The Use of Coated Seed in Modern Agriculture

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Any discussion of coated or pelleted seed should be prefaced by a paragraph on nomenclature. The term "coated seed" refers to a single seed coated with an inert material, primarily to increase its size to facilitate planting. Chemicals, such as pesticides and fertilizers, are sometimes added to the coating as it is applied to the seed. Coated seeds are mostly used in row crop farming for precision planting. Pelleted seeds are a mixture of seeds and an inert material formed into pellets, usually by molding by some mechanical means. The number of seeds in a pellet is not controlled accurately and any average number can be included, the average seed content depending upon the ratio of seed to pelleting material in the mixture from which the pellets are formed. Pelleted seeds are generally used in range land reseeding. The seed used is normally the forage grasses and some of the more hardy legumes. Fertilizers and seed protectants can be added if desired. Planting usually is done with an airplane. While this paper deals primarily with single-seed-coated seeds, pelleted seeds and their use will be mentioned later.

Since the development of a satisfactory coating material and the method of applying this coating material to an individual seed, the use of coated seed has become an accepted practice in the production of a number of row crops. The number of crops which can be benefited, either by reducing production costs and/or by improving the quality of the harvest, is being increased as research and experimentation continue.

The idea of coating seeds is quite old. A search of the Patent office files shows the first patent relating to seed coating was issued in 1868. Quite a number of patents have been granted since then. Nearly all of these patents have as their subject matter the coating of seeds with some fertilizer or other growth-promoting substance, and all used a binder of some sort to hold the coating material to the seed and to form a coated seed. Since the idea of precision planting is a comparatively recent introduction, nothing is mentioned in the older patents about increasing the size of the seed to facilitate planting.

The beet sugar industry was the initiator of the recent interest in seed coating. After the development of a successful method of breaking the beet seed ball into segments containing a high percentage of single germ seeds, the full advantage of the singleness of the processed seed could not be realized because of the fact that the planters available would not accurately space the seed in the row. As a means to obtain better spacing with the planters in use, the idea of increasing the size of the seed to approximate the size of the unprocessed seed was advanced. While the

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coating work was in an experimental stage, precision planters were also being developed. Both developments became practical at about the same time.

The number of materials and mixtures of materials which was tried experimentally as seed coating materials runs into the hundreds. None of them was entirely satisfactory as long as a binder was required to make them adhere to the seed. Some of the experimental coated seeds gave fair results if they were planted immediately after coating, but after short storage periods the viability of the seed was affected. Further research showed that the binders used were for the most part responsible for the loss of viability. Experiments with various binders showed that if they were used in sufficient quantities and concentrations to produce a coated seed of sufficient mechanical strength to withstand passing through a planter, they also sealed the seed hermetically. Unless seeds are kept under ideal storage conditions they must respire, and the binder prevented respiration. Another objection to the binder is the length of time required for it to dissolve out of the coating and permit the soil moisture to contact the seed.

Research was directed toward finding a material which would adhere to the seed and form a coating without the use of a binder. The material should be porous to permit respiration, yet it should give the seed some protection against unfavorable atmospheric conditions during storage. It should not absorb moisture from the atmosphere but it should soften rapidly when in contact with moist soil and hold the moisture to the seed to promote germination. After considerable research and experimentation, a coating material meeting the above requirements and having additional attributes was developed. The most important of these additional attributes is the inherent fungicidal activity of the coating material.

After the demonstration of the successful use of the coating material on processed beet seed, farmers who grow other row crops became interested in the use of coated seed to reduce labor costs. One of the first of the row crop seeds other than sugar beet seed to be processed to coated seed was head lettuce seed. Other coated seeds used at present are: tomato, cabbage, broccoli, cauliflower, carrot, radish, onion — in fact, most of the annual vegetables and a large number of the annual flowers, both for cut flowers and for seed production. Inquiries are being received from growers of various other crops relative to the use of coated seed to reduce their growing costs, to save valuable seed or to protect seed during storage and planting.

The culture of head lettuce is quite similar to the culture of sugar beets in irrigated areas. Rows are spaced about the same—20 to 24 inches apart—and the plants need 12 to 14 inches in the row to develop properly. With the use of uncoated lettuce seed, a pound and one-half to three pounds of seed are used per acre. Each pound of lettuce seed contains an average of 400,000 units. Consequently, from 600,000 to more than a million seeds were planted to obtain a plant population of about 25,000 per acre. Lettuce seed is normally a high germinating seed, nearly all of it germinating well over 90%. The thinning operation was definitely a stoop labor, finger thinning job. The plants left to produce the crop were injured in that

their root systems were disturbed by having adjacent plants removed or by having part of their root systems exposed in removing unwanted plants. With coated seed, 3 to 4 ounces of original seed are used per acre and the seed spaced approximately two inches apart in the row. The thinning job becomes a long handled hoe operation and the expense was cut about 75%. The plants grew better since there was no seedling competition and plants were not subjected to any shock during thinning. Yields are increased and the percentage of premium heads is increased materially.

The coating of lettuce seed involved considerable difficulty in its development. Even now, after a vast amount of experience, it requires a much longer time to coat lettuce seed than is required for most other seeds. If a binder could be used successfully with this seed, a considerable amount of time would be saved. Lettuce seed is very sensitive to smothering and the coating must be porous to permit air movement during germination. The use of coated lettuce seed is becoming more popular as more vegetable growers learn of its advantages. The only hold-back to much wider use is the non-availability of suitable precision planters.

Tomato seed received early attention upon the request of farmers who were growing large acreages for canning factories. There was, at first, some doubt about being able to secure early enough harvest to compete with transplants from plant beds. Experience over the past several years has shown that direct seeding permits as early a first picking as is possible from transplanting in normal seasons. The direct field-seeded plants have a certain amount of frost resistance which is not apparent in the transplants. The saving involved in direct seeding amounts to the cost of the plants plus the transplanting costs, less the coated seed cost and the cost of planting. A direct-seeded field could be replanted repeatedly after frosts and the cost would not approach the cost of plants.

The tomato growers were, of course, primarily interested in the saving involved in using direct seeding in preference to transplanting. However, after the first season, this saving, as large as it was, became one of the minor advantages to the use of coated tomato seed. The spread of disease in the plant beds and by handling of the plants during transplanting was entirely eliminated. Very few tomato growers realized the toll taken by diseases which were spread in this manner. The direct seeded plants grew more upright and bushy, holding the fruit off the ground and permitting the harvest of a much higher percentage of first class tomatoes. Some expense was also saved in irrigation since the tap roots of the plants were allowed to develop normally, never being injured by removal from the plant bed or during the transplanting operation. Tomatoes are normally a deep-rooted plant, and when these tap roots were allowed to develop without interruption, they grew to a greater depth in the soil and showed less signs of wilting if irrgation was delayed.

During the 1948 season in the Sacramento area of California the spring weather was so wet and disagreeable that it was impossible to get into the fields until six weeks after the regular planting date. The tomato plants

in the plant beds were larger than was normally desired for transplanting but they were used in an effort to make up for the late transplanting date. Some direct seeding was done with coated seed at the same time the plants were set in the field. The transplanted fields did come into bearing about a week earlier than the direct-seeded fields but the direct-seeded fields outyielded the others and continued to yield better fruit longer. The plants developed from the transplants were more or less prostrate in their growth and a large percentage of the tomatoes ripened on the ground and were subject to mildew and rot. The amount of disease in the transplanted fields was very pronounced. Nearly all the plants which were set out had been topped and the roots shortened. This topping and root amputation, spread diseases among the plants and whole fields were infected with virus diseases.

It was thought that the shock of transplanting would delay the plants about a week or ten days. Actual experience has shown that it takes never less than two weeks, and sometimes as long as six weeks, for a plant to recover after being transplanted. Experiments were tried with the so-called "green wrap" tomatoes. These tomatoes are planted so that the fruit can be picked during the last part of September and October to be shipped to eastern markets after the eastern crop has been frosted. Normally, the plant beds for this crop are planted during the middle of April and the plants field-set during the latter part of May and early June. In the experiment, the plant beds were planted as usual and two weeks later the direct seeding was done. The direct-seeded tomatoes came into bearing four weeks ahead of the transplanted tomatoes and the first two pickings were sold to canners. The actual gain from the use of direct seeding was six weeks, showing that it took the transplanted plants six weeks to overcome the shock of transplanting.

The production of carrots from coated seed is another crop which is receiving considerable attention. Carrots are normally planted with what is commonly called a spread shoe. An effort is made to scatter the carrot seed in the band about $4^{1/2}$ inches wide. One band is placed on each side of a regular bed. Very poor distribution of the seed is obtained since the seed is quite light and it does not scatter well in the band. Some commercial carrot growers figured that if they could plant one carrot seed each inch or inch and one-half in the row, and have the rows spaced from one to two inches apart, their yield would be materially increased. Several large growers developed their own planters to handle coated seed in this manner. Their yields were increased at least 50% and the culls left on the fields were reduced by 85 to 90%.

The use of coated seed in the growing of onions is receiving considerable attention. Market gardeners who grow onions for bunching purposes want to plant in a manner similar to that used by the carrot growers. Growers of dried onions are obtaining better yields of more uniform-sized onions by accurate spacing of the seed in the row with the use of coated seed. In some areas, particularly the winter onion area, transplanting has been practiced. The cost under present day labor conditions amounts to about $30.00 per acre to have onions transplanted and the plant population after transplanting is seldom as large as desired.

Almost immediately after the seed coating idea was developed, the thought of adding various materials which might affect the germination of the seed or the vigor of the seedling was advanced. Experiments to date have failed to show a significant benefit to be derived from the use of the various plant foods or growth regulating chemicals. Most agronomists are of the opinion that the roots, as sent out from the seed, do not serve to nourish the plant until all of the plant food available in the seed has been used. Unless the coating material is unduly thick on the seed, any material incorporated in the coating will have no effect on the plants' growth. Neither food nor moisture is absorbed by the loots until the cotyledon appears above the ground.

The use of toxins, such as the fungicides and insecticides, does have a definite place in seed coating. It was established quite early that the seed coating developed to overcome the objections found with the use of a binder did have some fungicidal power inherent in itself. This coating material is 80% as effective as most fungicides. The amount of protection given by the coating alone would probably be sufficient to give a stand except under the most adverse conditions. However, in order to secure more definite protection and to meet the most adverse conditions, additional fungicides can be added to the coating without injury to the seed. Some of the metallic fungicides have proven toxic to the seed or seedling. The organic materials can be used in much larger dosage when combined with the coating than is recommended by the manufacturers for application to uncoated seed. The newer organic insecticides, such as DDT, BHC and Chlordane, have proved quite effective in the protection of the seed and seedling against soil insects and worms. These insecticides can be incorporated in the coating and experiments to date indicate that an adequate dosage has no adverse effect on the growth of the plant from the seed.

The general use of coated seed by the truck crop growers and market farmers is somewhat contingent on the development and widespread distribution of precision planters and weed control measures. Considerable advance has been made in the production of precision planters. Several planters on the market at the present time do a fair job. There is still room for a simple, inexpensive planter which can be used for planting coated seed and, with minor changes, for planting seed that is large enough not to require coating for precision planting. This field is being invaded by new firms and some of the new models look very promising.

When precision planters are generally available, potential users of coated seed will need to be instructed in planting techniques. It has definitely been shown that emergence is retarded by packing the soil over the seed. All agronomists agree that, in order for the seed to take up sufficient moisture to germinate properly, the soil must be held firmly around the seed. The present press wheels and methods of packing the soil around the seed are at fault since the pressure is applied on the top of the soil and very little is transferred to the area containing the seed, particularly if the planting is made at a depth of one inch or more. With the use of coated seed the packing becomes unnecessary providing the seed bed is firm. The coating material itself serves as the soil packed around the seed to conduct the moisture to

the seed. Coated seed plantings should be covered with loose soil. This permits ready emergence and the water-hungry coating pulls the moisture from the soil without having to be packed tightly. The furrow former, as developed by the Beet Sugar Development Foundation, is, in our opinion, one of the most noteworthy improvements in planting equipment to be developed *in* the last half century. With this type of furrow former the soil is compacted *in* the bottom of the furrow and, with the use of the proper method of covering the seed with loose soil, ideal emergence conditions are created.

The weed control problem is being given attention by the companies which supply chemicals to the agricultural industry. Several good herbicides are available but their proper application needs further study and experimentation. In the not too distant future, many of the row crops requiring considerable hand labor at present will be grown without any labor except for irrigation and pest control.

The idea of pelleting range seed to facilitate the reseeding of large areas has been under consideration for some time now and with some measure of success; however, not of the order even remotely suggesting a commercial product. This lack of success is due probably to the fact that it was thought initially that the idea involved merely the formation of a pelleted seed mass. More recent investigation has shown that on the contrary a number of factors are involved both as to the pelleting material to be employed and the manner of forming the pellet. Experiments embracing these more recent developments are now under way and it is expected shortly that it will be found that this entire problem will have been solved.