UPGRADING PHYSIOLOGICAL QUALITY OF SEED LOTS 1/

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Often the stage is reached in the processing of seed where all of the contaminants, such as weed seed, other crop seed, and inert material have been removed. Yet, the quality of the seed lot may still be below par because the germination percentage is sub-standard or for other reasons. In such situations, the processor may still have several possibilities for improving the overall quality of the lot.

In order to use specific items of processing equipment to improve germination, the processor must be aware of those seed characteristics associated with the physiological quality of seed. These include: seed size, shape, condition of seed coat, specific gravity, and color.

When seed size is used as a basis for improving quality, the processor must first determine which size range of seed must be removed. Generally, the smaller seed are lowest in quality, but this relationship does not always hold. For example: in crimson clover, the extremely large seed are lowest in quality; in white clover, the small seed are lowest in quality; while in red clover, both the extremely large seed and small seed are lower in quality than the seed of intermediate size (Figure 1).

When sizing seed to upgrade quality, two machines are available to the processor. There are more than 200 different sizes and types of screens that can be used in various combinations for sizing of seed with an air-screen cleaner. Often, sizing for quality can be accomplished at the same time contaminants are being removed. The precision grader (width-thickness grader) has also traditionally been used to size-grade seed for quality. Seed are sized for width by using cylindrical screens with round hole openings and sized for thickness by using cylindrical screens with oblong openings. It is desirable to use test screens to determine the percentage of the seed lot that must be removed to obtain the desired quality level in the seed lot.

In recent years, spiral separators have been used to upgrade seed quality in soybeans. The basis for this operation is a difference in the shape of the seed. Diseased and immature soybeans are not as round as mature, healthy seed. This provides a basis for removal of the low

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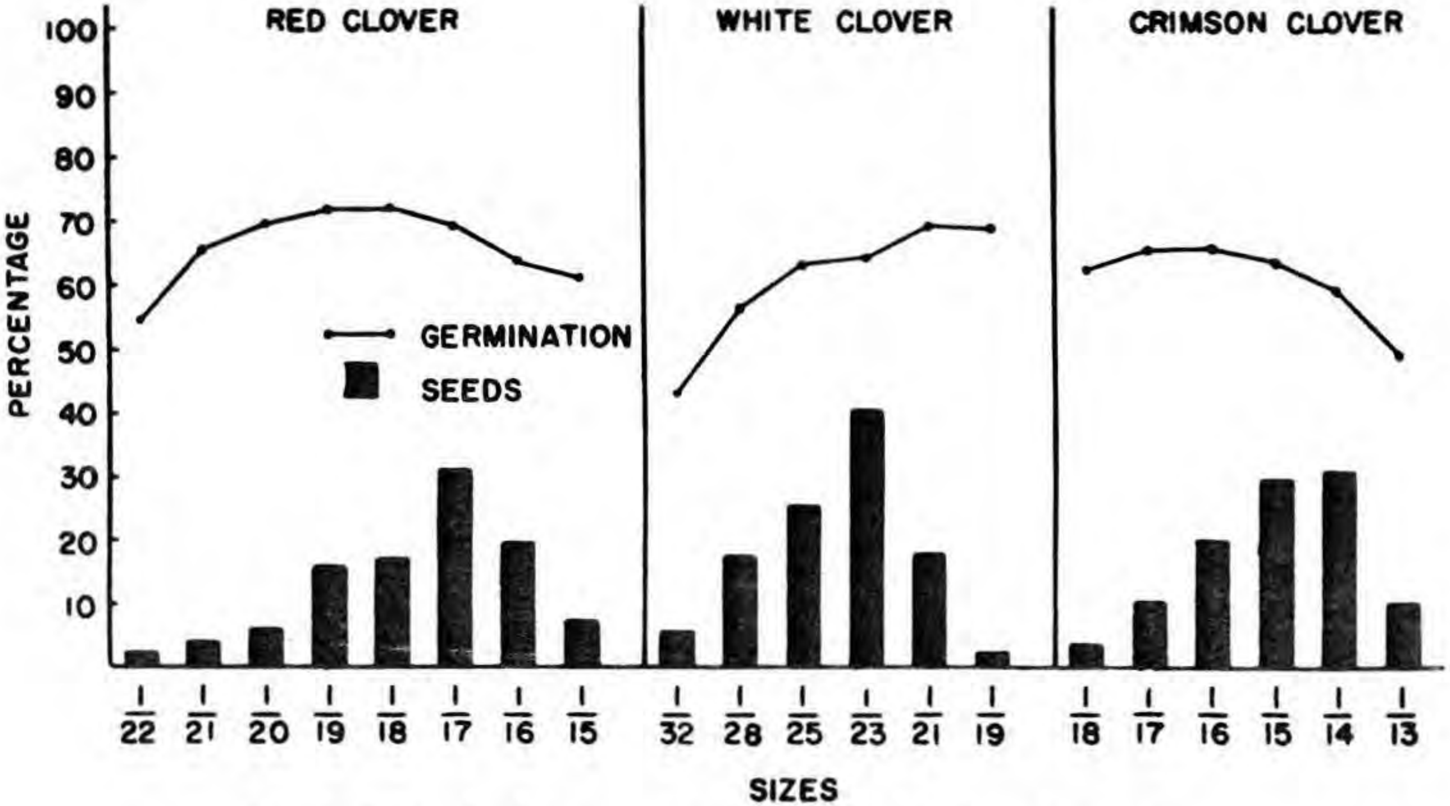

Figure 1. Relation of seed size to germination of red clover, white clover and crimson clover (line graphs), and distribution of seeds among different size classes (bar graphs).

quality seed from the lot with a spiral separator, thereby upgrading the quality. Improvement in quality is dependent upon the percentage of malformed seed removed.

Mechanical damage, resulting in cracks in the seed coat, affords opportunity for upgrading quality, particularly in small-seeded crops, such as the small-seeded legumes. Both the magnetic separator and the roll mill can be used for removing seeds with breaks or chips in the seed coat. Seeds that are damaged mechanically have lower germination percentages than non-damaged seeds.

Another way in which the quality of a seed lot can be improved is by the use of a specific gravity separator. There has been much research work that has demonstrated a close and consistent relationship between specific gravity and viability and vigor (Figure 2). For example, gravity grading can be used to great advantage in upgrading quality of acid-delinted cottonseed.

Some recent work by Seed Technology Laboratory Personnel provides an example of how a specific gravity separator can be used to upgrade quality. Nineteen lots of acid-delinted cottonseed, including nine varieties grown in six states, were gravity-graded into ten fractions each, according to discharge position, by use of an Oliver Model 160 gravity separator. Twenty physical and biological measurements were made on samples from each position to determine their interrelationships, the effectiveness of the gravity separator in upgrading seed quality, and to identify and characterize associations between specific physical and biological seed parameters.

The gravity separator graded the seed into fractions according to differences in volume and total weight of individual seed, which appeared to be the major factors contributing to bulk density. Differences among the fractions were most easily measured in terms of their bulk density (weight per bushel). Seed of lowest bulk density discharged from the lowest side of the deck, and bulk density increased as sample or discharge position moved toward the high side of the deck.

Viability and vigor, as indicated by germination percentage of both untreated and treated seed, cold test reaction, field emergence, and accelerated aging response, followed the same trend as bulk density, i.e., lowest germination-emergence was obtained from the lightest bulk density seed discharging at the lowest side of the deck, and increased as discharge position moved toward the high side of the deck in proportion to the increase in bulk density (Figure 3). The only difference was a slight decline in germination-emergence of the heaviest fraction of seed discharging from the highest position on the deck. Bulk density was positively correlated with the various germination-emergence parameters. Specific gravity and compactibility of the seed were not closely correlated with the other test parameters and varied only slightly with sample position.

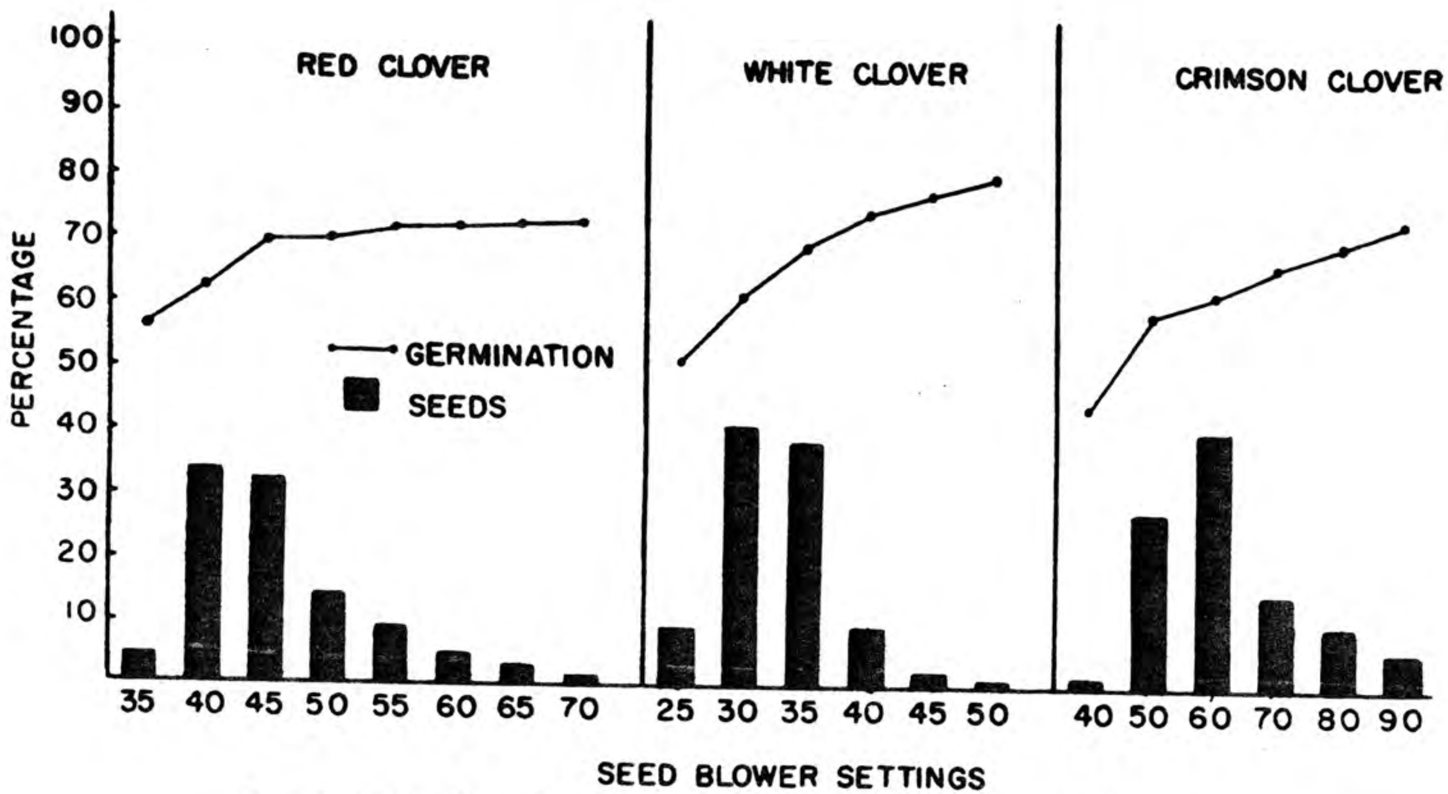

Figure 2. Relation of specific gravity to germination of red clover, white clover and crimson clover (line graphs), and distribution of seeds among different specific gravity classes (bar graphs).

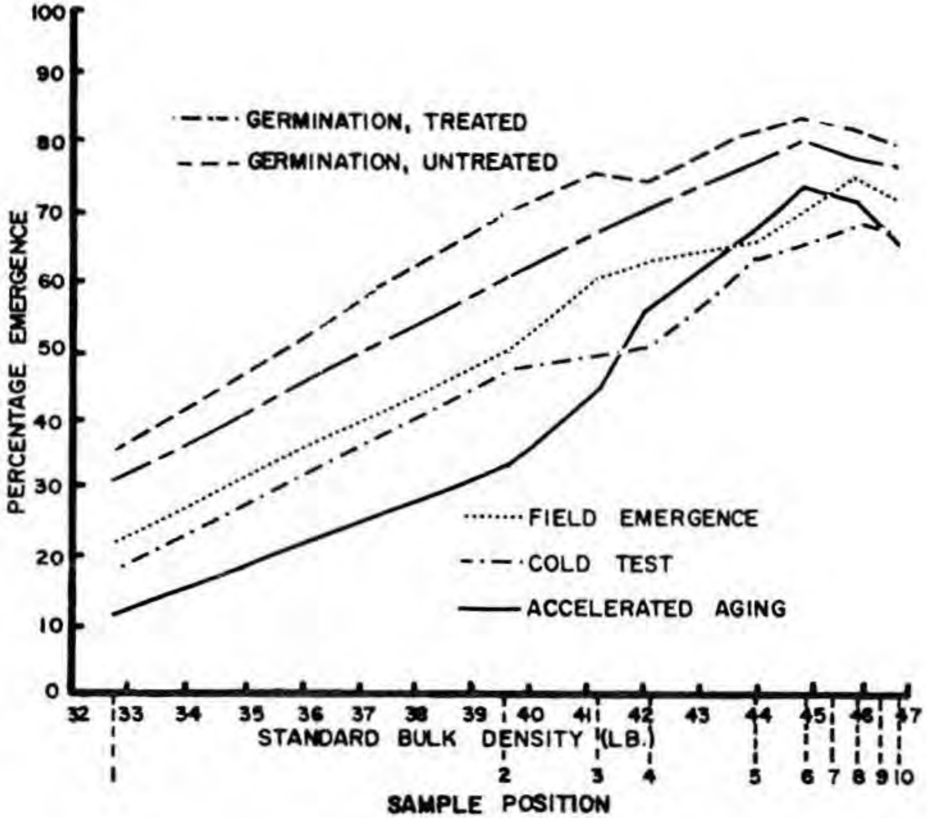

Figure 3. Comparison of emergence from seeds of different standard bulk density in germination tests of treated and untreated seed, cold tests, accelerated aging tests, and field emergence tests.

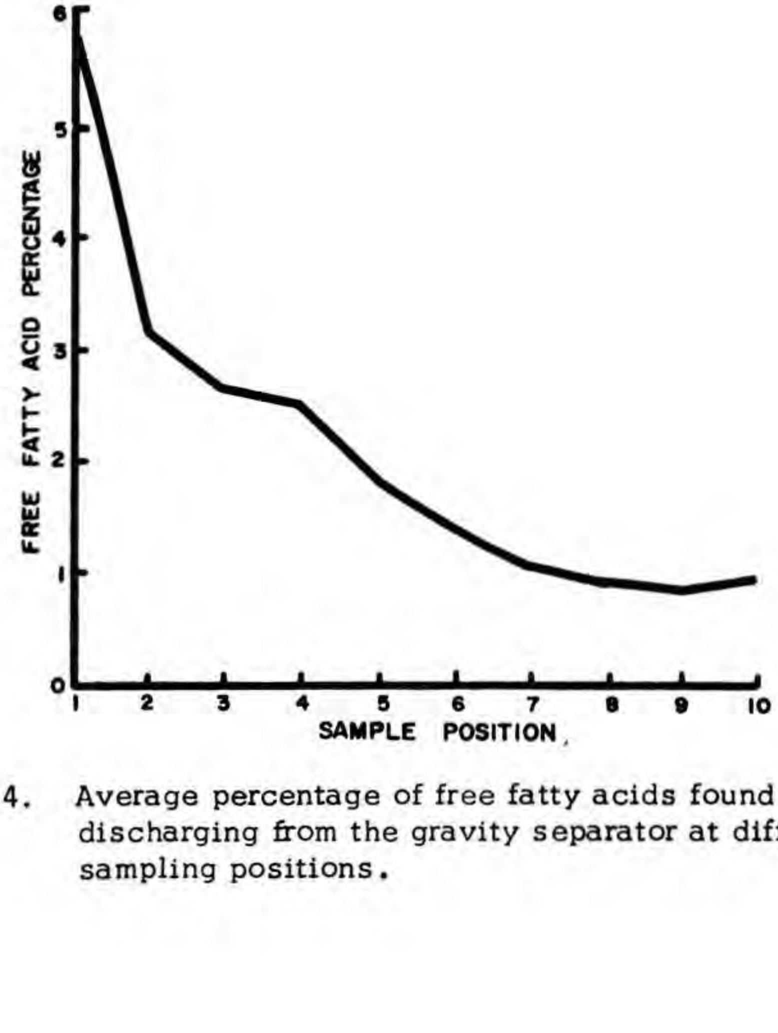

Figure 4. Average percentage of free fatty acids found in seed discharging from the gravity separator at different sampling positions.

Average length of seedlings and dry weight of radicle-hypocotyl axes and cotyledonary leaves, seven days after planting, generally increased with increasing bulk density.

Free fatty acid content was highly and negatively correlated with both bulk density and germinability (Figure 4). It was highest in seed from the low sample positions and decreased to minimal values in seed from sample positions 8 and 9. There was slight increase in free fat acidity in seed from sample position 10, corresponding to the slight decrease in germinability of seed from that position. Seed from different lots with a given free fatty acid content varied considerably in germinability; however, a high fatty acid content was consistently associated with low germinability and bulk density.

Incidence of mechanical injury was highest in seed of low bulk density from the low side of the gravity separator deck, and declined to a minimal level in seed from sample positions 6 to 8, after which it slightly increased. However, the percentage of injured seed among sample positions did not parallel either bulk density or germinability closely enough to produce high correlation coefficients.

Based on these results, acid-delinted cottonseed with bulk density below 42 pounds per bushel should be rejected during gravity grading of a seed lot and diverted to commercial use. In this manner, the accepted fraction of the lot would generally germinate above 80%. For higher quality seed, the rejection point should be about 44 pounds per bushel, and the very heaviest seed discharging from the extreme high side of the gravity separator deck should also be rejected.

Recent work at Texas A & M produced generally the same information; however, two other ways in which gravity-grading can improve seed quality were identified. First, the heaviest seed within a gravity group gave consistently higher yield than the lightest seed in that group. Second, seed density exerted a strong influence on the earliness of germination. High density seed, on the average, emerged first. It has also been shown that the first seed to emerge contribute more to yield than those that emerge later.

The trends reported here with cottonseed have also been found with other crops. For example, significant increases in germination percentages have been obtained in sorghum and millet with the use of a specific gravity separator.

Another machine that can be used to great advantage for improving seed quality is the air separator. Air separators are widely used in seed processing as separate systems or structurally incorporated in other cleaning devices. Indeed, air separation systems have been so well integrated in other separators that they have almost lost their identity. The basic seed cleaner, the air-screen machine, has one, two, three, or more air systems that assist in the separation made by these machines.

Air separators - as considered here - can be classified as pneumatic separators, aspirators, and scalping aspirators. Although these three types of air separators are different in appearance, they utilize the same principle of separation.

Air separators are used in three different and distinct ways:

1. General cleaning: Air separators are widely used to clean seed by removing dust, chaffy inert material, pieces of broken seed, immature and shrivelled seed, and other light contaminating material. Air systems in an air-screen cleaner perform this type of general cleaning operation.

2. Specific separations: In some cases, an air separator can be used to remove a specific contaminant that was not removed by previous cleaning operations. The seed mixture should be closely pre-sized before the air separation is attempted.

3. Close grading: Air separators are used to "grade" seed for density or volume weight. Removal of lightweight seed or insect damaged seed from grass, grain, vetch, or cotton seed increases bushel weight (volume weight) and may upgrade germination. The effectiveness of this separation depends on the purity of the seed to be upgraded. For best results, the seed should be thoroughly cleaned on other machines before the final air separation is attempted. It is this close grading that offers the greatest possibilities for improving seed quality.

In a study conducted several years ago, the air separator proved to be an effective machine for improving the germination of various clover seed lots (see Figure 2). Specific gravity, as determined by an air separator, was consistently related to viability. An increase in specific gravity of the seed was accompanied by an increase in germination percentage. The range in average germination percentage from seed of low specific gravity to seed of high specific gravity was as follows for the different crops in the study: red clover 15.9%, white clover 29.3%, and crimson clover 30.0%. The greatest difference in germination percentage between any two specific gravity groups always occurred between the lightest and second heaviest specific gravity group.

The color of seed is another seed characteristic that can be used to upgrade quality. In many seed kinds, as seed deteriorate, they darken in color (Figure 5). By removing the darker, more deteriorated seed within a lot, seed quality may be improved. Color sorters, therefore, have a great potential in providing the processor with the capability for improving the quality of seed lots. Electric color sorters have potential application in three areas of seed processing: research, purification of seed stocks, and upgrading seed quality. Specific data from five different applications show that the color sorter is an effective tool in upgrading seed quality. These are:

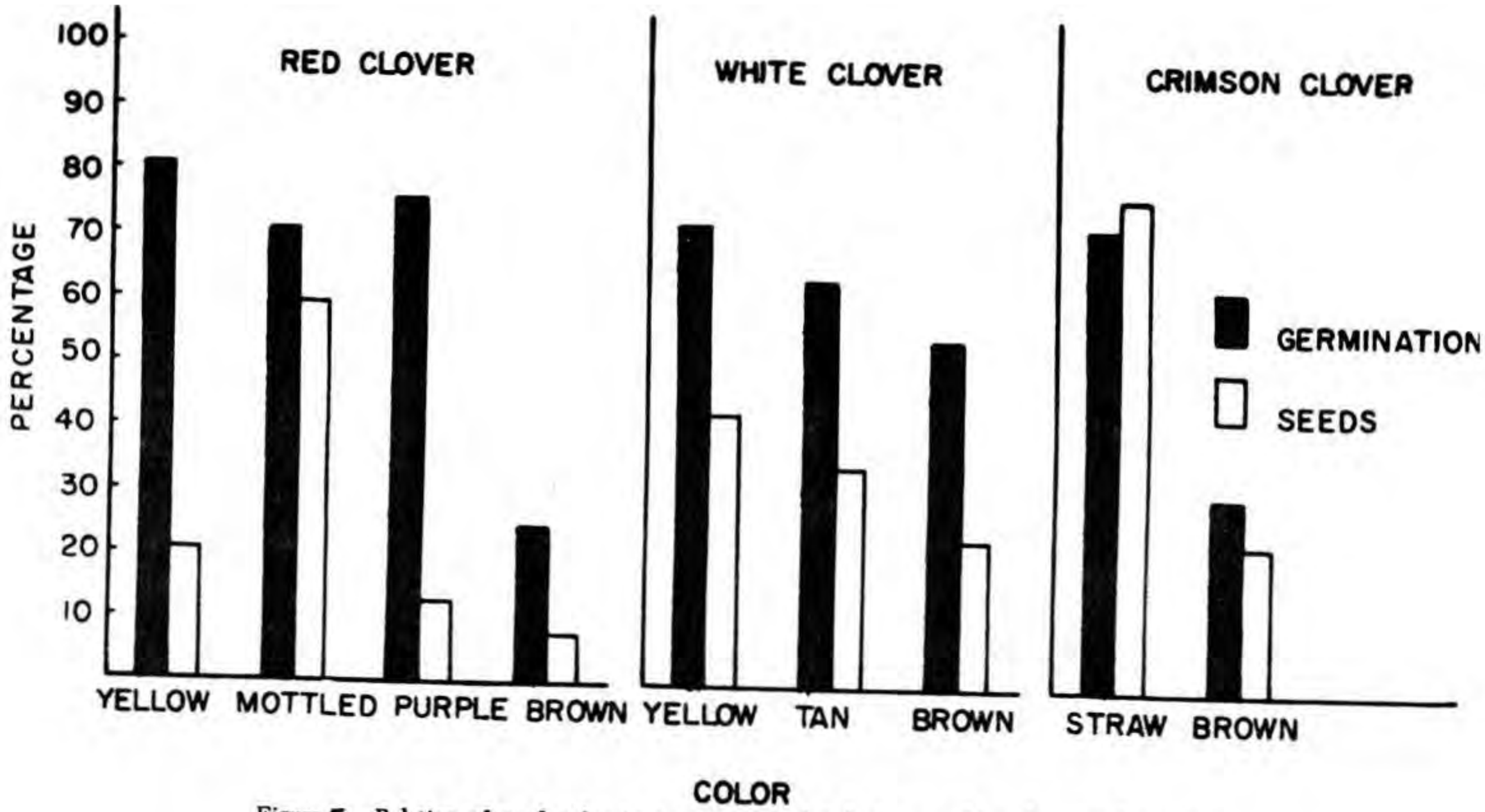

Figure 5. Relation of seed color to germination of red clover, white clover and crimson clover (shaded bars), and distribution of seeds among different seed color classes (unshaded bars).

Damaged Corn Seed - Four lots of corn seed, two white-seeded and two yellow-seeded, were mechanically damaged by passing the seed through a Crippen Model Scarifier. After mechanical treatment, 5-pound samples of each lot were briefly soaked in a 0.1% solution of fast green to stain damaged areas on the seed. The effectiveness of the color sorter in separating the mechanically damaged, stained seed from undamaged, unstained seed was then evaluated.

Standard germination percentage of the acceptable (undamaged) seed was 1 to 6% higher than that of the composite, and 5 to 21% higher than that of the rejected seed. The effectiveness of color sorting for removal of damaged seed was even more evident when cold test germination results were considered. The accept fraction had a cold test germination 22 to 29% higher than the reject fraction. These data indicated that color sorting after pre-treatment of the seed with fast green was effective in removing mechanically damaged seed and upgrading both standard and cold test germination percentages.

Mechanically Damaged Soybeans - A lot of Lee soybeans was obtained from Foundation Seed Stocks at Mississippi State University. These seed had been damaged at harvest by excessive threshing cylinder speed. Normal processing procedures could not remove the seed with cracked seed coats, broken cotyledons, and fractures extending into the cotyledons. Also, there was not enough color difference in the damaged areas for detection with electric color sorters. To induce a color difference, the seed were immersed in a solution of indoxyl acetate, removed immediately, and placed in an electric dryer where ammonia fumes, introduced into the intake air stream of the dryer, developed a blue-indigo stain on the damaged areas of the seed.

After drying, the seed were processed on a color sorter to remove the stained seed. Germination percentages of the original and stained seed before sorting indicated a reduction in germination of 12%. This reduction was caused by the staining and drying processes. The damage, however, appeared to be more attributable to seed coats sloughing off from wetting and drying than to any toxic effect of the indoxyl acetate. After electric color sorting, the "accepts" germinated 98% and rejects germinated 36%.

Green Seed from Lee Soybean Seed - Four lots of Lee soybeans that contained 18 to 36% "green" colored seed were obtained from seed stocks in the Seed Technology Laboratory. Seed of Lee are normally buff colored, but in some seasons, some of the seed of Lee and other varieties retain a green color in the cotyledons. It is not known what prevents the cotyledons of these seed from changing to the normal, light yellow color during maturation.

The green seed were separated using a color sorter and germination tests were made to determine if there was any difference in the quality of the green and normal colored seed. The normal buff colored seed germinated 22 to 32% higher than the green seed. These results indicated that there is a pronounced difference in germinability of the buff colored and green seed and that a color sorter can separate them and upgrade germination.

Weathered Cowpea Seed - Two lots of cowpeas were obtained from Foundation Seed Stocks, Mississippi State University. One lot, Bunch Purplehull, a white-seeded variety, had been moderately weathered, while the other lot, Mississippi Silver, was more uniformly damaged by frequent showers and humid weather at harvest time. Both lots failed to meet minimum germination standards for Foundation seed (80%).

Weather damaged seed were removed from both lots and germination tests run on each separately. the germination of the Bunch Purplehull lot was increased from 68 to 84% with a loss of 34% of the lot, and thus qualified as Foundation class seed. Germination of the Mississippi Silver lot was increased only 6% with a loss of 28% of the lot. It did not meet standards even after sorting. The electric sorter performed well where there was a visible difference due to weathering. However, when weathering was severe and uniform, effective separation was not possible.

Deteriorated Clover and Alfalfa Seed - Lots of crimson clover and alfalfa seed were separated into three fractions in two passes through a color sorter. On the first pass, the lightest colored seed (light) were rejected. The accept fraction was further divided by the second pass into rejects (tan seed) and accepts (brown seed).

Germination of crimson clover seed was increased by 8 to 18% over the composite at the expense of seed losses of 24 to 42%. The light colored seed separates germinated 30 to 67% higher than the brown seed separates. Color sorting alfalfa seed increased germination by 11 to 20% over the composite at the expense of seed losses of 26 to 49%. The light colored seed separates germinated 20 to 67% higher than the brown colored seed separates.

The electric color sorters can be a valuable tool for research and commercial processing. They are extremely versatile and accurate when operated properly. Their principal disadvantages are high cost, low capacity, and the need for some specialized training for operators.

A successful processor, then, should look beyond the removal of contaminants in normal cleaning operations to operations that will help in improving the overall quality of the seed.