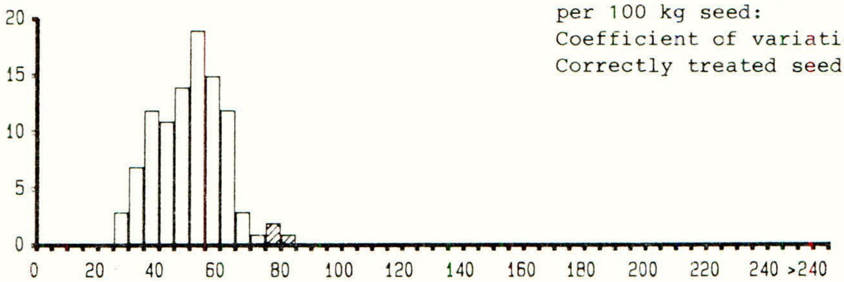
Percentage of target dose per 100 kg seed: 60%
Coefficient of variation: 95%
Correctly treated seeds: 8%

Fig. 2b



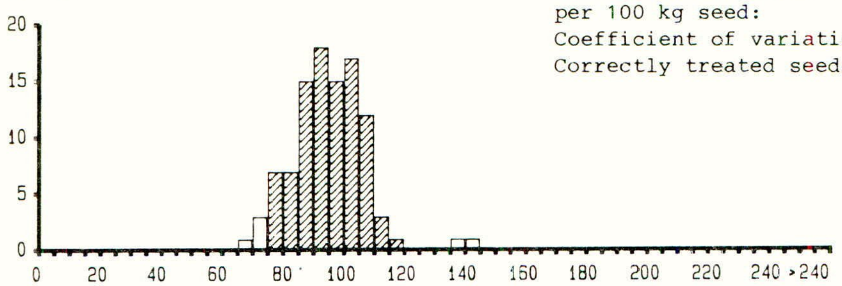
Percentage of target dose per 100 kg seed: 99%
Coefficient of variation: 103%
Correctly treated seeds: 27%

Fig. 2c



Percentage of target dose per 100 kg seed: 50%
Coefficient of variation: 10%
Correctly treated seeds: 3%

Fig. 2d



Percentage of target dose per 100 kg seed: 95%
Coefficient of variation: 13%
Correctly treated seeds: 94%

Percentage of target dose per single seed (%)

Fig. 2 a-d. Dependence of quality of seed treatment expressed as correctly treated seeds on percentage of target dose per 100 kg and distribution pattern. Correctly treated seeds ( ) do not deviate more than + 25% of the target dose which is indicated as 100% on the abscissa.

Fig. 2c and 2d show laboratory treated samples with a fairly uniform distribution pattern. The main difference is the total adhering dose while coefficients of variation are 10% and 13% respectively. A good sample with correct dose and uniform distribution is shown in Fig. 2d with 94% of seeds in the proposed range of deviation of the target dose.

According to the results of seed batches that carry a reasonable amount of seed treatment a coefficient of variation of 40% demonstrates that only 50% of all individual seeds are correctly treated.

DISCUSSION

Recent investigations of commercially treated seed bulks show that:

1 The quality of seed treatment is not satisfactory.
2 Fluorescence of liquid seed treatments can be measured after extraction from individual seeds and gives reproducible results.
3 A sample size of 100 single seeds is appropriate to determine the percentage of correctly treated seeds.
4 The method is limited to fluorescing formulations.

Different investigations of commercially treated seed show that the quality of seed treatment has hardly improved (Lord et al. 1971; Radtke, 1983; Koch & Spieles, 1985 a; Jachmann & Ufer, 1986). The major reason might be the lack of a simple method for single seed analysis. The procedure, ie, sampling, measuring and calculation of specific described parameters, takes about 2.5 hours.

A statistical approach to the analysis of batches of eg, 10 seeds was reported by Lord et al. (1971) and Rietz & Kohsiek (1984). Since this method leads to misinterpretation if there is a skewness of distribution pattern it is limited to bulks showing a Gaussian distribution pattern.

Universal application of the Fluorescence Distribution Test demands a dye or any other ingredient that shows typical fluorescence and can be extracted from the seed. The Fluorescence Distribution Test should not be considered for investigation of commercially treated seed lots delivered to farmers. This could only confirm the general situation but not help to improve the quality. Single seed analysis should be used during the stage of development of seed treatments and seed treatment machinery. In the same way it is necessary to examine techniques of seed treatment used in the laboratory in order to obtain seed of high quality for biological tests.

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