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Title: Effect of Lot Size on Lot Uniformity in *Lolium* *spp.* Seed

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Studies were conducted to determine the uniformity of three commercial seed lots of ryegrass (*Lolium* *spp.*) and the effects of lot size on lot uniformity. Individual bag-samples were taken from each seed lot. Factors considered were percentage purity, annual ryegrass, perennial ryegrass, weed, other crop, inert matter, and germination. Number of rattail fescue (*Festuca* *myuros*) seeds and number of orchardgrass (*Dactylis* *glomerata*) seeds in a purity sample were counted, and number of noxious weed seeds were also totaled.

Uniformity in 30,000 kilogram lots was measured by an H-test, heterogeneity value, state seed law labeling tolerance tables, and by a Chi-square test for homogeneity of a binomial distribution on each sub-lot. Subdivisions of each seed lot were examined for uniformity by use of an analysis of variance test. The analysis used within sub-lot variance of lot size approximately 1,500 kilograms as an acceptable

level of variation and used an analysis of variance test to examine variance among sub-lots of approximate size 1,500, 3,000, 6,000, and 12,000 kilograms.

The greatest potential for violation in labeling and non-uniformity in ryegrass seed lots was found in percentage perennial ryegrass and annual ryegrass factors calculated by formula from fluorescence. Changing seed lot size had no effect on lot uniformity. Reducing the lot size below the current 24,947 kilogram limit did not significantly reduce the number of violations in labeling. Fewer violations were found in high purity seed lots than in low purity seed lots.

Effect of Lot Size on Lot Uniformity
in *Lolium spp*. Seed

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INTRODUCTION

Lot uniformity is an important concept in seed production, processing, handling, and marketing stages of the seed industry. Lot uniformity is a basic requirement in the seed business, and is required by law.

> Lot of seed--The term 'lot of seed' means a definite quantity of seed identified by a lot number, every portion or bag of which is uniform, within permitted tolerances, for the factors which appear in the labeling. (Federal Seed Act)

Failure of a lot of seed to be uniform in the legal definition, has been a topic of concern to seed handlers for many years. Non-uniformity in seed lots can cause many problems in commercial trade. For example, when a seed lot moves in interstate commerce it may be retested by another state regulatory agency. If the analysis in a retest does not agree with the original test results for factors labeled on the seed lot within a specified tolerance, the seed lot is in violation of the Federal Seed Act pertaining to a lot of seed and a "stop sale" is placed on the lot. This situation is compounded when the seed of a non-uniform lot is divided during the marketing process and bags within the seed lot are sent to different seed dealers for resale. When this occurs, portions of the original seed lot found at different locations are subject to retest. Test results on each bag or sub-lot must, by law, agree with the label placed on the original lot. Retesting should present few problems if the original lot was uniform in accordance with the legal definition of a lot.

Seed lots found to be in violation of labeling laws are the responsibility of the seedsman who labeled and shipped the seed. Failure to provide a seed lot of proper uniformity may result in seed being held from market by a "stop sale" order, returned to shipper, fines for mislabeling a seed lot, discontented customers, and possible future lost sales in this particular area.

Prior to 1974, there were no maximum limits on seed lot size in Oregon. In 1974, the Oregon State Department of Agriculture set a maximum lot size of 29,937 kilograms on most grass seed types to reduce lot variability. In 1975, the lot size was further reduced, by the Oregon State Department of Agriculture to 24,947 kilograms. This regulation was based on the following assumptions: (a) smaller lots would have less variation within the lot, (b) there would be fewer sub-lots or bags for seed law labeling comparisons, (c) seed lots would more likely represent seed from one field, and (d) the label would more likely represent the seed lot.

Most seedsmen are aware of the problems that non-uniformity in seed lots create and try to avoid practices that contribute to non-uniformity. Seedsmen try to maintain a good reputation for supplying high quality seed for the consumer. When a non-uniform lot is found, it reflects unfavorably on the seed trade and the seed grower.

Some advocate reducing the maximum size of a seed lot below the current 24,947 kilogram limit as a means for additional uniformity within a lot, but seed handler units costs are increased as lot size decreases. Seed tests, lot labels, and handling costs are greater per kilogram as lot sizes decrease. There is need to determine if further decreases in lot size will improve lot uniformity and reduce infractions of seed law on labeling.

No studies have been conducted to evaluate the effect of reducing seed lot size on uniformity of seed lots grown in large fields and processed in large lots as in Oregon. Ryegrass, (Lolium spp.), one of the more important seed crops in Oregon, was chosen for this research.

The objective of this study was to evaluate the effect of reducing lot size on the uniformity of commercial ryegrass seed lots. Established homogeneity tests and statistical tests were used to measure the effect of lot size on uniformity.

LITERATURE REVIEW

Distribution of Weed, Inert, and/or Other Crop Seeds in a Seed Lot

Leggatt initiated much of the work and research in distribution of weed and other crop seeds in seed lots.

Leggatt (1935) sampled 98 sacks of _Phleum pratense_ on an individual basis, obtaining approximately 7 gram samples for determination of total weed seeds and approximately 14 gram samples for determination of total noxious weeds. Each bag-sample was kept separate for laboratory analysis. Observed and expected results were then compared by means of Chi-square tests. Results confirmed that weed seed distribution was in agreement to the Poisson distribution.

Bulk lots of _Melilotus alba_, _Trifolium pratense_, and _Medicago sativa_ were generated to contain 1, 7, 10, 15, and 50 percent stained seeds. A bulk lot of _Poa pratensis_ was also prepared containing ten percent stained seed (Leggatt, 1936). Each bulk lot consisted of only a few kilograms. In each bulk lot examined, at least 1,000 samples, drawn at random, containing 100 seeds each were examined for number of stained seeds present. Theoretical binomial curves and corresponding Poisson curves were calculated. Data from this study showed that the sampling error follows the binomial distribution where the impurity is of the same size and weight as the pure seed.

Leggatt (1937) prepared a bulk lot of *Poa compressa* in which ten percent inert matter was stained red and added to the pure seed. Inert matter in this test consisted mainly of empty glumes. From this bulk lot, 1,000 samples of 100 seeds each were drawn at random and analyzed. Theoretical binomial curves and Chi-square tests were in agreement to earlier tests by Leggatt (1936). In a further test, ten percent by number of *Trifolium hybridum* seeds were added to a bulk lot of *Melilotus alba*. From this bulk lot, 5,000 samples of 100 seeds each were drawn at random by use of a sampling machine. In this test of *Trifolium hybridum* seed in *Melilotus alba*, the distribution did not follow the binomial curve. Leggatt formed the hypothesis that seed lots containing different size seeds in mixture tend to encourage smaller seeds to associate in clusters. The mean cluster size being determined by the relative sizes of the seeds in question.

Leggatt (1939) tested the cluster hypothesis by preparing larger bulks of *Trifolium pratense* and *Phleum pratense* with weighed quantities of *Amaranthus retroflexus* and *Camelina microcarpa* added to these bulk lots. The bulk lots were mixed and then divided into 100 gram samples. Working samples of 14 grams for *Trifolium pratense* and seven grams for *Phleum pratense* were obtained and analyzed to determine number of weed seeds. There were 472 samples of *Trifolium pratense* and 816 samples of *Phleum pratense* analyzed. Data from these tests substantiated the cluster theory in which cluster frequencies instead of individual seed follow the theoretical Poisson or binomial distribution in seed lots in which the admixture seeds are smaller than the substrate seed.

Woodbridge (1935) obtained 140 samples 1.83 grams each from a 255.9 gram bulk sample of Dactylis glomerata. Two sampling techniques were used in this test. Sixty samples were obtained from a mechanical mixer of the revolving funnel type and 80 samples were obtained by a pan method similar to a mixing basin. He found the distribution of Rumex seeds followed the Poisson distribution.

Przyborowski and Wilenski (1935) prepared a bulk lot of 100 kilograms of Trifolium pratense containing 2,000 Cuscuta seed dyed for easy identification. The seed was mixed, placed in a sack, and the seed was then transported by a four-wheeled wagon over a bad road for a distance of six kilometers. Five hundred samples of 100 grams each were then removed, beginning at the top of the sack and examined for Cuscuta seed. Data obtained in this study supports the theory that Cuscuta seed found in Trifolium pratense are distributed according to the Poisson distribution.

Shenberger (1962) prepared a 150 gram Red clover sample containing one Sorghum halepense, two Cirsium arvense, four Lepidium latifolium six Lepidium campestre, and nine Setaria faber. The prepared sample was mixed and a subsample containing 50 grams was obtained by use of a Boerner divider. This procedure was repeated until 48 examinations were obtained. Chi-square tests were utilized and data agreed with numbers expected from statistical theory.

Homogeneity Tests

Leggatt (1951) developed a test of homogeneity to describe uniformity with respect to numbers of weed or other crop seeds (foreign seeds) in a unit weight, germination percentages, and purity percentages. The Leggatt homogeneity test is a Chi-square test and measures the dispersion of observed values around the mean. Leggatt also suggested a table of uniformity limits (calculated for P=.05) for seed lots examined. No instruction was given as to sample size or number of samples to be examined in the determination of lot homogeneity.

Miles, Carter, and Shenberger (1960) proposed two new homogeneity tests. The short homogeneity test was proposed to be used to determine uniformity for number of foreign seeds (weeds or other crops), for germination, and for any component of a purity analysis. In the short test for homogeneity, analysis results obtained from individual bag-samples were compared with a table for "maximum ranges for homogeneity". The long homogeneity test was proposed to determine uniformity for number of foreign seeds, germination percents, and purity percents. The long test is an F-test and consists of dividing the variance of the samples by the maximum variance permitted in a homogeneous lot. The computed F-value is then compared to a tabulated F-value for determination of lot homogeneity.

Westmacott and Linehan (1960), working with seed purity, proposed a new measure of uniformity called the h value test which is a comparison of the observed variance to the theoretical minimum variance. They suggested that the Leggatt homogeneity test should be replaced with a test that measures the extent of heterogeneity, rather than a definite line between homogeneous and heterogeneous seed lots. They further suggested that limits of acceptability could best be determined through accumulation of data from seed lots being processed and h values being achieved by competent seed dealers.

Miles (1962) proposed the H heterogeneity value to determine uniformity of any component of a purity analysis, of percent germination, of number of weed seeds, or of other foreign seeds in a specified weight of seed. The H heterogeneity value is a comparison of the observed variance to the theoretical minimum variance minus one. Critical H values were to be determined from seed lots selected at random. Lots suspected of being heterogeneous should not be included in data used to determine critical H values. Miles, further suggested the sample size to test for this H heterogeneity value.

The H heterogeneity test, as prescribed by Miles (1962), was included in the 1966 International Seed Testing Association Rules (ISTA). In the test procedures, the heterogeneity value is a comparison of the actual variance to the expected theoretical variance minus one. Included in the test procedures are the number of bags to sample, sampling procedures to use, and the minimum size of the working sample. The object of this test is to measure the level of homogeneity within a seed lot.

Effectiveness of Available Tests

Miles, Carter, and Shenberger (1960), in a review of the 1956 International Rules for Seed Testing for seed lot homogeneity, (the Leggatt homogeneity test), reported that this test is unrealistic. They reported that this test assumes perfect mixing of seed which is unattainable and makes no allowance for within-bag segregation.

The Leggatt test also assumes working samples are obtained at random and seed analysts results are perfect. The authors reported that the rules allow for random variation only.

Westmacott and Linehan (1960), in a study to determine the effectiveness of the Leggatt homogeneity test, examined eight seed lots of Lolium perenne. Each bag was sampled within each seed lot and four working samples of 5, 10, 15, and 20 grams were examined for each submitted sample. Using the Leggatt homogeneity test, only one seed lot was classified as homogeneous. It was further shown that as the size of the working sample increased, there was a tendency for the homogeneity value to increase (less uniformity present in a seed lot).

Westmacott and Linehan (1960), evaluated 458 seed lots of Lolium perenne and 247 seed lots of Lolium multiflorum. A purity analysis was run on all submitted samples. The h value statistic for homogeneity was applied. For Lolium perenne, using an h value of 3.00, 75 percent of the lots are classified as uniform. For Lolium multiflorum, using an h value of 4.00, 72 percent of the lots are classified as uniform.

Linehan and Mathews (1962) studied 816 seed lots of Lolium perenne. Seed lots were tested for percentage purity and number of weed seeds. Using the H homogeneity test for percent pure seed, 81.8 percent of the lots had an H-value of less than 1.00. For number of weed seeds, an H-value of 1.99 would allow 76.3 percent of the seed lots to be classified as uniform. Linehan and Mathews also examined 349 lots of Lolium multiflorum for percentage purity, number of weed seeds, and awned seed content. H-values of 1.99 are required for percentage purity in Lolium multiflorum for 82.5 percent of the seed lots to be classified uniform. For number of weed seeds, an H-value of 3.99 would be required for 75.4 percent of the seed lots to be classified uniform. Finally, for awned seeds, an H-value of 4.99 would be required before 62.8 percent of the seed lots would be classified uniform in Lolium multiflorum lots. Linehan and Mathews also noted a correlation (r=.52) between H-values based on percentage purity and number of weed seeds on samples tested.

Thomson (1965) in a study of 75 seed lots of Lolium perenne and 46 seed lots of Lolium multiflorum, found 73 percent of Lolium perenne lots to have H-values of less than one for purity considerations. For Lolium multiflorum, 87 percent of the seed lots examined for purity showed H-values less than one. When germination levels were examined in Lolium perenne and Lolium multiflorum 75 and 89 percent of the seed lots, respectively were found to have H-values less than one. For weed seeds, Lolium perenne showed 72 percent of the seed lots with H-values less than two and Lolium multiflorum showed 72 percent of the seed lots with H-values less than one.

Tattersfield and Johnston (1970) studied uniformity in 41 seed lots of Lolium spp. They applied the H-test as prescribed in the 1966 ISTA rules. Samples were analyzed for pure seed, number of weed seeds, and for seed germination. For the purity test, 83 percent of the seed lots showed H-values of less than two. For germination levels, 88 percent of the seed lots showed H-values of less than 1.30. No critical H-value was suggested in this study. The authors did comment, however, that the amount of variability that is allowable will depend upon the average purity, the nature of the variability, and the purpose for which the seed is to be used.

Niffenegger (1967) prepared seed lots containing approximately 73,000 seeds per lot and then mixed lots to various levels of uniformity. Indicator seeds were used to determine variances between samples and homogeneity levels were compared by use of the Leggatt homogeneity test, the H-homogeneity test, the Miles _et al_. "long" homogeneity test, and the Miles _et al_. "short" homogeneity test. They concluded that the Leggatt homogeneity test led to more lots being declared heterogeneous, while use of the long and short homogeneity tests were the least severe. The H-homogeneity test could distinguish the level of uniformity, but only in cases when indicator seed concentrations in batches being compared were identical. Niffenegger suggested a modification in the H-homogeneity test for critical H-values to be: critical H=0.50 when $\bar{x}$=20; critical H=0.90 when $\bar{x}$=40. Niffenegger also found mixtures prepared on a laboratory scale with stained indicator seeds showed higher levels of heterogeneity for similar levels of mixing as the number of indicator seeds increased.

Bould (1975) reported on a study and distribution of the heterogeneity value H. Seed lots of _Triticum spp_., _Hordeum spp_., _Lolium perenne_, _Lolium multiflorum_, _Dactylis glomerata_, _Phleum pratense_, _Trifolium pratense_, _Trifolium repens_, _Brassica oleracea_, and _Beta vulgaris_ were studied over a period of eight year beginning in 1963. Seed lots were examined for purity, germination, and weed counts using the methods for the heterogeneity test as listed in the ISTA rules for seed testing. Bould presented a table of critical H-values

(values above which a seed lot may not be uniform) based upon this study and depending upon the number of bags sampled. Critical H-values ranged from 3.62 for five bags sampled in a seed lot to 1.01 for 30 bags sampled in a seed lot. The critical H-values were based upon a probability level of 0.001.

MATERIALS AND METHODS

Two seed lots of annual ryegrass (Lolium multiflorum Lam.) and one seed lot of perennial ryegrass (Lolium perenne L.) were selected and sampled for uniformity.

Selection of Seed Lots

The annual ryegrass lots represented different handling systems. Seed lot AR2 was from the 1974 harvest. The seed was harvested from four fields, placed in a storage bin, processed, then passed through a mechanical "mixer" with a capacity of 136,000 to 181,000 kilograms of seed per "batch" to help in blending the seed lot before bagging. The 29,937 kilogram seed lot was placed in 22.68 kilogram paper bags and stacked on pallets for winter storage. The lot was stored on pallets under plastic outside from July, 1975 until it was sampled in September, 1975.

Annual ryegrass seed lot AR3 was from the 1975 crop year and represented seed from one field. The seed had been rained on before harvest. This 24,947 kilogram seed lot was placed in 45.36 kilogram burlap bags and stored on pallets after processing. The seed lot was sampled in September, 1975.

The perennial ryegrass lot studied was selected because it represented seed from a field with recognized uniformity problems. This seed was from the 1975 harvest from a 'Linn' perennial ryegrass field that had passed the field inspection of the Oregon seed certification program. Lot PR4 was one of three lots from the same field bagged in 22.64 kilogram paper bags. This lot failed to meet the seed quality standards for certified seed because of excessive annual ryegrass. A second lot from this field was certified and shipped but was subsequently found to be in violation of state seed law labeling requirements in another state. A third lot from the field met certification standards for seed quality.

Successive sampling and testing of lot PR4 produced differing laboratory analysis (Table 1). Seedling root fluoresence varied from 6 to 24 per 100 seed germination test in the three laboratory examinations.

This preliminary information suggested that seed from this field was indicative of the problem of lack of uniformity within a lot. Samples were drawn from the 24,675 kilogram seed lot, PR4 in February, 1976. An average of six of 42 bags on each pallet in the lot were sampled.

Sampling and Analysis

All seed lots were sampled using techniques prescribed in the 1966 proceedings of the ISTA (Appendix Table 1). Representative samples of each bag sampled were taken using a 76-centimeter double-tube trier with nine slots.

Individual bag-samples were taken from the 29,937 kilogram seed lot AR2 representing 180 of the 1320 bags. One-hundred-thirty-five individual bag-samples were taken from the 24,947 kilogram seed lot AR3

Table 1. Comparison of results from three laboratories testing three separate samples of perennial ryegrass seed lot, PR4.

PR4	Sample 1	Sample 2	Sample 3	Average
Fluorescence[1]	14	24	6	14.7
Germination, %	93	95	94	94.0
Pure Seed, %	99.51	99.58	99.24	99.44
Perennial Ryegrass, %	88.76	78.14	97.54	88.15
Annual Ryegrass, %	10.75	21.44	1.70	11.29
Other Crop, %	.04	.08	.20	.11
Inert Matter, %	.25	.10	.32	.22
Weed Seed, %	.20	.24	.24	.23

[1]Number of fluorescent seedlings per 100 seed germination test.

with 550 bags. Individual bag-samples were taken from the 24,675 kilogram seed lot representing 150 of the 1088 bags produced in 1975, PR4.

In general, standard laboratory procedures were used in sample analysis following Association of Official Seed Analysts (AOSA) rules (1970). Exceptions were purity tests and all states noxious weed seed examinations which were run on approximately 2,000 seeds and 10,000 seeds, respectively, rather than the normal five and 50 grams. Germination and fluorescence tests were run on 100 seeds rather than the normal 400 seeds. In addition to pure seed, as specified by law, the proportion of annual ryegrass and perennial ryegrass was calculated from the percentages of fluorescence, nonfluorescence, and germination. The specific formula, by law and listed in the AOSA rules for testing seeds (1970) was used for making these calculations. All annual ryegrass and perennial ryegrass percentages reported in this study are calculated from this formula prescribed by AOSA rules. The 100-seed weight for each seed lot was established by random sampling (Appendix Tables 2-4). In making comparisons, it is assumed that the results from the modified procedures for purity, all states noxious weed seed examinations,[2] germination, and fluorescence tests would be the same as in the normal test procedures for the AOSA rules. Further, homogeneity test procedures used are those prescribed in the ISTA instructions for testing uniformity of seed lots (Appendix Table 1).

[2]A list of every seed prohibited or restricted for sale in any state in the United States of America.

A working sample for each bag-sample was divided using a Boerner divider to insure random selection. Each bag-sample of AR2 and AR3 was analyzed for purity, germination and fluorescence, number of all states noxious weed seeds, and number of rattail fescue (Festuca myuros) seeds. Each bag-sample of PR4 was analyzed for purity, germination and fluorescence, number of rattail fescue seeds, and number of orchardgrass (Dactylis glomerata) seeds.

A total of 465 individual bag-samples were drawn from the three lots. Each sample was analyzed for pure seed, annual ryegrass, perennial ryegrass, other crop, weed seed, inert matter, number of certain weed seeds, and germination. A total of 5,115 laboratory tests were conducted. These provided the basis for the homogeneity evaluation.

Study One

Individual bag-samples from the three ryegrass lots were analyzed for purity factors. Each purity analysis included percentage pure seed, annual ryegrass, perennial ryegrass, other crop, weed, and inert matter. It is assumed that the best estimate of the average analysis of the seed lot is the mean of all bags sampled and the best estimate is used for labeling.

Purity factors on individual bag-samples in each seed lot were compared to state seed labeling law requirements. Tolerance tables published in the AOSA regulations (1970) which are used by most state regulatory agencies were used as the basis for bag-sample uniformity tests.

Study Two

Individual bag-samples from the three lots were analyzed in accordance with instructions in the ISTA (1966) rules for evaluating lot homogeneity. Samples from each seed lot were divided into sub-lots to simulate divisions that might occur in trade channels. Lots of approximately 5,000 kilograms, 10,000 kilograms, 13,600 kilograms, from the original seed lot of 24,947 kilograms or 29,937 kilograms were compared. All purity factors were examined, as well as percent germination, and number of other seeds of certain weeds and other crop; rattail fescue in the purity analysis of all three seed lots and the orchardgrass seeds in the perennial ryegrass seed lot. For the two annual ryegrass seed lots sampled, the number of all states noxious weed seeds found in each 10,000 seed bag-sample were counted. For number of rattail fescue seeds, noxious weed seeds, and orchardgrass seeds, counts were also adjusted to a standard weight to account for weight differences present in working samples.

Each lot division was compared to given critical H-values from previous research on uniformity, and trends were examined to see if H-values changed as lot sizes decreased. A Chi-square test for homogeneity of the binomial distribution was used to examine purity and germination results for each sub-lot (Snedecor and Cochran, 1967). As in study one, average results for each purity factor were checked to determine if they met state seed labeling law requirements.

Study Three

Individual bag-samples from three seed lots of ryegrass were obtained and analyzed for all factors of purity, germination, and number of rattail fescue seeds in a purity sample. For the two annual ryegrass seed lots, the number of all states noxious weed seeds found in each bag-sample of 10,000 seeds were counted. In the perennial ryegrass seed lot, counts were made of orchardgrass seeds found in each purity test of 2,000 seeds. For number of rattail fescue seeds, noxious weed seeds, and orchardgrass seeds, counts were adjusted to a standard weight to adjust for weight differences present in working samples.

A systematic breakdown and examination of the bag-samples was made to determine the effects of lot size on uniformity (Figure 1). An analysis of variance test and the F-value was used to check for significant differences. A Chi-square test for homogeneity of the binomial distribution also checked each sub-lot for purity and germination results (Snedecor and Cochran, 1967).

The H-value for homogeneity was used to compare values for each sub-lot to a critical H-value. H-values were averaged for similar lot sizes and examined to determine if decreasing lot sizes improved homogeneity.

Average values for each sub-lot and purity factor were compared to the over-all average of the seed lot to determine the number of sub-lots in violation of state labeling laws (AOSA, 1970).

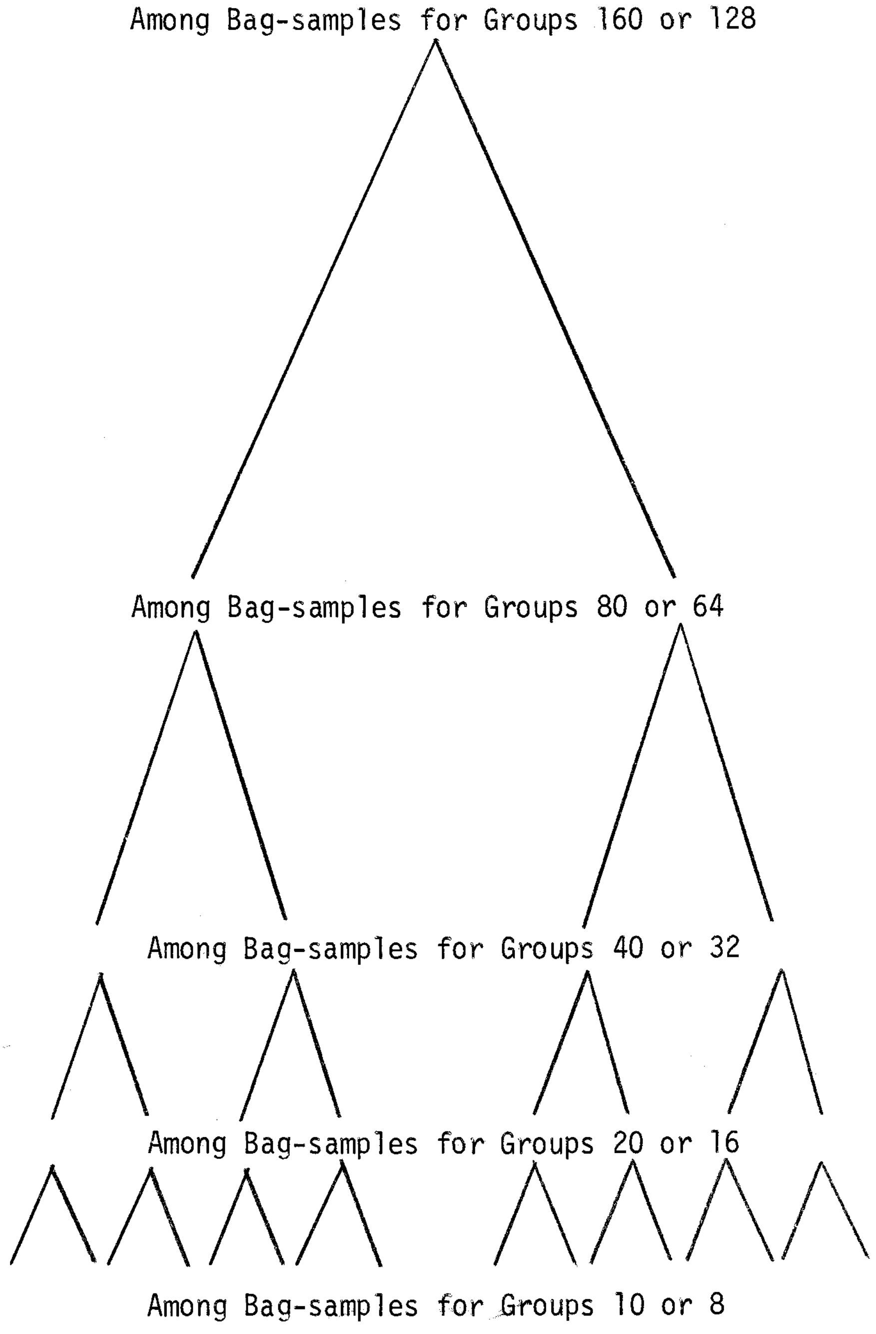

Figure 1. Procedure for systematic breakdown of bag-samples used for examining uniformity of sub-lots in study three.

RESULTS

Study One

All three seed lots had a high purity with respect to pure seed. The average pure seed percentages were 99.59, 99.50, and 99.11 in lots AR2, AR3, and PR4, respectively. The complete analysis for the three lots are presented in Tables 2 through 4.

Each purity factor for each bag-sample was compared to the average value for that factor for the entire seed lot. This comparison would be used by law enforcement officials checking bag-samples against the label value. Seed lots AR2 and AR3 showed approximately 50 percent of bag-samples tested in violation of seed law labeling tolerances for factors percentage perennial ryegrass and annual ryegrass. Lot PR4 showed 96 percent of bag-samples tested in violation of seed law labeling tolerances for factors percentage perennial ryegrass and annual ryegrass (Table 5).

Table 2. Statistical summary - seed lot AR2.[1]

	Pure Seed %	Ann. Ryg. %	Per. Ryg. %	Other Crop %	Inert Matter %	Weed %	Germ. %	Total Nox. Weed	Total Nox. Weed by Wgt.	Rattail Fescue	Rattail Fescue by Wgt.
MEAN	99.59	97.73	1.86	0	.23	.18	96.19	2.91	2.83	5.12	4.83
MAXIMUM	99.85	99.82	6.23	.02	.75	.64	100	10	9.61	15	14.47
MINIMUM	98.94	93.35	0	0	.05	0	89	0	0	0	0
Standard Deviation	.17	1.44	1.41	0	.12	.12	2.09	2.07	2.01	2.49	2.36
Chi-square	261.8**	3354.4**	3923.1**	71.6	236.4**	297.5**	213.1	NE	NE	NE	NE

[1] Sample size 180 bags

**Significance at one percent level

NE Not Examined

Table 3. Statistical summary - seed lot AR3.[1]

	Pure Seed %	Ann. Ryg. %	Per. Ryg. %	Other Crop %	Inert Matter %	Weed %	Germ. %	Total Nox. Weed	Total Nox. Weed by Wgt.	Rattail Fescue	Rattail Fescue by Wgt.
MEAN	99.50	98.41	1.08	.05	.22	.23	94.62	1.64	1.60	6.96	6.68
MAXIMUM	99.87	99.84	4.24	.33	.63	.69	100	8	7.77	25	24.37
MINIMUM	98.87	95.27	0	0	.05	0	85	0	0	0	0
Standard Deviation	.22	1.15	1.11	.08	.12	.16	2.46	1.94	1.88	5.74	5.52
Chi-square	268.2**	2286.5**	3080.8**	317.8**	172.0**	281.9**	159.1	NE	NE	NE	NE

[1] Sample size 135 bags

**Significance at one percent level

NE Not Examined

Table 4. Statistical summary - seed lot PR4.[1]

	Pure Seed %	Ann. Ryg. %	Per. Ryg. %	Other Crop %	Inert Matter %	Weed %	Germi. %	Orchard-grass	Orchard-grass by Wgt.	Rattail Fescue	Rattail Fescue by Wgt.
MEAN	99.11	12.56	86.56	.11	.39	.38	94.04	4.20	3.53	17.31	16.87
MAXIMUM	99.77	84.80	99.60	.46	.99	1.71	100	20	19.40	54	54.33
MINIMUM	97.70	0	14.66	0	.02	.02	86	0	0	0	0
Standard Deviation	.40	22.44	22.32	.10	.19	.31	2.85	4.44	4.29	13.38	13.09
Chi-square	529.9**	136675**	127578**	267.8**	284.2**	768.3**	216.2**	NE	NE	NE	NE

[1]Sample size 150 bags

**Significance at one percent level

NE Not Examined

Table 5. Percentage of individual bag-samples in violation of state seed labeling laws in study one.

	AR2	AR3	PR4
Pure Seed	0.6	0.0	7.3
Perennial Ryegrass	58.3	63.0	96.7
Annual Ryegrass	48.3	51.9	96.0
Other Crop	0.6	0.0	0.0
Inert Matter	0.0	0.0	0.0
Weed	0.0	0.0	4.0

Study Two

Each purity factor in each sub-lot was compared to the average value for that factor for the entire seed lot. This is the comparison used by law enforcement officials checking sub-lots against the label placed on the entire lot. Sub-lots of AR2 and AR3 were within tolerances used by seed law enforcement agencies. Sub-lots of lot PR4 would not meet label requirement tolerances for perennial ryegrass and annual ryegrass factors in 90.9 percent of the cases (Table 6).

In study two, seed lots were broken into sub-lots and sampled according to instructions in the ISTA (1966) rules for examining lot homogeneity. Corresponding H-values for each sub-lot were calculated and averaged for similar lot sizes. H-values for percentage perennial ryegrass and annual ryegrass were highest in all three lots. In seed lots AR3 and PR4, H-values appear to be lower at sub-lot sizes below 9,100 kilograms. This trend will be examined further in study three. The results of this test are shown in Tables 7 through 9. Figures 2 through 14 show graphically these relationships for all factors tested.

All sub-lots of all three seed lots were classed as non-uniform when a critical H-value of two was used for percentage perennial ryegrass and annual ryegrass in study two. Sub-lots exceeding this value in this test are declared heterogeneous. Table 10 shows the results for each analysis factor examined in each seed lot. Lot PR4 was the only seed lot showing sub-lots for factor pure seed being non-uniform. This was for 36 percent of the sub-lots. Lot PR4 also showed 73 percent of the sub-lots tested for factor of percent weed seed being non-uniform.

A Chi-square test for homogeneity of the binomial distribution determined the percentage of sub-lots for all purity factors and germination showing significant differences at five percent levels and one percent levels. All three seed lots showed 100 percent of the sub-lots being significant at the one percent level for factors of percentage perennial ryegrass and annual ryegrass. Lot PR4 showed 100 percent of the sub-lots for percentage pure seed and weed seed were significant at the one percent level. This is consistent with the heterogeneous declarations in Table 10 by a critical H-value of two for lot PR4 for factors pure seed and weed seed. Tables 11 and 12 show the results of this uniformity test.

Table 6. Percentage of sub-lots of all sizes in violation of state seed labeling laws in study two.

	AR2	AR3	PR4
Pure Seed	0	0	0
Perennial Ryegrass	0	0	90.9
Annual Ryegrass	0	0	90.9
Other Crop	0	0	0
Inert Matter	0	0	0
Weed	0	0	0

Table 7. Average H-values for sub-lots examined in study two for seed lot AR2.

LOT SIZE Kilograms	Pure Seed	Ann. Ryg.	Per. Ryg.	Other Crop	Inert Matter	Weed	Germ.	Total Nox. Weed	Total Nox. Weed by wgt.	Rattail Fescue	Rattail Fescue by wgt.
29,937	.46	17.74	20.92	0.00[1]	.32	.66	.19	.47	.43	.21	.16
14,968	.38	17.81	21.04	.50	.21	.67	.20	.46	.42	.20	.15
9,979	.38	17.74	21.07	.67	.29	.65	.20	.48	.44	.21	.16
4,989	.35	17.07	20.31	.83	.20	.67	.23	.50	.47	.22	.17

[1]Negative values of H to be reported as zero

Table 8. Average H-values for sub-lots examined in study two for seed lot AR3.

LOT SIZE Kilograms	Pure Seed	Ann. Ryg.	Per. Ryg.	Other Crop	Inert Matter	Weed	Germ.	Total Nox. Weed	Total Nox. Weed by wgt.	Rattail Fescue	Rattail Fescue by wgt.
24,947	1.00	16.06	21.99	1.37	.28	1.10	.19	1.29	1.22	3.73	3.56
14,474	1.02	15.88	21.77	.93	.23	.46	.18	.98	.92	1.27	1.15
9,979	1.20	16.66	22.42	.79	.21	.97	.20	.94	.87	2.27	2.10
4,989	.52	15.80	22.56	.41	.18	.25	.23	.61	.56	1.05	.93

Table 9. Average H-values for sub-lots examined in study two for seed lot PR4.

LOT SIZE Kilograms	Pure Seed	Ann. Ryg.	Per. Ryg.	Other Crop	Inert Matter	Weed	Germ.	Orchard-grass	Orchard-grass by wgt.	Rattail Fescue	Rattail Fescue by wgt.
24,675	2.56	916.28	855.23	.80	.91	4.16	.45	3.69	3.53	9.34	9.16
12,338	2.51	886.57	804.89	.40	.76	4.03	.43	2.74	2.60	8.77	8.61
8,225	2.24	614.30	577.96	.54	.81	3.51	.37	3.10	2.95	8.27	8.06
4,935	1.95	410.37	388.26	.20	.77	2.60	.37	1.52	1.40	5.23	5.07

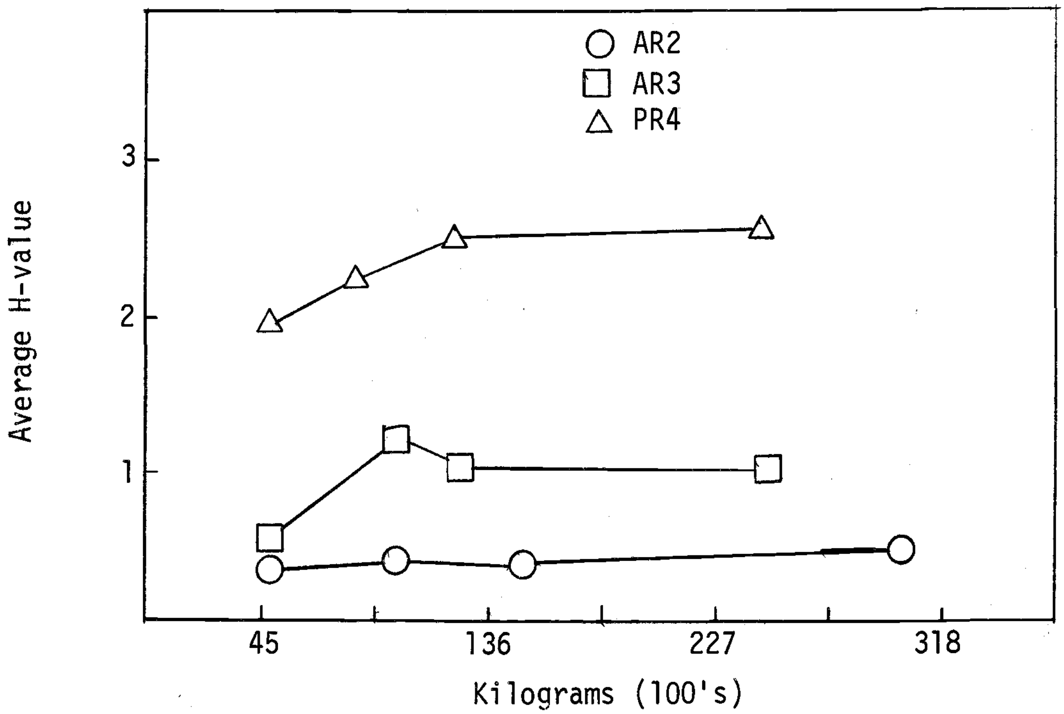

Figure 2. Averages of H-values by heterogeneity test instructions of different lot sizes for factor percentage pure seed in study two.

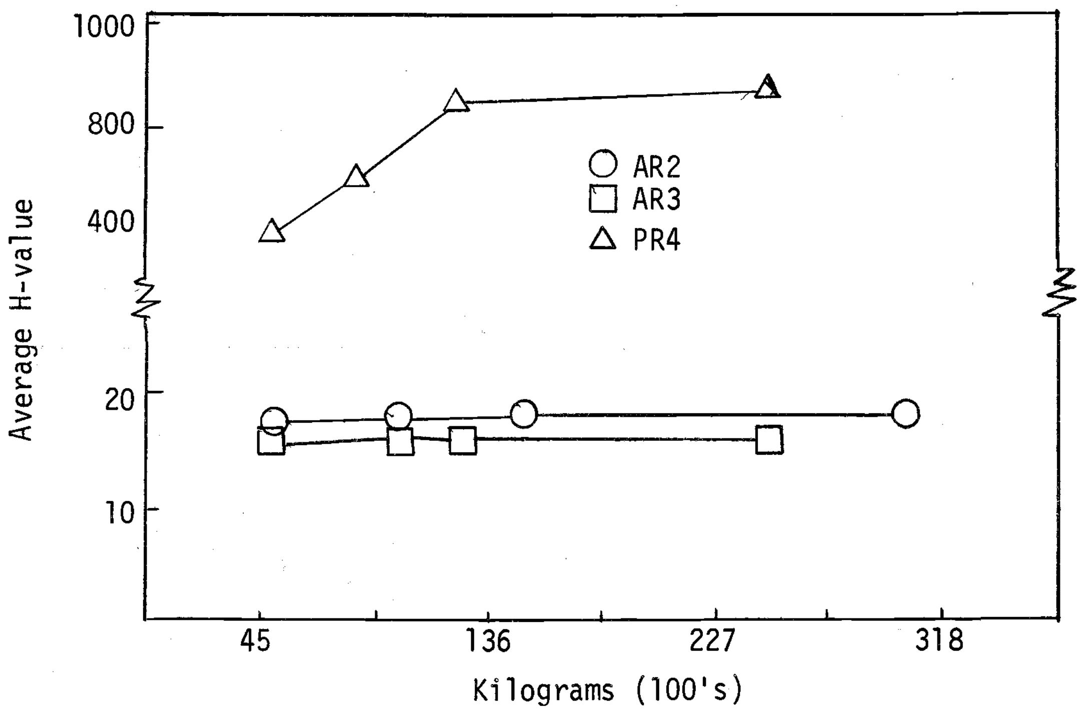

Figure 3. Averages of H-values by heterogeneity test instructions of different lot sizes for factor percentage annual ryegrass in study two.

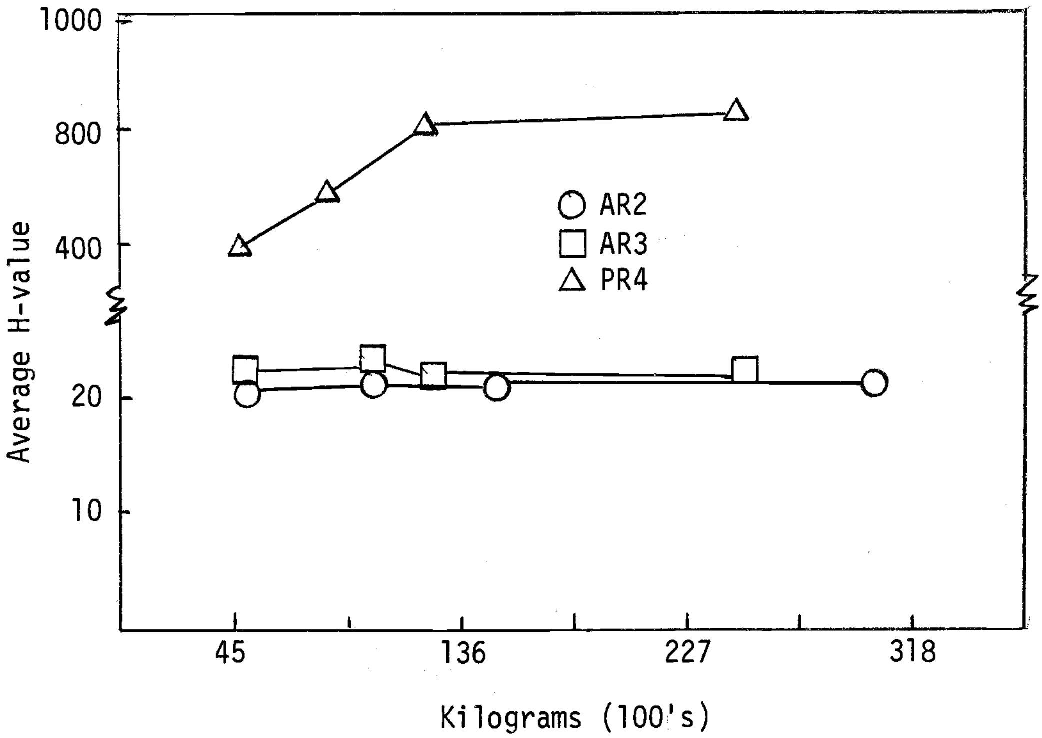

Figure 4. Averages of H-values by heterogeneity test instructions of different lot sizes for factor percentage perennial ryegrass in study two.

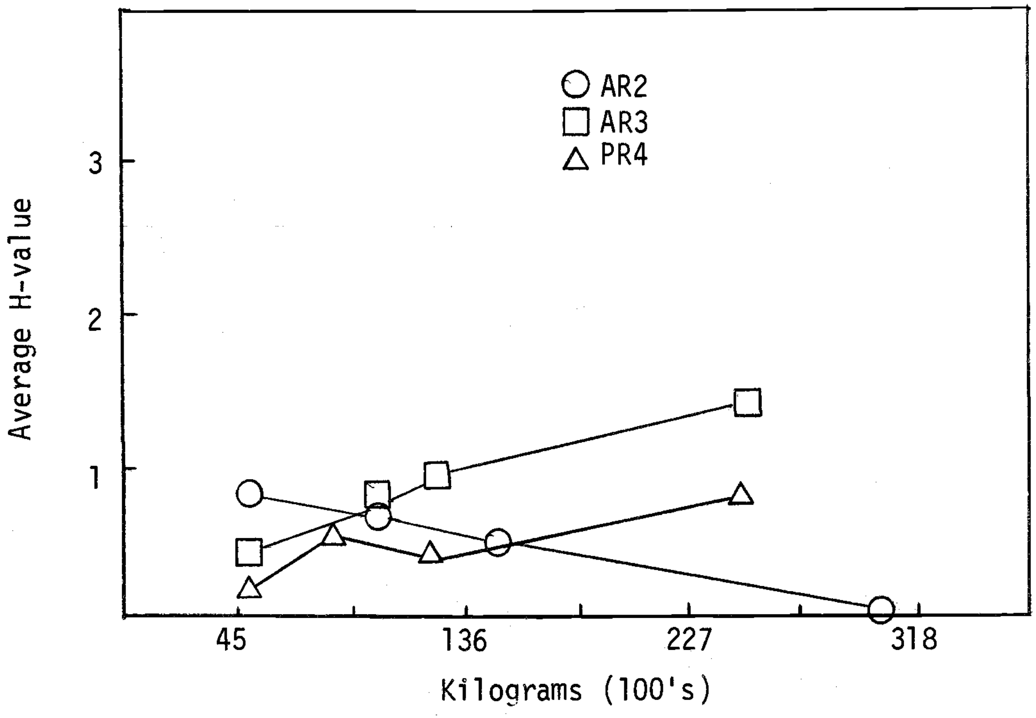

Figure 5. Averages of H-values by heterogeneity test instructions of different lot sizes for factor percentage other crop in study two.

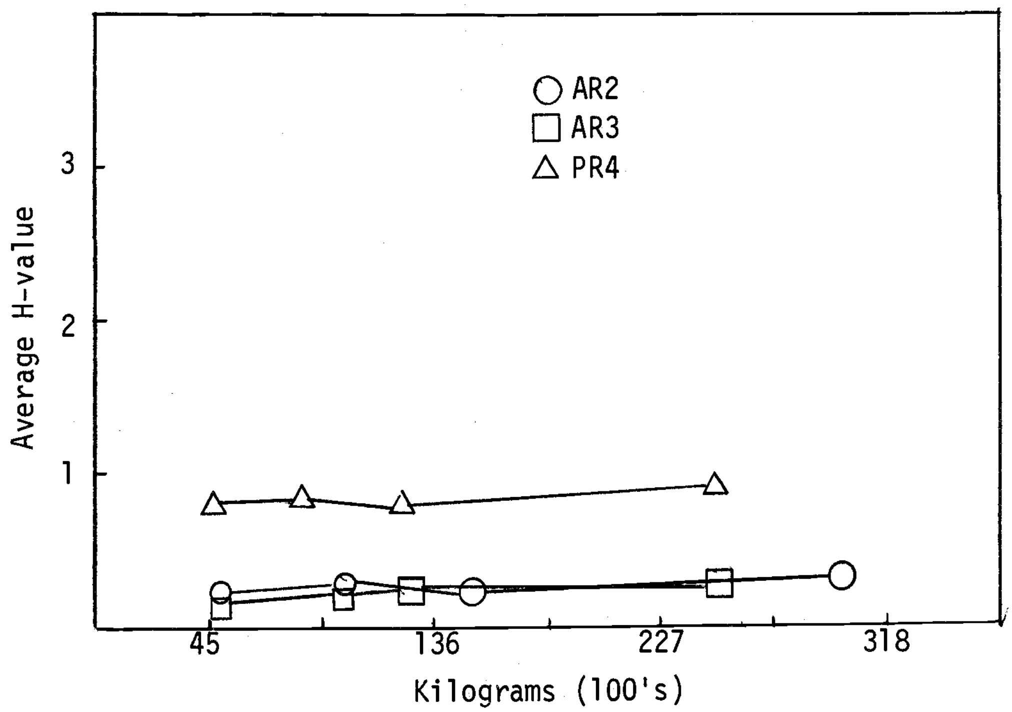

Figure 6. Averages of H-values by heterogeneity test instructions of different lot sizes for factor percentage inert matter in study two.

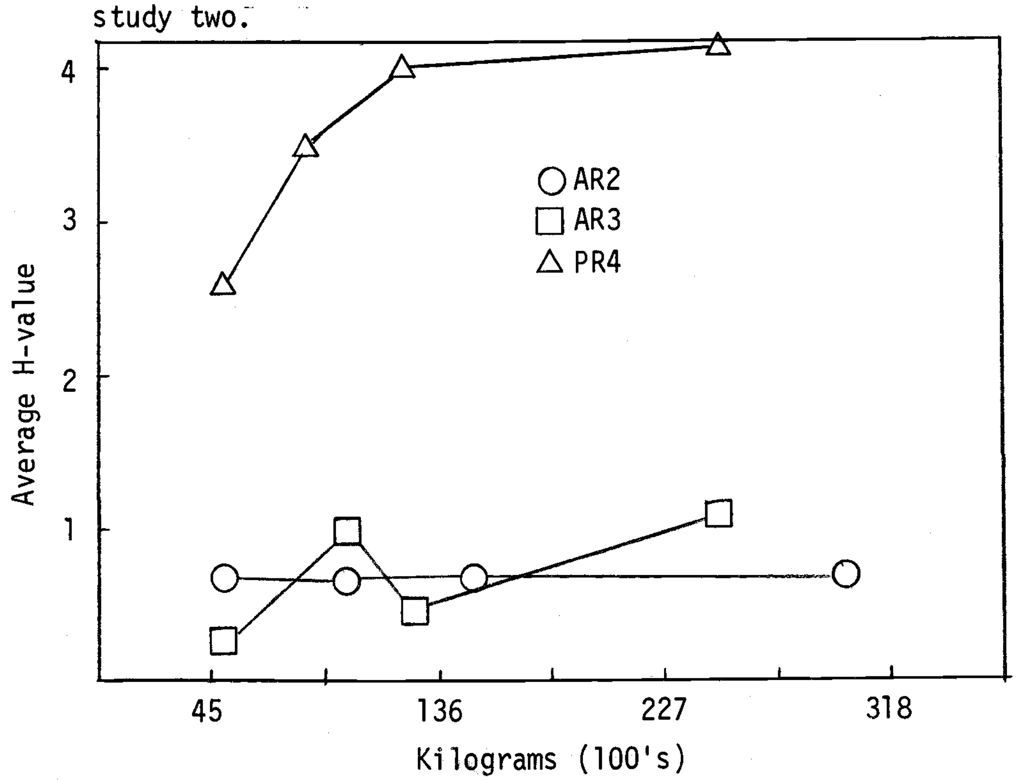

Figure 7. Averages of H-values by heterogeneity test instructions of different lot sizes for factor percentage weed in study two.

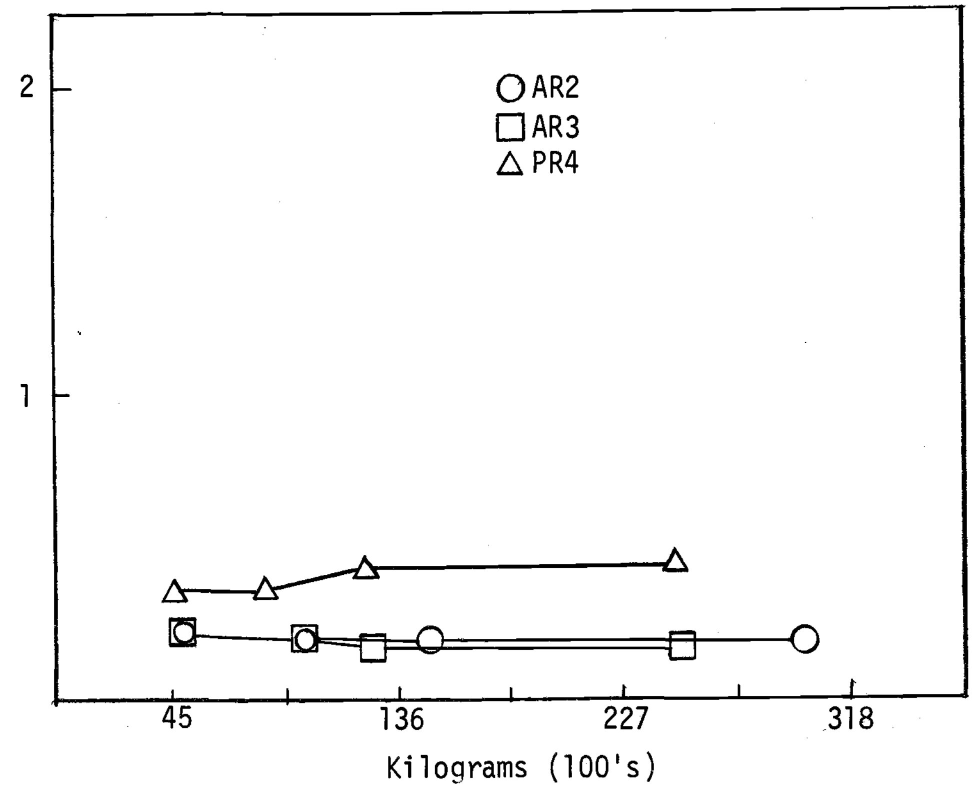

Figure 8. Averages of H-values by heterogeneity test instructions of different lot sizes for factor percentage germination in study two.

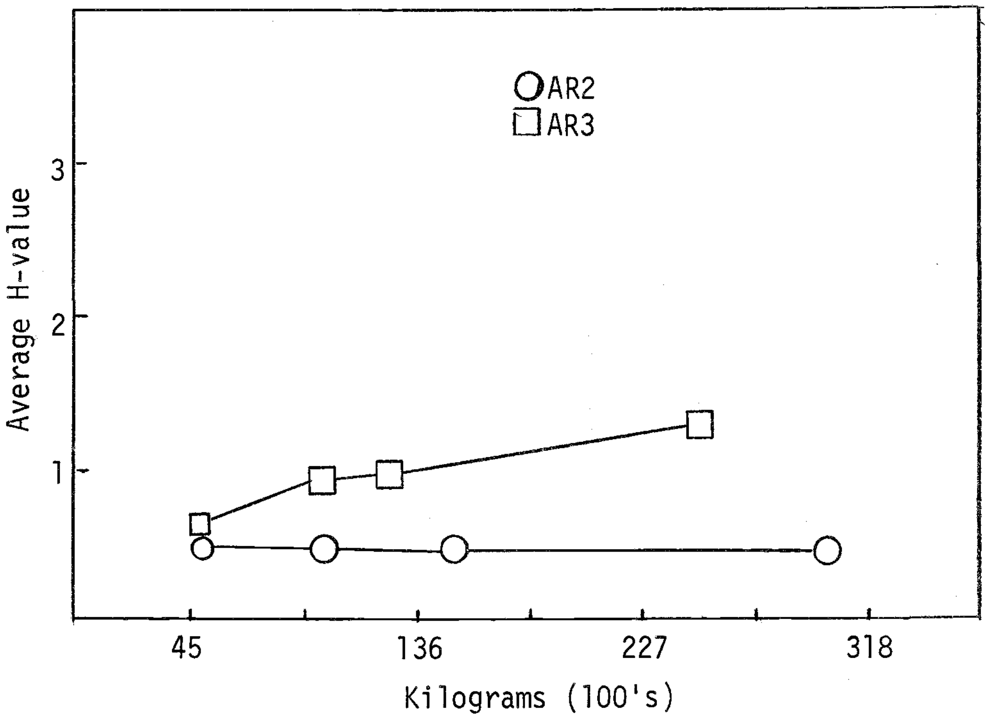

Figure 9. Averages of H-values by heterogeneity test instructions of different lot sizes for factor number of total noxious weed seeds in study two.

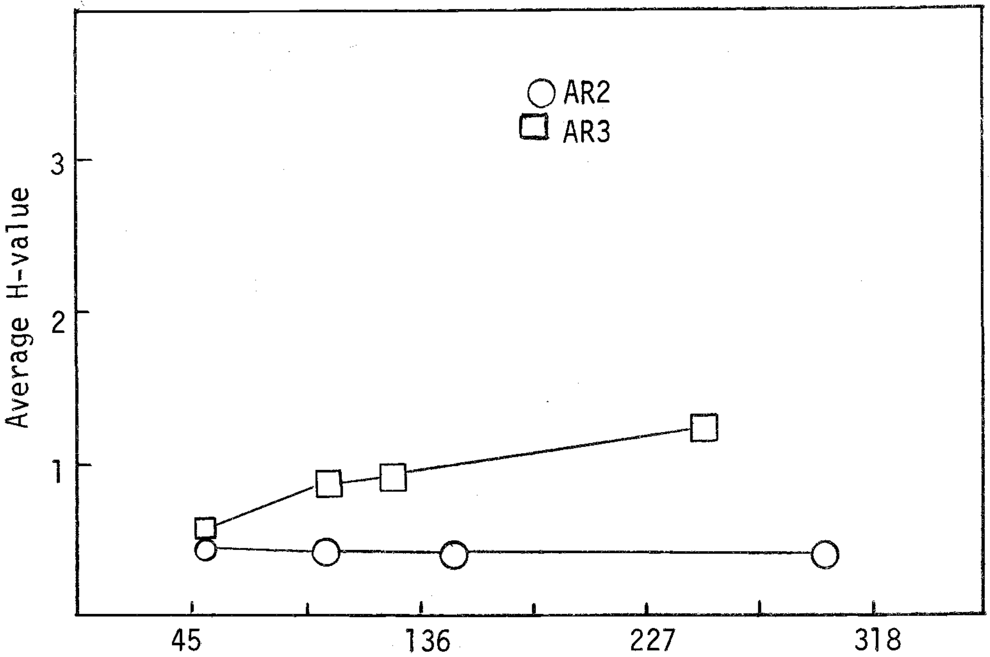

Figure 10. Averages of H-values by heterogeneity test instructions of different lot sizes for factor number of total noxious weed seeds adjusted to one weight in study two.

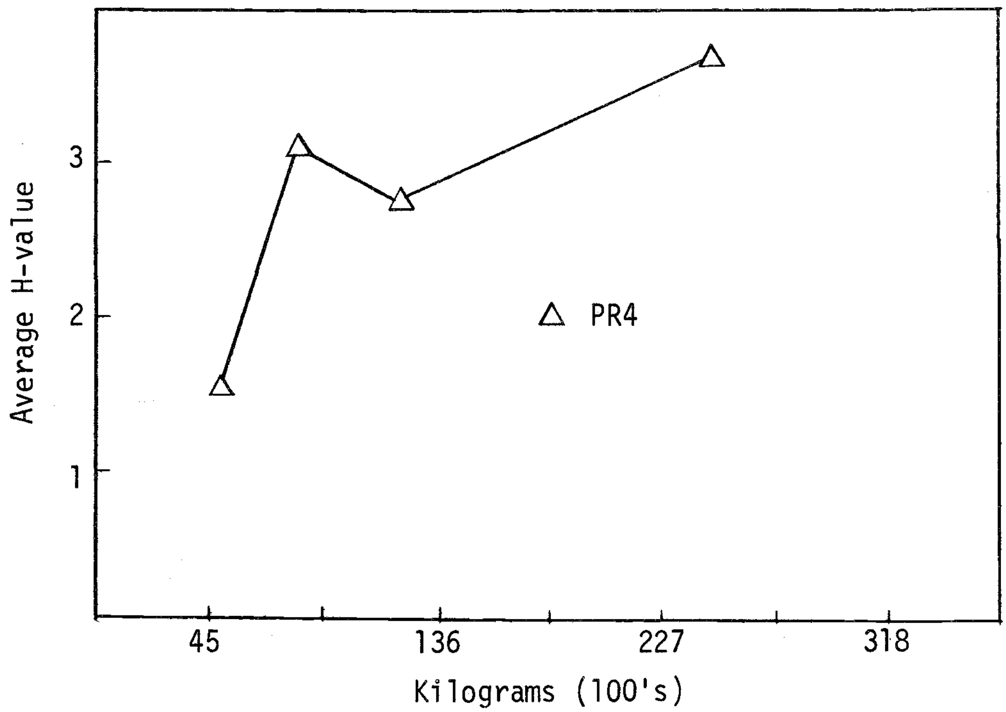

Figure 11. Averages of H-values by heterogeneity test instructions of different lot sizes for factor number of orchardgrass seeds in study two.

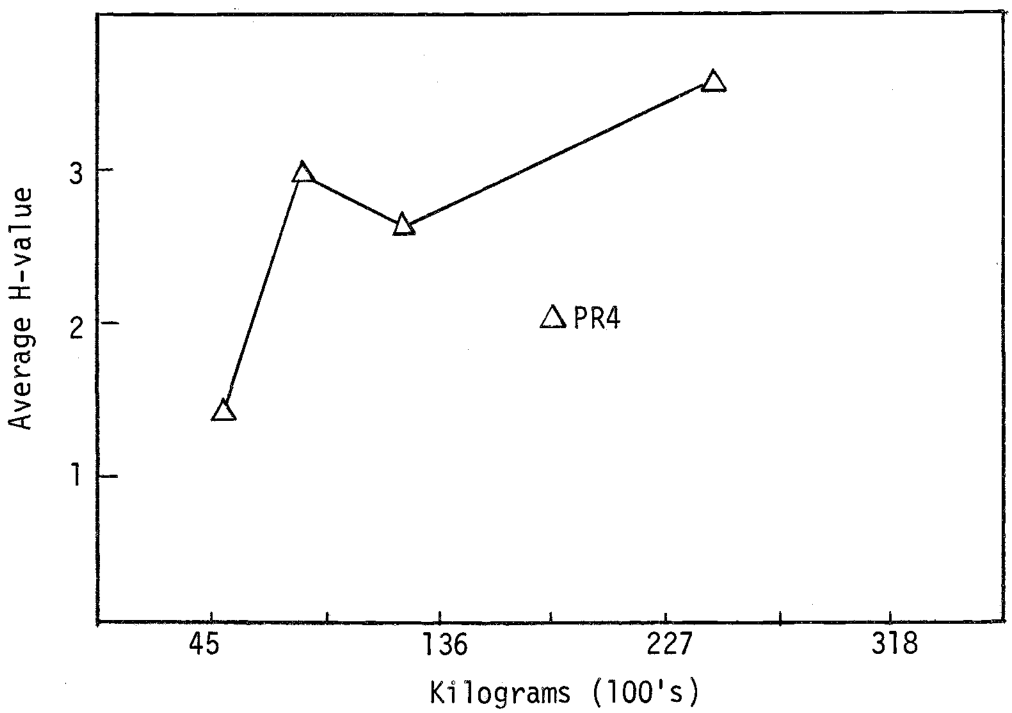

Figure 12. Averages of H-values by heterogeneity test instructions of different lot sizes for factor number of orchardgrass seeds adjusted to one weight in study two.

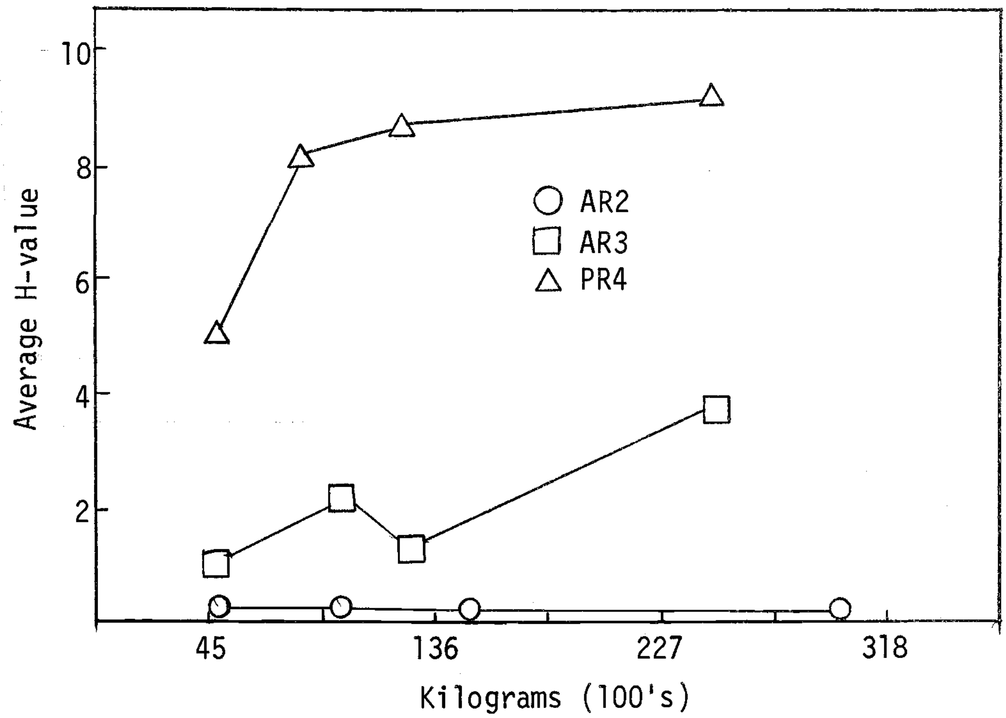

Figure 13. Averages of H-values by heterogeneity test instructions of different lot sizes for factor number of rattail fescue seeds in study two.

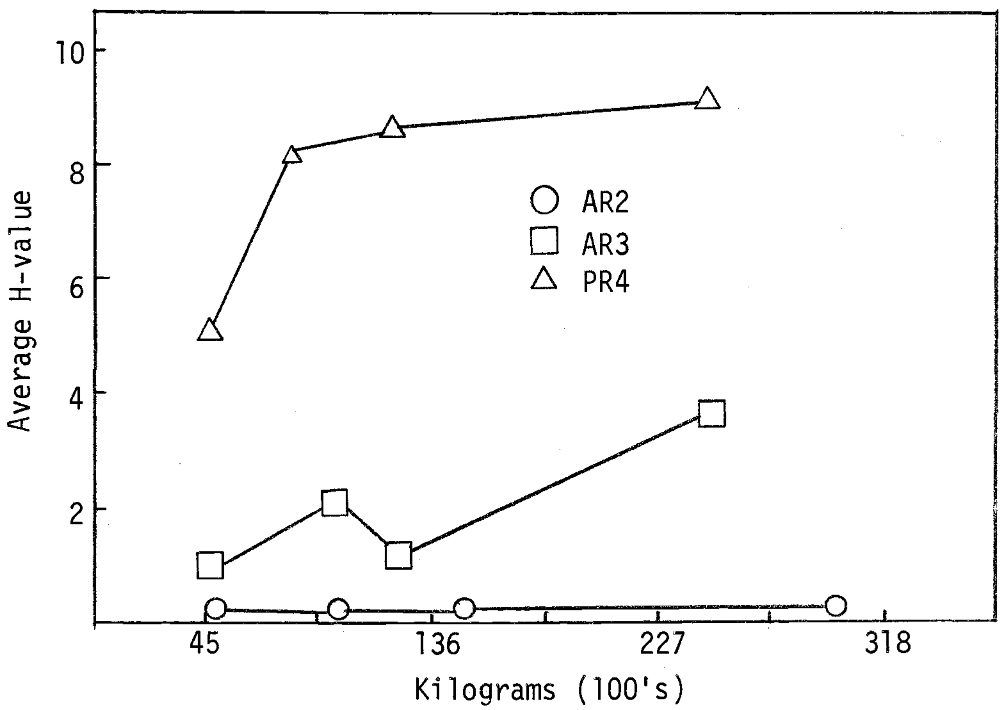

Figure 14. Averages of H-values by heterogeneity test instructions of different lot sizes for factor number of rattail fescue seeds adjusted to one weight in one weight study two.

Table 10. Percentage of sub-lots of all sizes exceeding a critical H-value of two in study two.

	AR2	AR3	PR4
Pure Seed	0	0	36
Perennial Ryegrass	100	100	100
Annual Ryegrass	100	100	100
Other Crop	0	0	0
Inert Matter	0	0	0
Weed	0	0	73
Germination	0	0	0
Total Noxious Weed	0	0	NE
Total Noxious Weed by Weight	0	0	NE
Rattail Fescue	0	30	82
Rattail Fescue by Weight	0	30	82
Orchardgrass	NE	NE	64
Orchardgrass by Weight	NE	NE	64

NE Not Examined

Table 11. Percentage of sub-lots of all sizes not fitting a variance test of homogeneity for a binomial distribution at a significance level of five percent in study two.

	AR2	AR3	PR4
Pure Seed	41.7	100	100
Perennial Ryegrass	100	100	100
Annual Ryegrass	100	100	100
Other Crop	0	80	90.9
Inert Matter	8.3	70	100
Weed	100	90	100
Germination	50	10	27.3

Table 12. Percentage of sub-lots of all sizes not fitting a variance test of homogeneity for a binomial distribution at a significance level of one percent in study two.

	AR2	AR3	PR4
Pure Seed	16.7	70	100
Perennial Ryegrass	100	100	100
Annual Ryegrass	100	100	100
Other Crop	0	80	90.9
Inert Matter	8.3	40	81.8
Weed	91.7	80	100
Germination	8.3	0	27.3

Study Three

Each purity factor in each sub-lot was compared to the average value for that factor for the entire seed lot. This comparison would be used by state seed law enforcement officials checking sub-lots against the label value for the entire lot. In lot PR4, 87.1 percent of the sub-lots would be in violation of state seed labeling law requirements for factors of percentage perennial ryegrass and annual ryegrass. This systematic approach in sub-lot breakdown is similar in results to the breakdown of sub-lots in study two. Table 13 shows the full results for this study.

In study three, seed lots were broken down to sub-lots in a systematic approach (Figure 1) and each sub-lot analysis included corresponding H-values for uniformity. H-values for each sub-lot were averaged for similar lot sizes for each seed lot. All three seed lots showed the highest H-values, or non-uniformity, for percentage perennial ryegrass and annual ryegrass factors (Table 14). As in study two, H-values tended to be lower at smaller lot size, however actual classification for uniformity did not change.

All three lots of ryegrass showed all sub-lots for percentage perennial ryegrass being classed as non-uniform in study three. A critical H-value of two was used. Table 15 shows the results for each factor of analysis examined for each seed lot.

A Chi-square test for homogeneity of the binomial distribution showed all three lots with 100 percent of the sub-lots being significant at the one percent level for factors of percentage perennial ryegrass and annual ryegrass. Tables 16 and 17 show the complete results on this uniformity test for all purity factors and germination for significance levels of five percent and one percent.

A systematic breakdown of each seed lot (Figure 1) was used to determine effects of lot size on uniformity for factors of purity, germination, and other seeds. A Chi-square test and the F-values showed lot PR4 to be the most variable at significance levels of five and one percent. The within lot variation for sub-lots of size ten or eight was used to examine statistical differences. Tables 18 through 30 show the results for these tests.

Table 13. Percentage of sub-lots of all sizes in violation of state seed labeling laws in study three.

	AR2	AR3	PR4
Pure Seed	0	0	0
Perennial Ryegrass	3.2	3.2	87.1
Annual Ryegrass	0	3.2	87.1
Other Crop	0	0	0
Inert Matter	0	0	0
Weed	0	0	0

Table 14. Comparison of average H-values for sub-lots examined in study three for seed lots AR2, AR3, and PR4.

Bag-samples in Lots	Lot Number	Pure Seed	Ann. Ryg.	Per. Ryg.	Other Crop	Inert Matter	Weed	Germ.	Total Nox. Weed	Total Nox. Weed by Wgt.	Orchard-grass	Orchard-grass by Wgt.	Rattail Fescue	Rattail Fescue by Wgt.
160	AR2	.48	17.23	20.29	1.00	.23	.71	.12	.51	.47	NE	NE	.25	.19
128	AR3	1.06	16.08	21.90	1.32	.28	1.22	.18	1.30	1.22	NE	NE	4.02	3.84
128	PR4	2.55	911.63	854.26	1.11	.99	3.35	.43	NE	NE	4.55	4.37	7.93	7.77
80	AR2	.40	17.37	20.45	1.00	.16	.72	.11	.50	.46	NE	NE	.22	.19
64	AR3	1.08	16.07	21.90	.88	.25	.60	.19	.99	.92	NE	NE	1.54	1.40
64	PR4	2.45	920.83	862.17	.88	.94	3.13	.41	NE	NE	4.04	3.88	7.21	7.09
40	AR2	.39	17.40	20.58	1.00	.15	.71	.15	.57	.53	NE	NE	.24	.20
32	AR3	1.11	16.34	22.26	.88	.26	.56	.22	.98	.92	NE	NE	1.45	1.33
32	PR4	2.39	598.59	564.07	.53	.98	2.36	.33	NE	NE	3.21	3.07	4.93	4.80
20	AR2	.43	17.28	20.66	1.00	.18	.70	.20	.60	.56	NE	NE	.25	.21
16	AR3	.63	16.06	22.89	.79	.26	.24	.24	.87	.82	NE	NE	.95	.81
16	PR4	1.52	405.46	373.90	.40	.67	1.52	.28	NE	NE	2.51	2.39	3.45	3.32
10	AR2	.45	16.82	20.25	1.00	.14	.74	.25	.63	.59	NE	NE	.29	.26
8	AR3	.67	15.20	22.85	.68	.37	.31	.35	.75	.71	NE	NE	1.00	.90
8	PR3	1.44	290.15	270.69	.21	.56	1.60	.32	NE	NE	1.29	1.22	2.90	2.79

NE Not Examined

Table 15. Percentage of sub-lots of all sizes being judged heterogeneous based on a critical H-value of two in study three.

	AR2	AR3	PR4
Pure Seed	0	12.9	25.8
Perennial Ryegrass	100	100	100
Annual Ryegrass	100	96.8	100
Other Crop	0	9.7	0
Inert Matter	0	0	6.5
Weed	6.5	0	35.5
Germination	0	0	0
Total Noxious Weed	0	9.7	NE
Total Noxious Weed by Weight	0	9.7	NE
Rattail Fescue	0	22.6	54.8
Rattail Fescue by Weight	0	19.4	51.6
Orchardgrass	NE	NE	45.2
Orchardgrass-by Weight	NE	NE	48.4

NE Not Examined

Table 16. Percentage of sub-lots of all sizes not fitting a variance test of homogeneity for a binomial distribution at a significance level of five percent in study three.

	AR2	AR3	PR4
Pure Seed	48.4	67.7	87.1
Perennial Ryegrass	100	100	100
Annual Ryegrass	100	100	100
Other Crop	0	58.1	67.7
Inert Matter	0	35.5	48.4
Weed	48.4	61.3	87.1
Germination	80.6	3.2	22.6

Table 17. Percentage of sub-lots of all sizes not fitting a variance test of homogeneity for a binomial distribution at a significance level of one percent in study three.

	AR2	AR3	PR4
Pure Seed	9.7	38.7	67.7
Perennial Ryegrass	100	100	100
Annual Ryegrass	100	100	100
Other Crop	0	51.6	64.5
Inert Matter	0	22.6	25.8
Weed	38.7	4.5	83.9
Germination	48.4	0	9.7

Table 18. Analysis of variance test results for a systematic breakdown of seed lots AR2, AR3, and PR4 for the factor percentage pure seed in study three.

Lot Number AR2		DF	MS	F
Among Groups of Size	80	1	.248062	8.6915**
	40	2	.0505625	1.7716
	20	4	.0103675	.3633
	10	8	.041700	1.4611
Within Groups of Size	10	144	.0285406	
	Total	159		

Lot Number AR3		DF	MS	F
Among Groups of Size	64	1	.0561125	1.5011
	32	2	.0525625	1.4062
	16	4	.482247	12.9012**
	8	8	.0392266	1.0494
Within Groups of Size	8	112	.0373799	
	Total	127		

Lot Number PR4		DF	MS	F
Amoung Groups of Size	64	1	.506270	4.4675*
	32	2	.373298	3.2941*
	16	4	1.12394	9.9179**
	8	8	.290002	2.5591*
Within Groups of Size	8	112	.113324	
	Total	127		

*Significance at five percent level
**Significance at one percent level

Table 19. Analysis of variance test results for a systematic breakdown of seed lots AR2, AR3, and PR4 for the factor percentage perennial ryegrass in study three.

Lot Number AR2		DF	MS	F
Among Groups of Size	80	1	.070560	.0375
	40	2	1.16444	.6183
	20	4	2.00344	1.0638
	10	8	2.06679	1.0974
Within Groups of Size	10	144	1.88331	
	Total	159		

Lot Number AR3		DF	MS	F
Among Groups of Size	64	1	.196095	.1645
	32	2	.246660	.2070
	16	4	1.09800	.9213
	8	8	2.01224	1.6884
Within Groups of Size	8	112	1.19181	
	Total	127		

Lot Number PR4		DF	MS	F
Among Groups of Size	64	1	60.7340	.2495
	32	2	6257.40	25.7057**
	16	4	4456.17	18.3061**
	8	8	1640.04	6.7374**
Within Groups of Size	8	112	243.425	
	Total	127		

** Significance at one percent level

Table 20. Analysis of variance test results for a systematic breakdown of seed lots AR2, AR3, and PR4 for the factor percentage annual ryegrass in study three.

Lot Number AR2		DF	MS	F
Among Groups of Size	80	1	.583222	.2979
	40	2	1.69960	.8682
	20	4	2.23739	1.1429
	10	8	2.24898	1.1489
Within Groups of Size	10	144	1.95758	
	Total	159		

Lot Number AR3		DF	MS	F
Among Groups of Size	64	1	.462001	.3766
	32	2	.474673	.3869
	16	4	2.60051	2.1196
	8	8	2.44243	1.9907
Within Groups of Size	8	112	1.22691	
	Total	127		

Lot Number PR4		DF	MS	F
Among Groups of Size	64	1	72.3304	.2928
	32	2	6225.94	25.2033**
	16	4	4573.94	18.5158**
	8	8	1658.19	6.7125**
Within Groups of Size	8	112	247.029	
	Total	127		

** Significance at one percent level

Table 21. Analysis of variance test results for a systematic breakdown of seed lots AR2, AR3, and PR4 for the factor percentage other crop in study three.

Lot Number AR2		DF	MS	F
Among Groups of Size	80	1	0	
	40	2	0	
	20	4	0	
	10	8	0	
Within Groups of Size	10	144	0	
	Total	159		

Lot Number AR3		DF	MS	F
Among Groups of Size	64	1	.152628	48.8097**
	32	2	.005313	1.6991
	16	4	.053373	17.0684**
	8	8	.003128	1.0003
Within Groups of Size	8	112	.003127	
	Total	127		

Lot Number PR4		DF	MS	F
Among Groups of Size	64	1	.164595	29.2874**
	32	2	.181332	32.2655**
	16	4	.035040	6.2349**
	8	8	.019001	3.3810**
Within Groups of Size	8	112	.005620	
	Total	127		

** Significance at one percent level

Table 22. Analysis of variance test results for a systematic breakdown of seed lots AR2, AR3, and PR4 for the factor percentage inert matter in study three.

Lot Number AR2		DF	MS	F
Among Groups of Size	80	1	.205206	18.4937**
	40	2	.010063	.9069
	20	4	.012491	1.1257
	10	8	.043339	3.9058**
Within Groups of Size	10	144	.011096	
	Total	159		

Lot Number AR3		DF	MS	F
Among Groups of Size	64	1	.092450	7.0691**
	32	2	.008341	.6378
	16	4	.043379	3.3169*
	8	8	.010128	.7744
Within Groups of Size	8	112	.013078	
	Total	127		

Lot Number PR4		DF	MS	F
Among Groups of Size	64	1	.080501	2.8826
	32	2	.035638	1.2761
	16	4	.191395	6.8534**
	8	8	.098918	3.5420**
Within Groups of Size	8	112	.027927	
	Total	127		

* Significance at five percent level
** Significance at one percent level

Table 23. Analysis of variance test results for a systematic breakdown of seed lots AR2, AR3, and PR4 for the factor percentage weed in study three.

Lot Number AR2		DF	MS	F
Among Groups of Size	80	1	.002031	.1258
	40	2	.033971	2.1044
	20	4	.014304	.8861
	10	8	.009226	.5715
Within Groups of Size	10	144	.016143	
	Total	159		

Lot Number AR3		DF	MS	F
Among Groups of Size	64	1	.867903	67.9323**
	32	2	.091841	7.1886**
	16	4	.166909	13.0643**
	8	8	.007622	.5966
Within Groups of Size	8	112	.012776	
	Total	127		

Lot Number PR4		DF	MS	F
Among Groups of Size	64	1	.694726	11.8143**
	32	2	.885566	15.0596**
	16	4	.520280	8.8477**
	8	8	.113151	1.9242
Within Groups of Size	8	112	.058804	
	Total	127		

** Significance at one percent level

Table 24. Analysis of variance test results for a systematic breakdown of seed lots AR2, AR3, and PR4 for the factor percentage germination in study three.

Lot Number AR2		DF	MS	F
Among Groups of Size	80	1	.006250	.1475
	40	2	.031250	.7377
	20	4	.068750	1.6230
	10	8	.031250	.7377
Within Groups of Size	10	144	.042361	
	Total	159		

Lot Number AR3		DF	MS	F
Among Groups of Size	64	1	.031250	1.0000
	32	2	0	0
	16	4	.046875	1.500
	8	8	.031250	1.00
Within Groups of Size	8	112	.031250	
	Total	127		

Lot Number PR4		DF	MS	F
Among Groups of Size	64	1	.070313	.9403
	32	2	.507814	6.7910**
	16	4	.132813	1.7761
	8	8	.007813	.1045
Within Groups of Size	8	112	.074777	
	Total	127		

**Significance at one percent level

Table 25. Analysis of variance test results for a systematic breakdown of seed lots AR2 and AR3 for the factor number of total noxious weed seeds in study three.

Lot Number AR2		DF	MS	F
Among Groups of Size	80	1	640.00	1.5759
	40	2	500.00	1.2312
	20	4	217.50	.5356
	10	8	740.00	1.8222
Within Groups of Size	10	144	406.11	
	Total	159		

Lot Number AR3		DF	MS	F
Among Groups of Size	64	1	4632.03	16.9746**
	32	2	253.91	.9305
	16	4	2213.28	8.1108**
	8	8	619.53	2.2703*
Within groups of Size	8	112	272.88	
	Total	127		

* Significance at five percent level
** Significance at one percent level

Table 26. Analysis of variance test results for a systematic breakdown of seed lots AR2 and AR3 for the factor number of total noxious weed seeds adjusted to one weight in study three.

Lot Number AR2		DF	MS	F
Among Groups of Size	80	1	10.3175	2.5030
	40	2	2.3495	.5699
	20	4	1.3926	.3378
	10	8	7.7144	1.8715
Within Groups of Size	10	144	4.1221	
	Total	159		
Lot Number AR3		**DF**	**MS**	**F**
Among Groups of Size	64	1	43.3613	16.9228**
	32	2	2.3012	.8981
	16	4	20.6774	8.0699**
	8	8	5.8479	2.2823*
Within Groups of Size	8	112	2.5623	
	Total	127		

* Significance at five percent level
** Significance at one percent level

Table 27. Analysis of variance test results for a systematic breakdown of seed lot PR4 for the factor number of orchardgrass seeds in study three.

Lot Number PR4		DF	MS	F
Among Groups of Size	64	1	1.1250	9.3333**
	32	2	.703125	5.8333**
	16	4	.078125	.6481
	8	8	.140625	1.1667
Within Groups of Size	8	112	.120536	
	Total	127		

* Significance at five percent level
** Significance at one percent level

Table 28. Analysis of variance test results for a systematic breakdown of seed lot PR4 for the factor number of orchardgrass seeds adjusted to one weight in study three.

Lot Number PR4		DF	MS	F
Among Groups of Size	64	1	330.856	35.2387**
	32	2	366.522	39.0374**
	16	4	67.642	7.2044**
	8	8	34.194	3.6419**
Within Groups of Size	8	112	9.389	
	Total	127		

**Significance at one percent level

Table 29. Analysis of variance test results for a systematic breakdown of seed lots AR2, AR3, and PR4 for the factor number of rattail fescue seeds in study three.

Lot Number AR2		DF	MS	F
Among Groups of Size	80	1	.1000	1.7562
	40	2	.0125	.2195
	20	4	.1625	2.8539*
	10	8	.0500	.8781
Within Groups of Size	10	144	.05694	
	Total	159		

Lot Number AR3		DF	MS	F
Among Groups of Size	64	1	1.3781	12.5969**
	32	2	.3906	3.5704*
	16	4	2.1719	19.8528**
	8	8	.1719	1.5713
Within Groups of Size	8	112	.1094	
	Total	127		

Lot Number PR4		DF	MS	F
Among Groups of Size	64	1	26.2812	34.0289**
	32	2	19.2656	24.9451**
	16	4	9.4531	12.2399**
	8	8	5.0938	6.5954**
Within Groups of Size	8	112	.772321	
	Total	127		

* Significance at five percent level
** Significance at one percent level

Table 30. Analysis of variance test results for a systematic breakdown of seed lots AR2, AR3, and PR4 for the factor number of rattail fescue seeds adjusted to one weight in study three.

Lot Number AR2		DF	MS	F
Among Groups of Size	80	1	18.1508	3.3342
	40	2	2.1449	.3940
	20	4	15.2871	2.8082*
	10	8	5.2731	.9686
Within Groups of Size	10	144	5.4438	
	Total	159		
Lot Number AR3		**DF**	**MS**	**F**
Among Groups of Size	64	1	1660.10	146.9935**
	32	2	88.3807	7.8257**
	16	4	216.529	19.1725**
	8	8	8.6240	.7636
Within Groups of Size	8	112	11.2937	
	Total	127		
Lot Number PR4		**DF**	**MS**	**F**
Among Groups of Size	64	1	2326.90	33.4168**
	32	2	2065.51	29.6629**
	16	4	899.81	12.9222**
	8	8	421.02	6.0463**
Within Groups of Size	8	112	69.6327	
	Total	127		

* Significance at five percent level
** Significance at one percent level

DISCUSSION

This is a study of factors in three commercial Oregon seed lots in "trade-channels" that could create problems for seed handlers, seed control officials, and consumers. Specific causes of non-uniformity within seed lots were not examined, however several sources have been suggested. These include:

A. Field Variation in:

1. Crop growth and maturity.
2. Weed population.
3. Other crop population.

B. Processing and Handling:

1. Inadequate cleaning of a seed lot.
2. Improper blending operations.
3. Failure to watch for and correct non-uniformity.
4. Separation during processing and handling of components on the basis of density or seed coat characteristics.

C. Shipping and Marketing:

1. Seed separation during shipping.
2. Purposeful or accidental mixing of bags from different lots or parts of lots.

Care must be used throughout the growing, harvesting, and processing of seed to produce and market uniform lots. Only when lots are uniform will the sample and laboratory test results represent each bag in the entire lot within allowed tolerances. The use of improper sampling procedures, such as sampling only exposed parts rather than complete randomization of the whole lot, or probing an insufficient number of bags, will greatly aggravate non-uniformity problems. If non-uniformity exists when the lot is sampled, improper sampling will alter the mean value of the test used for labeling.

There is no previous research on effects of lot size on lot uniformity in ryegrass seed or grass seed in general. Many of the results in this study are new.

For all three lots of ryegrass studied, the percentage annual ryegrass and perennial ryegrass is a function of the degree of fluorescence that is detected during germination. The principle is, roots of germinating annual ryegrass seedlings exude a substance that fluoresces while perennial ryegrass seedlings do not. Using the number of seedlings that fluoresce or do not fluoresce under near-ultraviolet light, a formula is used (AOSA, 1970) to determine percentage annual ryegrass and perennial ryegrass. The test is widely used and accepted in seed testing and is a quick procedure to distinguish between seedlings of annual ryegrass and perennial ryegrass.

State seed labeling laws were applied to the purity analysis on lots AR2, AR3, and PR4. The percentage perennial ryegrass and annual ryegrass factors consistently exceeded allowed tolerances and were in violation of seed law. Sub-lots in study two and study three showed a reduction in percentage violations for percentages perennial ryegrass and annual ryegrass, but lot PR4 had consistently more than 85 percent violations. Lot PR4, the only perennial ryegrass seed lot examined, had the lowest purity of the three lots studied. Lots AR2 and AR3 had the highest purity, however even in these lots one-half of the bag-samples tested showed violations in state seed law labeling requirements in at least one factor. These results show the extent of variation which occurs when individual bag-samples are compared to complete seed lot tests by use of state seed law labeling requirements. It further shows that high purity seed lots were more uniform than low purity seed lots.

The H-value (heterogeneity value) is prescribed in the ISTA (1966) rules to compare actual variance to expected theoretical variance minus one. The object of this test is to measure the level of heterogeneity within a seed lot. The H-value will indicate the amount of variation in excess of random sampling variation. If a seed lot is perfectly uniform and homogeneous and good sampling methods and good seed analysis work is achieved, the mathematical expectation is for an H-value of zero. The H-value test was made in studies two and three. H-values for each sub-lot were calculated and averaged for similar lot sizes on each seed lot tested. In study two, using minimum sampling requirements for H-value testing, no consistent trends on H-values (uniformity) were observed when comparing similar decreasing lot sizes. Results for study three with a systematic breakdown of each seed lot, showed as in study two, no consistent trends on H-values (uniformity) when comparing similar decreasing lot sizes. In study two and study three, there is some indication that H-values are lower at smaller lot sizes, however the actual uniformity classification did not change. No consistant trends emerged from this study.

Much research has been done with testing and examining seed lots for uniformity using the H-value as prescribed in the ISTA (1966) rules. Tattersfield and Johnston (1970) reported that an H-value of two would allow 83 percent of ryegrass seed lots tested for purity to be classified as uniform. For germination, 88 percent of the seed lots showed H-values less than 1.30. Thomson (1965) allowed 72 percent of the seed lots of perennial ryegrass to be classified uniform when an H-value of less than two was used as a critical H-value.

Westmacott and Linehan (1960), using an h value test showed that a critical h value of three for perennial ryegrass and four for annual ryegrass would enable 75 percent and 72 percent of seed lots examined for purity to be classified uniform. Relating this to the H-value statistic used in this research, an H-value of two and three would be the critical H-value to use for determining lot uniformity for perennial ryegrass and annual ryegrass, respectively.

Based on a review of literature, there is no accepted standard critical H-value to define lot uniformity. Critical H-values are based upon many examinations of seed lots in trade channels. The critical H-value is the most heterogeneous lot which is considered acceptable in trade. A critical H-value of two was selected for this study as a best estimate to determine sub-lots exceeding an acceptable uniformity level. In study two, all perennial and annual ryegrass factors in sub-lots of lots AR2, AR3, and PR4 were declared non-uniform on this basis. There was also a high degree of non-uniformity for factors: weed (rattail fescue), other crop (orchardgrass), and percentage weed seeds in lot PR4. This is in agreement with work by Linehan and Mathews (1962) when they noted a correlation between H-values based on percentage purity and number of weed seeds in samples tested. In study three, there was a high percentage of sub-lots for percentage perennial ryegrass and annual ryegrass exceeding a critical H-value of two for lots AR2, AR3, and PR4. Lot PR4 showed approximately 50 percent level of non-uniformity for factors of number rattail fescue seeds and orchardgrass seeds.

Fluorescence plays an important role in determining the percentage annual and perennial ryegrass in ryegrass seed lots. In the case of all three seed lots, the H-value, a measure of non-uniformity, is greatly reduced when examining variability of fluorescence and non-fluorescence rather than percentage annual ryegrass and perennial ryegrass as calculated by formula. The calculated percentage annual ryegrass and perennial ryegrass becomes a function of percentage fluorescent seedlings, pure seed, and germination. Table 31 shows the H-value relationships in study two for lot AR2, AR3, and PR4 for factors of percentage annual ryegrass and perennial ryegrass, fluorescence and nonfluorescence, and percentage germination for different sub-lot sizes. In the case of lot AR2 and AR3, each sub-lot breakdown would be classified as uniform based on a critical H-value of two if fluorescence and nonfluorescence was used instead of percentage annual ryegrass and perennial ryegrass. The use of the formula increases the H-value in the sub-lots. In this study, all

Table 31. Summary of average H-values for sub-lots in study two for factors used in determining percentage annual ryegrass and perennial ryegrass in ryegrass seed lots.

Lot	LOT SIZE Kilograms	Annual Ryegrass	Perennial Ryegrass	Fluorescence	Nonfluorescence	Germination
AR2	29,937	17.74	20.92	.23	.06	.19
AR3	24,947	16.06	21.99	.15	.11	.19
PR4	24,675	916.28	855.23	32.07	22.91	.45
AR2	14,968	17.81	21.04	.23	.06	.20
AR3	14,474	15.88	21.77	.16	.13	.18
PR4	12,338	886.57	804.89	28.92	20.40	.43
AR2	9,979	17.74	21.07	.23	.08	.20
AR3	9,979	16.66	22.42	.30	.20	.20
PR4	8,225	614.30	577.96	22.45	17.61	.37
AR2	4,989	17.07	20.31	.19	.07	.23
AR3	4,989	15.80	22.56	.26	.18	.23
PR4	4,935	410.37	388.26	15.22	12.35	.37

sub-lot breakdowns for percentage annual ryegrass and perennial ryegrass were classified as non-uniform when using a critical H-value of two. Further study should be done to evaluate the effect of the use of formulas in seed testing and the established tolerances when used to derive percentage annual ryegrass and perennial ryegrass.

Using the Chi-square test for homogeneity of the binomial distribution, results for purity factors and germination were more stringent than the H-value statistic in declaring variability in sub-lots examined in study two and study three. Trends were similar for the Chi-square test and the H-value test results, showing the greatest variability appearing in percentage annual ryegrass and perennial ryegrass for lots AR2, AR3, and PR4. Also, percentage pure seed and weed seed showed high variability in lot PR4. Lot PR4 was the lowest purity of any seed lot tested and also showed the highest percentage of weed seed present of any seed lot tested in this research study. This is consistent with work by Linehan and Mathews (1962), mentioned earlier, for their work showing correlations between H-values based on percentage purity and number of weed seeds on samples tested.

In study three, a systematic breakdown of each seed lot and factor of analysis was made to examine effects of lot size on uniformity utilizing a variance test and the F-value to check for significant differences. Each seed lot was broken down into sub-lots to study variation among bag-samples for groups of 160 or 128, 80 or 64, 40 or 32, 20 or 16, and 10 or 8 depending upon the total number of bags in the lot. Using the within lot variation for smallest sub-lots (sizes ten or eight) as an acceptable level of variation in seed lots, each larger size seed lot was examined for significant differences. Each F-test was studied to determine if the F-value was progressively smaller or larger as the lot size decreased. If changing lot size has an effect on lot uniformity, this type of testing procedure would indicate this fact for some or all of the factors examined in this study. Study three showed no trend for lot sizes or the effects of lot sizes on uniformity when looking at all of the factors analyzed.

CONCLUSIONS

In this study of three commercial Oregon grown ryegrass seed lots, the greatest potential for violation in labeling and non-uniformity occurred in percentage perennial ryegrass and annual ryegrass factors calculated by formula from fluorescence. Changing seed lot size from the original 30,000 kilogram lot size had no effect on lot uniformity. Reducing the lot size below the current 24,947 kilogram limit did not significantly reduce the number of violations in labeling. Fewer violations were found in high purity seed lots than in low purity seed lots.

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APPENDIX

Appendix Table 1. The H homogeneity test[1].

Sampling of the lot - bags sampled should be no less than the following	
Number of Bags in Lot	Number of Bags to Sample
1 - 9	every bag
10 - 15	10
16 - 25	12
26 - 35	15
36 - 49	17
50 - 64	20
65 - 80	23
81 - 100	25
101 - 120	27
over 120	30

Bags are sampled at random. Each bag that is selected, a bag-sample is drawn. Small portions are taken across the diameter of the bag at the top, middle and bottom. The weight of each bag-sample shall be not less than one-half of the weight required for samples submitted for purity analysis.

Working samples of 10,000 seeds are drawn from each bag-sample. Thus, 2,000 seeds are used for a purity test and the additional 8,000 seeds plus the original 2,000 seeds for a total of 10,000 seeds to be used for a noxious weed exam or for the attribute of number of other seeds.

[1]Condensed from the 1966 International rules for seed testing (3, pp. 140-144).

Testing for Purity

Any component may be used in this test, provided it can be separated and expressed as a percentage by weight. Each working sample is separated into two fractions--the selected component and the rest. Both fractions are weighed and the weight of the former calculated as a percentage of both together. Calculate the Heterogeneity value (H).

$$H = (V/W) - 1$$

where V = sample variance

$$W = \frac{\bar{x}\ (100-\bar{x})}{2000}$$

Report H, $\bar{x}$,[2] n[3] and number of bags in the lot. Negative values of H are to be reported as zero.

Testing for Other Seed (Noxious Weed Exam)

Any component may be used in this test, provided it can be expressed as the number of seed present in the working sample. In each working sample, the number of seeds being checked are counted. Calculate the Heterogeneity value (H).

$$H = (V/W) - 1$$

where V = sample variance

W = sample mean $\bar{x}$

Report H, W, number of working samples, weight of working samples, and the number of bags in the lot. Negative values of H are to be reported as zero.

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[2]Mean of all values of x determined for the lot = $\Sigma x/n$.

[3]Number of bag-samples taken.

Testing for Germination

Any component may be used in this test, provided it can be expressed as a percentage by number. From each bag-sample a germination test of 100 pure seeds is set up simultaneously and completed according to the specific rules for testing seeds. Calculate the Heterogeneity value (H).

$$H = (V/W) - 1$$

where V = sample variance

$$W = \frac{\bar{x}\ (100 - \bar{x})}{100}$$

Report H, $\bar{x}$, n, and the number of bags in the lot. Negative values of H are to be reported as zero.

Appendix Table 2. Determination of seeds per gram for seed lot AR2.

Sample Number	Weight of 100 Seeds	Weight of 100 Seeds	Average seeds Per Gram
2001	.1973	.1934	511.95
2016	.1962	.1797	533.08
2031	.2056	.2143	476.51
2046	.1687	.1912	557.89
2061	.1734	.1999	538.48
2076	.1876	.1984	518.54
2091	.2013	.1941	505.99
2106	.1785	.1950	536.52
2121	.2014	.1990	499.52
2136	.1954	.1842	527.33
2151	.2026	.1952	502.94
2166	.1714	.1799	569.65
2180	.1849	.1785	550.53
Average Seeds Per Gram			523

2,000 Seeds Used for Purity = 3.83 Grams

10,000 Seeds Used for Total Noxious Weed Exam = 19.11 Grams

Appendix Table 3. Determination of seeds per gram for seed lot AR3.

Sample Number	Weight of 100 Seeds	Weight of 100 Seeds	Average seeds Per Gram
3001	.2089	.2013	487.73
3016	.2200	.2026	474.07
3031	.2162	.2249	453.59
3046	.2039	.2029	491.65
3061	.2156	.2166	462.75
3076	.2438	.2231	429.20
3091	.2230	.2263	445.16
3106	.2046	.1976	497.42
3121	.2029	.2072	487.74
3135	.2174	.2055	473.30
Average Seeds Per Gram			470

2,000 Seeds Used for Purity = 4.26 Grams

10,000 Seeds Used for Total Noxious Weed Exam = 21.32 Grams

Appendix Table 4. Determination of seeds per gram for seed lot PR4.

Sample Number	Weight of 100 Seeds	Weight of 100 Seeds	Average Seeds Per Gram
4001	.2465	.2391	411.96
4016	.2528	.2585	391.21
4031	.2654	.2514	387.28
4046	.2024	.1963	501.75
4061	.2514	.2596	391.49
4076	.2516	.2726	382.15
4091	.1941	.1986	509.37
4106	.2035	.1980	498.23
4121	.1983	.1891	516.56
4135	.2434	.2587	398.70
4150	.2385	.2539	406.58
Average Seeds Per Gram			429

2,000 Seeds Used for Purity = 4.66 Grams

Appendix Table 5. Detailed experimental data on bag-samples for all analysis factors for seed lot AR2.

Sample Number	Pure Seed %	Annual Rye-grass %	Perennial Ryegrass %	Other Crop %	Inert Matter %	Weed %	Total Nox. Weed	Total Nox. Weed by Wgt.	Rattail Fescue	Rattail Fescue by Wgt.	Germi-nation %	Fluor.	Nonfluor.
2001	99.56	98.55	1.01[A]	0	.37	.07	10	9.61	3	2.81	99	98	1
2002	99.67	97.62	2.05	0	.18	.15	1	.95	3	2.91	97	95	2
2003	99.45	99.45[A]	0[A]	0	.20	.35	4	3.91	7	6.74	92	92	0
2004	99.64	99.64[A]	0[A]	0	.27	.09	6	5.85	4	3.45	92	92	0
2005	99.54	97.51	2.03	0	.36	.10	6	5.80	2	1.85	98	96	2
2006	99.80	99.80[A]	0[A]	0	.13	.07	1	.99	3	2.90	98	98	0
2007	99.81	98.74[A]	1.07	0	.17	.02	0	0	1	.94	93	92	1
2008	99.56	94.32[A]	5.24[A]	0	.34	.10	1	.96	4	3.72	95	90	5
2009	99.63	96.42[A]	3.21[A]	0	.17	.20	3	2.91	4	3.83	93	90	3
2010	99.71	98.67	1.04	0	.17	.12	3	2.92	5	4.75	96	95	1
2011	99.33	98.32	1.01[A]	0	.29	.38	3	2.94	7	6.43	98	97	1
2012	99.76	96.77	2.99[A]	0	.22	.02	4	3.93	2	1.87	100	97	3
2013	99.73	97.65	2.08	0	.20	.07	1	.97	4	3.76	96	94	2
2014	99.74	98.72[A]	1.02[A]	0	.19	.07	0	0	5	4.63	98	97	1
2015	99.58	97.53	2.05	0	.27	.15	2	1.97	7	6.66	97	95	2
2016	99.76	97.72	2.04	0	.19	.05	1	.97	3	2.79	98	96	2
2017	99.81	97.62	2.19	0	.12	.07	3	2.94	5	4.66	91	89	2
2018	99.81	97.77	2.04	0	.14	.05	1	.97	4	3.63	98	96	2
2019	99.16	98.15	1.01[A]	0	.30	.54	7	6.79	4	3.78	98	97	1
2020	99.78	97.68	2.10	0	.07	.15	2	1.93	2	1.85	95	93	2
2021	99.73	95.62[A]	4.11[A]	0	.15	.12	1	.98	10	9.39	97	93	4
2022	99.78	99.78[A]	0[A]	0	.17	.05	2	1.92	2	1.85	100	100	0
2023	99.55	99.55[A]	0[A]	0	.15	.30	3	2.95	8	7.59	99	99	0
2024	99.69	95.58[A]	4.11[A]	0	.14	.17	1	.95	7	6.40	97	93	4
2025	99.50	98.49	1.01[A]	0	.13	.37	4	3.96	8	7.71	98	97	1
2026	99.57	94.38[A]	5.19[A]	0	.19	.24	0	0	9	8.25	96	91	5
2027	99.73	96.71	3.02[A]	0	.12	.15	2	1.93	7	6.55	99	96	3
2028	99.59	99.59[A]	0[A]	0	.17	.24	3	2.88	6	5.49	97	97	0
2029	99.78	98.73[A]	1.05	0	.12	.10	1	.97	5	4.61	95	94	1
2030	99.39	98.36	1.03[A]	0	.31	.30	4	3.84	3	2.72	96	95	1
2031	99.82	98.78[A]	1.04	0	.13	.05	7	6.82	2	1.92	96	95	1
2032	99.52	97.40	2.12	0	.20	.28	9	8.78	5	4.83	94	92	2
2033	99.68	99.68[A]	0[A]	0	.20	.12	1	.98	7	6.59	98	98	0
2034	99.81	99.81[A]	0[A]	0	.12	.07	2	1.96	5	4.59	94	94	0
2035	99.78	97.74	2.04	0	.12	.10	2	1.94	3	2.79	98	96	2

Appendix Table 5. (cont.)

Sample Number	Pure Seed %	Annual Rye-grass %	Perennial Ryegrass %	Other Crop %	Inert Matter %	Weed %	Total Nox. Weed	Total Nox. Weed by Wgt.	Rattail Fescue	Rattail Fescue by Wgt.	Germi-nation %	Fluor.	Nonfluor.
2036	99.36	98.30	1.06	0	.43	.21	8	7.76	6	5.47	94	93	1
2037	99.82	98.77[A]	1.05	0	.05	.13	5	4.90	6	5.81	95	94	1
2038	99.79	98.76[A]	1.03[A]	0	.15	.06	2	1.94	4	3.64	97	96	1
2039	99.73	97.67	2.06	0	.17	.10	2	1.90	6	5.64	97	95	2
2040	99.62	97.55	2.07	0	.19	.19	2	1.91	3	2.75	96	94	2
2041	99.73	97.65	2.08	0	.10	.17	3	2.94	2	1.88	96	94	2
2042	99.83	97.81	2.02	0	.10	.07	3	2.89	3	2.75	99	97	2
2043	99.55	97.48	2.07	0	.23	.22	4	3.83	4	3.83	96	94	2
2044	99.79	98.74[A]	1.05	0	.05	.16	4	3.91	3	2.73	95	94	1
2045	99.75	98.71[A]	1.04	0	.10	.15	2	1.96	2	1.89	96	95	1
2046	99.41	98.35	1.06	0	.39	.20	1	.98	5	4.69	94	93	1
2047	99.37	97.26	2.11	0	.15	.48	6	5.84	8	7.46	94	92	2
2048	99.70	98.70[A]	1.00[A]	0	.15	.15	2	1.98	4	3.84	100	99	1
2049	99.73	99.73[A]	0 [A]	0	.17	.10	3	2.94	5	4.65	98	98	0
2050	99.68	98.65	1.03[A]	0	.20	.12	2	1.96	5	4.77	97	96	1
2051	99.59	99.59[A]	0 [A]	0	.23	.18	2	1.96	4	3.91	97	97	0
2052	99.75	94.66[A]	5.09[A]	0	.08	.17	2	1.97	4	3.87	98	93	5
2053	99.54	97.47	2.07	0	.13	.33	4	3.85	5	4.91	96	94	2
2054	99.52	95.33[A]	4.19[A]	0	.12	.36	3	2.90	5	4.57	95	91	4
2055	99.40	99.40	0 [A]	0	.31	.29	2	1.93	9	8.28	95	95	0
2056	99.72	96.60	3.12[A]	0	.15	.13	5	4.92	2	1.94	96	93	3
2057	99.69	99.69[A]	0 [A]	0	.19	.12	5	4.88	8	7.44	95	95	0
2058	99.59	97.45	2.14[A]	0	.33	.08	2	1.97	3	2.92	93	91	2
2059	99.48	99.48	0 [A]	0	.15	.37	6	5.88	11	10.45	99	99	0
2060	99.56	95.45[A]	4.11[A]	0	.22	.22	3	2.94	4	3.75	97	93	4
2061	99.65	98.61	1.04	0	.08	.27	6	5.92	3	2.88	96	95	1
2062	99.37	96.17	3.20[A]	0	.20	.43	8	7.81	7	6.85	93	90	3
2063	99.69	98.65	1.04	0	.12	.19	5	4.87	5	4.66	96	95	1
2064	99.65	97.53	2.12[A]	0	.25	.10	5	4.87	3	2.84	94	92	2
2065	99.70	97.51	2.19	0	.15	.15	5	4.94	2	1.93	91	89	2
2066	99.44	93.35[A]	6.09[A]	0	.24	.32	3	2.94	6	5.59	98	92	6
2067	99.52	96.41[A]	3.11[A]	0	.29	.19	6	5.84	3	2.74	96	93	3
2068	99.12	95.99[A]	3.13[A]	0	.44	.44	3	2.92	5	4.67	95	92	3
2069	99.41	97.36	2.05	0	.40	.19	5	4.85	4	3.78	97	95	2
2070	99.66	97.63	2.03	0	.27	.07	5	4.84	4	3.82	98	96	2

Appendix Table 5. (cont.)

Sample Number	Pure Seed %	Annual Rye-grass %	Perennial Ryegrass %	Other Crop %	Inert Matter %	Weed %	Total Nox. Weed	Total Nox. Weed by Wgt.	Rattail Fescue	Rattail Fescue by Wgt.	Germi-nation %	Fluor.	Nonfluor.
2071	99.65	99.65[A]	0 [A]	0	.30	.05	0	0	3	2.90	98	98	0
2072	99.75	97.63	2.12	0	.05	.20	4	3.94	3	2.93	94	92	2
2073	99.54	97.47	2.07	0	.13	.33	3	2.94	7	6.84	96	94	2
2074	99.53	97.52	2.01	0	.15	.32	3.	2.91	6	5.63	99	97	2
2075	99.82	99.82[A]	0 [A]	0	.13	.05	0	0	3	2.97	96	96	0
2076	99.72	97.66	2.06	0	.10	.18	3	2.94	6	5.92	97	95	2
2077	99.43	99.43[A]	0 [A]	0	.17	.40	4	3.86	6	5.73	94	94	0
2078	99.46	94.33[A]	5.13[A]	0	.34	.20	1	.96	10	9.43	97	92	5
2079	99.73	98.70[A]	1.03[A]	0	.10	.17	2	1.94	2	1.85	97	96	1
2080	99.77	98.73[A]	1.04	0	.15	.08	4	3.93	5	4.82	96	95	1
2081	99.71	94.46[A]	5.25[A]	0	.16	.13	0	0	8	8.03	95	90	5
2082	99.26	97.17	2.09	0	.10	.64	7	6.84	10	9.39	95	93	2
2083	99.65	97.57	2.08	0	.15	.20	5	4.92	4	3.80	96	94	2
2084	99.63	96.55[A]	3.08[A]	0	.10	.27	0	0	5	4.79	97	94	3
2085	99.75	98.71[A]	1.04	0	.20	.05	0	0	1	.94	96	95	1
2086	99.66	98.61	1.05	0	.24	.10	2	1.92	4	3.68	95	94	1
2087	99.64	97.54	2.10	0	.22	.14	1	.97	7	6.49	95	93	2
2088	99.68	99.68[A]	0 [A]	0	.05	.27	4	3.91	4	3.83	97	97	0
2089	99.70	97.67	2.03	0	.25	.05	3	2.89	3	2.85	98	96	2
2090	99.65	97.60	2.05	0	.21	.14	3	2.90	7	6.37	97	95	2
2091	99.46	98.45	1.01[A]	0	.27	.27	2	1.94	7	6.52	98	97	1
2092	99.50	97.47	2.03	0	.33	.17	1	.95	10	9.07	98	96	2
2093	99.55	99.55[A]	0 [A]	0	.38	.07	2	1.95	5	4.51	93	93	0
2094	99.48	97.36	2.12	0	.45	.07	3	2.91	2	1.90	94	92	2
2095	98.94[A]	96.88	2.06	0	.54	.52	2	1.92	12	11.34	96	94	2
2096	99.38	97.35	2.03	0	.45	.17	5	4.70	3	2.74	98	96	2
2097	99.50	96.42[A]	3.08[A]	0	.19	.31	3	2.92	10	9.15	97	94	3
2098	99.68	99.68[A]	0 [A]	0	.22	.10	3	2.93	5	4.75	98	98	0
2099	99.61	97.56	2.05	0	.27	.12	3	2.87	9	8.38	97	95	2
2100	99.36	96.16[A]	3.20[A]	0	.52	.12	4	3.91	6	5.46	93	90	3
2101	99.43	98.35	1.08	0	.21	.36	4	3.75	5	4.57	92	91	1
2102	99.26	98.22	1.04	0	.52	.22	4	3.79	8	7.58	95	94	1
2103	99.75	98.72[A]	1.03[A]	0	.20	.05	3	2.92	4	3.78	97	96	1
2104	99.60	96.55[A]	3.05[A]	0	.25	.15	4	3.95	5	4.78	98	95	3
2105	99.61	99.61[A]	0 [A]	0	.25	.14	4	3.84	8	7.51	98	98	0

Appendix Table 5. (cont.)

Sample Number	Pure Seed %	Annual Rye-grass %	Perennial Ryegrass %	Other Crop %	Inert Matter %	Weed %	Total Nox. Weed	Total Nox. Weed by Wgt.	Rattail Fescue	Rattail Fescue by Wgt.	Germi-nation %	Fluor.	Nonfluor.
2106	99.09	96.98	2.11	0	.71	.20	4	3.90	6	5.80	94	92	2
2107	99.51	97.48	2.03	0	.32	.17	1	.97	6	5.70	98	96	2
2108	99.71	96.66	3.05[A]	0	.24	.05	0	0	2	1.84	98	95	3
2109	99.33	98.25	1.08	0	.25	.42	5	4.82	7	6.63	92	91	1
2110	99.33	96.35[A]	2.98[A]	0	.60	.07	1	.97	4	3.81	100	97	3
2111	99.29	96.25[A]	3.04[A]	0	.21	.50	5	4.83	5	4.54	98	95	3
2112	99.22	97.11	2.11	0	.38	.40	4	3.83	6	5.77	94	92	2
2113	99.61	96.50[A]	3.11[A]	0	.27	.12	2	1.94	6	5.60	96	93	3
2114	99.56	98.51	1.05	0	.26	.18	2	1.98	7	6.86	95	94	1
2115	99.62	99.62[A]	0[A]	0	.28	.10	1	.99	5	4.89	96	96	0
2116	99.61	98.61	1.00[A]	0	.12	.27	1	.97	7	6.52	100	99	1
2117	99.83	98.80[A]	1.03[A]	0	.10	.07	1	.98	5	4.69	97	96	1
2118	99.56	94.43[A]	5.13[A]	0	.17	.27	7	6.87	3	2.78	97	92	5
2119	99.71	98.71[A]	1.00[A]	0	.27	.02	1	.97	1	.94	100	99	1
2120	99.49	95.26[A]	4.23[A]	0	.27	.24	4	3.93	7	6.55	94	90	4
2121	99.68	97.60	2.08	0	.17	.15	2	1.94	2	1.89	96	94	2
2122	99.70	99.70[A]	0[A]	0	.25	.05	2	1.93	2	1.93	98	98	0
2123	99.67	98.61	1.06	0	.25	.08	2	1.95	5	4.83	94	93	1
2124	99.55	98.50	1.05	0	.24	.21	2	1.91	3	2.74	95	94	1
2125	99.36	98.35	1.01[A]	0	.29	.35	7	6.82	3	2.74	98	97	1
2126	99.57	98.51	1.06	0	.23	.20	5	4.88	4	3.84	94	93	1
2127	99.69	96.61	3.08[A]	0	.21	.10	0	0	6	5.48	97	94	3
2128	99.52	96.41[A]	3.11[A]	0	.25	.23	5	4.97	3	2.91	96	93	3
2129	99.55	97.48	2.07	0	.23	.22	2	1.99	4	3.84	96	94	2
2130	99.74	98.74[A]	1.00[A]	0	.11	.15	0	0	6	5.67	100	99	1
2131	99.56	99.56[A]	0[A]	0	.22	.22	2	1.94	2	1.85	97	97	0
2132	99.69	98.64	1.05	0	.17	.14	4	3.86	4	3.68	95	94	1
2133	99.67	98.65	1.02[A]	0	.18	.15	1	.96	9	8.70	98	97	1
2134	99.48	98.48	1.00[A]	0	.47	.05	1	.96	3	2.70	99	98	1
2135	99.74	95.71[A]	4.03[A]	0	.19	.07	2	1.92	4	3.73	99	95	4
2136	99.42	99.42[A]	0[A]	0	.51	.07	1	.97	5	4.66	98	98	0
2137	99.52	99.52[A]	0[A]	0	.41	.07	1	.96	4	3.69	98	98	0
2138	99.44	99.44[A]	0[A]	0	.27	.29	2	1.91	9	8.38	98	98	0
2139	99.79	97.71	2.08	0	.19	.02	8	7.71	0	0	96	94	2
2140	99.42	98.38	1.04	0	.48	.10	0	0	7	6.75	96	95	1

Appendix Table 5. (cont.)

Sample Number	Pure Seed %	Annual Rye-grass %	Perennial Ryegrass %	Other Crop %	Inert Matter %	Weed %	Total Nox. Weed	Total Nox. Weed by Wgt.	Rattail Fescue	Rattail Fescue by Wgt.	Germi-nation %	Fluor.	Nonfluor.
2141	99.63	96.55[A]	3.08[A]	0	.17	.20	1	.98	2	1.90	97	94	3
2142	99.65	99.65[A]	0 [A]	0	.20	.15	1	.99	8	7.66	92	92	0
2143	99.73	98.70[A]	1.03[A]	0	.27	0	0	0	0	0	97	96	1
2144	99.68	96.60	3.08[A]	0	.22	.10	2	1.98	5	4.75	97	94	3
2145	99.33	97.28	2.05	0	.24	.43	9	8.76	3	2.75	97	95	2
2146	99.35	99.35[A]	0 [A]	0	.22	.43	2	1.97	12	11.07	98	98	0
2147	99.69	97.66	2.03	0	.19	.12	5	4.86	7	6.49	98	96	2
2148	99.64	98.61	1.03[A]	0	.23	.13	1	.97	7	6.80	97	96	1
2149	99.15	96.15[A]	3.00[A]	0	.54	.31	3	2.90	10	9.86	99	96	3
2150	99.75	97.71	2.04	0	.13	.12	2	1.94	7	6.77	98	96	2
2151	99.78	95.71[A]	4.07[A]	0	.12	.10	1	.98	4	3.73	98	94	4
2152	99.77	98.76	1.01[A]	0	.10	.13	2	1.97	6	5.86	99	98	1
2153	99.56	97.55	2.01	0	.20	.24	4	3.85	5	4.72	99	97	2
2154	99.54	97.49	2.05	0	.31	.15	2	1.98	8	7.85	97	95	2
2155	99.42	96.31[A]	3.11[A]	0	.25	.33	0	0	15	14.47	96	93	3
2156	99.36	98.34	1.02[A]	0	.52	.12	6	5.80	6	5.72	97	96	1
2157	99.85	98.82[A]	1.03[A]	0	.10	.05	3	2.90	3	2.95	97	96	1
2158	99.70	98.66	1.04	0	.10	.20	2	1.97	4	3.82	96	95	1
2159	99.25	95.12[A]	4.13[A]	0	.24	.51	7	6.76	3	2.81	96	92	4
2160	99.26	94.14[A]	5.12[A]	0	.25	.49	5	4.91	7	6.63	97	92	5
2161	99.65	98.58	1.07	0	.33	.02	0	0	2	1.92	93	92	1
2162	99.68	95.30[A]	4.38[A]	0	.25	.07	1	.96	4	3.78	91	87	4
2163	99.60	95.32[A]	4.28[A]	0	.20	.20	5	4.80	4	3.79	93	89	4
2164	99.58	98.53	1.05	0	.16	.26	3	2.89	6	5.41	95	94	1
2165	99.67	96.49[A]	3.18[A]	0	.28	.05	1	.98	4	3.83	94	91	3
2166	99.18	96.05[A]	3.13[A]	0	.75	.07	1	.97	6	5.74	95	92	3
2167	99.33	96.23[A]	3.10[A]	0	.30	.37	3	2.93	11	10.51	96	93	3
2168	99.33	99.33[A]	0 [A]	0	.41	.26	2	1.94	6	5.51	94	94	0
2169	99.26	96.09[A]	3.17[A]	0	.54	.20	1	.98	8	7.53	94	91	3
2170	99.49	98.44	1.05	0	.27	.24	2	1.95	3	2.81	95	94	1
2171	99.78	96.42[A]	3.36[A]	0	.10	.12	2	1.95	5	4.59	89	86	3
2172	99.61	93.38[A]	6.23[A]	0	.27	.12	4	3.90	8	7.45	96	90	6
2173	99.63	98.57	1.06	.02[A]	.07	.28	3	2.91	8	7.21	94	93	1
2174	99.51	98.50	1.01[A]	0	.17	.32	5	4.91	3	2.82	98	97	1
2175	99.75	95.51[A]	4.24[A]	0	.15	.10	0	0	2	1.91	94	90	4

Appendix Table 5. (cont.)

Sample Number	Pure Seed %	Annual Rye-grass %	Perennial Ryegrass %	Other Crop %	Inert Matter %	Weed %	Total Nox. Weed	Total Nox. Weed by Wgt.	Rattail Fescue	Rattail Fescue By Wgt.	Germi-nation %	Fluor.	Nonfluor.
2176	99.64	96.49[A]	3.15[A]	0	.10	.26	2	1.96	4	3.68	95	92	3
2177	99.76	98.73[A]	1.03[A]	0	.17	.07	1	.96	4	3.76	97	96	1
2178	99.75	97.58	2.17	0	.15	.10	3	2.85	6	5.69	92	90	2
2179	99.64	98.57	1.07	0	.22	.14	4	3.91	7	6.42	93	92	1
2180	99.67	99.67[A]	0[A]	0	.24	.09	4	3.88	5	4.56	96	96	0

A: Observation in violation of state seed labeling laws only for percentage pure seed, annual ryegrass, perennial ryegrass, other crop, inert matter, and weed factors (see study one).

Appendix Table 6. Detailed experimental data on bag-samples for all analysis factors for seed lot AR3.

Sample Number	Pure Seed %	Annual Rye-grass %	Perennial Ryegrass %	Other Crop %	Inert Matter %	Weed %	Total Nox. Weed	Total Nox. Weed by Wgt.	Rattail Fescue	Rattail Fescue by Wgt.	Germi-nation %	Fluor.	Nonfluor.
3001	99.76	98.71	1.05	0	.11	.13	6	5.72	2	1.89	95	94	1
3002	99.20	99.20[A]	0 [A]	.13	.45	.22	5	4.89	1	.92	93	93	0
3003	99.46	96.32[A]	3.14[A]	0	.41	.13	4	3.85	5	4.58	95	92	3
3004	99.54	98.45	1.09	.07	.20	.19	7	6.65	0	0	91	90	1
3005	99.63	98.56	1.07	.15	.18	.04	8	7.77	0	0	93	92	1
3006	99.62	99.62[A]	0 [A]	0	.19	.19	0	0	9	8.20	95	95	0
3007	99.82	99.82[A]	0 [A]	0	.07	.11	0	0	5	4.76	96	96	0
3008	99.61	98.57	1.04	0	.09	.30	0	0	9	8.35	96	95	1
3009	99.58	98.55	1.03	0	.24	.18	0	0	8	7.50	97	96	1
3010	99.52	98.49	1.03	.13	.24	.11	0	0	4	3.79	97	96	1
3011	99.36	97.20[A]	2.16[A]	0	.33	.31	2	1.96	4	3.81	92	90	2
3012	99.31	99.31[A]	0 [A]	.07	.44	.18	4	3.82	5	4.89	95	95	0
3013	99.67	98.60	1.07	.07	.22	.04	0	0	2	1.90	93	92	1
3014	99.47	98.39	1.08	.14	.30	.09	4	3.84	4	3.97	92	91	1
3015	99.32	95.27[A]	4.05[A]	0	.25	.43	5	4.93	4	3.87	98	94	4
3016	99.42	98.36	1.06	.09	.38	.11	3	2.88	5	4.73	94	93	1
3017	99.74	98.69	1.05	.04	.11	.11	0	0	4	3.68	95	94	1
3018	99.10	98.01	1.09	.11	.55	.24	2	1.92	4	3.78	91	90	1
3019	99.15	98.07	1.08	.04	.35	.46	8	7.73	5	4.71	92	91	1
3020	99.48	98.43	1.05	.11	.23	.18	1	.98	4	3.90	95	94	1
3021	99.69	98.66	1.03	0	.11	.20	1	.98	5	4.81	97	96	1
3022	99.82	98.75	1.07	0	.16	.02	0	0	2	1.95	93	92	1
3023	99.59	99.59[A]	0 [A]	.15	.22	.04	0	0	2	1.88	96	96	0
3024	99.66	96.51[A]	3.15[A]	.07	.09	.18	1	.97	3	2.88	95	92	3
3025	99.44	98.32	1.12	.16	.34	.06	2	1.96	0	0	89	88	1
3026	99.33	99.33[A]	0 [A]	.16	.21	.30	3	2.90	4	3.97	93	93	0
3027	99.71	97.65	2.06[A]	0	.20	.09	3	2.95	4	3.80	97	95	2
3028	99.44	97.37[A]	2.07[A]	.07	.36	.13	3	2.94	1	.95	96	94	2
3029	99.33	97.24[A]	2.09[A]	.22	.15	.30	4	3.86	10	9.23	95	93	2
3030	99.39	99.39[A]	0 [A]	.11	.34	.16	1	.98	3	2.88	91	91	0
3031	99.51	99.51[A]	0 [A]	.07	.27	.15	2	1.93	1	.94	92	92	0
3032	99.25	99.25[A]	0 [A]	.20	.42	.13	3	2.91	2	1.88	92	92	0
3033	99.10	95.97[A]	3.13[A]	.33	.42	.15	2	1.90	3	2.82	95	92	3
3034	99.49	99.49[A]	0 [A]	.16	.30	.05	2	1.92	2	1.96	92	92	0
3035	99.59	98.57	1.02	.16	.23	.02	0	0	1	.97	98	97	1
3036	99.55	99.55[A]	0 [A]	.20	.07	.18	2	1.95	1	.95	98	98	0
3037	99.60	98.58	1.02	.06	.21	.13	3	2.92	3	2.74	98	97	1

Appendix Table 6. (cont.)

Sample Number	Pure Seed %	Annual Rye-grass %	Perennial Ryegrass %	Other Crop %	Inert Matter %	Weed %	Total Nox. Weed	Total Nox. Weed by Wgt.	Rattail Fescue	Rattail Fescue by Wgt.	Germi-nation %	Fluor.	Nonfluor.
3038	99.29	98.28	1.01	.22	.27	.22	4	3.89	2	1.91	99	96	3
3039	99.25	97.07[A]	2.18[A]	.23	.27	.25	3	2.87	1	.97	91	89	2
3040	98.93	98.93	0[A]	.09	.63	.35	2	1.94	7	6.51	97	97	0
3041	99.30	99.30[A]	0[A]	.11	.41	.18	4	3.89	3	2.90	92	92	0
3042	99.75	99.75[A]	0[A]	.06	.17	.02	3	2.93	1	.92	94	94	0
3043	99.61	98.56	1.05	.19	.20	0	5	4.91	0	0	95	94	1
3044	99.28	99.28[A]	0[A]	.28	.24	.20	6	5.82	3	2.80	95	95	0
3045	99.09	98.01	1.08	.16	.40	.35	3	2.92	1	.95	92	91	1
3046	99.07	98.00	1.07	.30	.56	.07	3	2.91	2	1.98	93	92	1
3047	99.59	98.55	1.04	.07	.18	.16	7	6.78	3	2.93	96	95	1
3048	99.24	96.11[A]	3.13[A]	.18	.37	.21	5	4.83	3	2.95	95	92	3
3049	99.25	98.18	1.07	.07	.58	.10	1	.98	4	3.79	93	92	1
3050	99.11	98.09	1.02	.23	.37	.29	7	6.86	5	4.89	97	96	1
3051	99.80	97.70	2.10[A]	0	.13	.07	0	0	2	1.90	95	93	2
3052	99.87	98.83	1.04	0	.11	.02	1	.98	1	.95	96	95	1
3053	99.86	97.82	2.04[A]	0	.14	0	0	0	0	0	98	96	2
3054	99.77	97.69	2.08[A]	0	.14	.09	1	.99	3	2.91	96	94	2
3055	99.82	98.77	1.05	0	.07	.11	0	0	3	2.88	95	94	1
3056	99.74	98.69	1.05	0	.13	.13	1	.97	7	6.65	95	94	1
3057	99.82	99.82[A]	0[A]	0	.09	.09	0	0	2	1.92	95	95	0
3058	99.84	99.84[A]	0[A]	0	.09	.07	0	0	2	1.93	92	92	0
3059	99.73	97.38[A]	2.35[A]	0	.25	.02	0	0	0	0	85	83	2
3060	99.84	99.84[A]	0[A]	0	.11	.05	0	0	2	1.94	93	93	0
3061	99.79	99.79[A]	0[A]	0	.16	.05	0	0	3	2.95	98	98	0
3062	99.51	99.51[A]	0[A]	0	.36	.13	0	0	5	4.78	94	94	0
3063	99.73	99.73[A]	0[A]	0	.18	.09	0	0	4	3.82	97	97	0
3064	99.87	98.81	1.06	.02	.11	0	0	0	0	0	94	93	1
3065	99.75	99.75[A]	0[A]	0	.23	.02	1	.97	1	.97	95	95	0
3066	99.68	99.68[A]	0[A]	0	.18	.14	0	0	4	3.95	94	94	0
3067	99.68	98.57	1.11	0	.27	.05	1	.99	1	.97	90	89	1
3068	99.77	99.77[A]	0[A]	0	.09	.14	0	0	5	4.82	96	96	0
3069	99.74	99.74[A]	0[A]	0	.22	.04	0	0	1	.93	95	95	0
3070	99.73	99.73[A]	0[A]	0	.09	.18	0	0	7	6.87	95	95	0
3071	99.51	98.44	1.07	0	.28	.21	1	.99	2	2.02	93	92	1
3072	99.84	97.72	2.12[A]	0	.14	.02	1	.96	0	0	94	92	2
3073	99.78	99.78[A]	0[A]	0	.13	.09	0	0	3	2.84	96	96	0
3074	99.38	99.38[A]	0[A]	0	.48	.14	0	0	3	2.94	98	98	0

Appendix Table 6. (cont.)

Sample Number	Pure Seed %	Annual Rye-grass %	Perennial Ryegrass %	Other Crop %	Inert Matter %	Weed %	Total Nox. Weed	Total Nox. Weed by Wgt.	Rattail Fescue	Rattail Fescue by Wgt.	Germi-nation %	Fluor.	Nonfluor.
3075	99.62	99.62[A]	0[A]	0	.24	.14	0	0	3	3.02	97	97	0
3076	99.70	95.46[A]	4.24[A]	0	.21	.09	0	0	2	1.95	94	90	4
3077	99.86	98.80	1.06	0	.05	.09	0	0	3	2.97	94	93	1
3078	99.59	99.59[A]	0[A]	0	.36	.05	1	.97	1	.97	91	91	0
3079	99.37	99.37[A]	0[A]	0	.33	.30	0	0	14	12.97	98	98	0
3080	99.51	97.42	2.09[A]	0	.13	.36	0	0	15	14.28	95	93	2
3081	99.55	97.48	2.07[A]	0	.20	.25	3	2.93	10	9.72	96	94	2
3082	99.68	98.65	1.03	0	.05	.27	0	0	11	10.74	97	96	1
3083	99.30	98.28	1.02	.18	.18	.34	0	0	14	13.42	97	96	1
3084	99.31	96.17[A]	3.14[A]	0	.20	.49	3	2.87	13	12.04	95	92	3
3085	99.45	95.39[A]	4.06[A]	0	.21	.34	0	0	12	11.71	98	94	4
3086	99.16	99.16	0[A]	0	.41	.43	2	1.94	10	9.27	95	95	0
3087	99.17	97.15[A]	2.02[A]	0	.27	.56	5	4.91	17	16.24	98	96	2
3088	99.42	98.35	1.07	0	.21	.37	1	.98	17	16.97	93	92	1
3089	99.24	96.07[A]	3.17[A]	0	.29	.47	4	3.83	17	16.42	94	91	3
3090	99.54	99.54[A]	0[A]	0	.12	.34	3	2.90	7	6.92	92	92	0
3091	99.31	98.27	1.04	0	.35	.34	0	0	15	14.74	95	94	1
3092	99.46	96.32[A]	3.14[A]	.07	.16	.31	4	3.94	13	12.57	95	92	3
3093	99.08	99.08	0[A]	.05	.18	.69	3	2.88	23	22.13	98	98	0
3094	99.50	99.50[A]	0[A]	0	.23	.27	0	0	10	9.67	97	97	0
3095	99.40	99.40[A]	0[A]	0	.09	.51	4	3.85	18	17.12	98	98	0
3096	99.24	98.16	1.08	.07	.28	.41	1	.97	14	13.81	92	91	1
3097	99.31	99.31[A]	0[A]	.09	.30	.30	1	.96	14	12.93	96	96	0
3098	99.17	98.16	1.01	0	.38	.45	1	.96	21	20.19	98	97	1
3099	99.34	99.34[A]	0[A]	0	.17	.49	4	3.92	14	12.86	96	96	0
3100	99.56	98.51	1.05	0	.19	.25	2	1.95	11	10.93	95	94	1
3101	99.45	97.36[A]	2.09[A]	0	.28	.27	0	0	11	10.85	95	93	2
3102	99.47	98.38	1.09	0	.23	.30	1	.99	10	9.84	91	90	1
3103	99.48	99.48[A]	0[A]	0	.11	.41	3	2.85	17	15.67	95	95	0
3104	99.39	98.33	1.06	.07	.20	.34	1	.98	16	15.31	94	93	1
3105	99.34	98.33	1.01	.14	.11	.41	0	0	17	16.45	98	97	1
3106	99.54	99.54[A]	0[A]	0	.21	.25	1	.98	8	7.88	94	94	0
3107	99.24	95.93[A]	3.31[A]	0	.27	.49	1	.97	9	8.58	90	87	3
3108	98.87	95.57[A]	3.30[A]	.12	.32	.69	0	0	23	22.70	90	87	3
3109	99.13	98.08	1.05	0	.23	.64	0	0	25	24.37	94	93	1
3110	99.27	97.29[A]	1.98[A]	.09	.27	.37	0	0	14	13.64	100	98	2
3111	99.48	99.48[A]	0[A]	0	.23	.29	1	.99	10	9.68	95	95	0

Appendix Table 6. (cont.)

Sample Number	Pure Seed %	Annual Rye-grass %	Perennial Ryegrass %	Other Crop %	Inert Matter %	Weed %	Total Nox. Weed.	Total Nox. Weed by Wgt.	Rattail Fescue	Rattail Fescue by Wgt.	Germi-nation %	Fluor.	Nonfluor.
3112	99.58	96.44[A]	3.14[A]	0	.12	.30	1	.97	10	9.95	95	92	3
3113	99.14	98.10	1.04	.07	.25	.54	1	.98	12	11.63	95	94	1
3114	99.40	98.33	1.07	0	.15	.45	4	3.86	17	15.50	93	92	1
3115	99.26	98.18	1.08	0	.27	.47	2	1.95	16	15.35	92	91	1
3116	99.73	97.70	2.03[A]	0	.16	.11	0	0	5	4.79	98	96	2
3117	99.50	99.50[A]	0[A]	0	.22	.28	2	1.92	11	10.18	93	93	0
3118	99.57	95.42[A]	4.15[A]	0	.11	.32	0	0	10	9.81	96	92	4
3119	99.39	98.33	1.06	.11	.11	.39	0	0	13	12.09	94	93	1
3120	99.67	97.59	2.08[A]	0	.11	.22	1	.98	7	6.49	96	94	2
3121	99.56	98.53	1.03	0	.05	.39	0	0	13	12.96	97	96	1
3122	99.59	99.59[A]	0[A]	0	.14	.27	0	0	7	6.75	96	96	0
3123	99.73	97.59	2.14[A]	0	.09	.18	0	0	6	5.67	93	91	2
3124	99.59	99.59[A]	0[A]	0	.07	.34	2	1.99	9	8.81	92	92	0
3125	99.37	98.34	1.03	0	.09	.54	1	.96	15	14.36	96	95	1
3126	99.80	99.80[A]	0[A]	0	.09	.11	0	0	3	2.85	95	95	0
3127	99.52	99.52[A]	0[A]	0	.20	.28	1	.96	8	7.50	88	88	0
3128	99.56	99.56[A]	0[A]	0	.13	.31	1	.98	9	8.41	93	93	0
3129	99.64	96.36[A]	3.28[A]	0	.06	.30	0	0	8	7.33	91	88	3
3130	99.48	99.48[A]	0[A]	0	.18	.34	1	.99	10	9.81	98	98	0
3131	99.50	97.41	2.09[A]	0	.23	.27	2	1.97	9	8.69	95	93	2
3132	99.56	99.56[A]	0[A]	0	.14	.30	0	0	9	8.88	95	95	0
3133	99.47	97.44	2.03[A]	0	.16	.37	1	.98	12	11.75	98	96	2
3134	99.36	99.36[A]	0[A]	0	.32	.32	1	.99	8	7.78	92	92	0
3135	99.77	98.70	1.07	0	.05	.18	0	0	7	6.79	93	92	1

A: Observation in violation of state seed labeling laws only for percentage pure seed, annual ryegrass, perennial ryegrass, other crop, inert matter, and weed factors (see study one).

Appendix Table 7. Detailed experimental data on bag-samples for all analysis factors for seed lot PR4.

Sample Number	Pure Seed %	Annual Rye-grass %	Perennial Ryegrass %	Other Crop %	Inert Matter %	Weed %	Rattail Fescue	Rattail Fescue by Wgt.	Orchard-grass	Orchard-grass by Wgt.	Germi-nation %	Fluor.	Nonfluor.
4001	99.34	3.55[A]	95.79[A]	.12	.36	.18	12	11.32	5	4.72	98	8	90
4002	99.62	6.03[A]	93.59[A]	.11	.23	.04	3	2.97	5	4.95	95	10	85
4003	99.27	4.91[A]	94.36[A]	.23	.42	.08	5	4.94	10	9.87	95	9	86
4004	99.46	0 [A]	99.46[A]	.10	.29	.15	6	5.82	5	4.85	94	3	91
4005	99.20	3.90[A]	95.30[A]	.36	.29	.15	6	5.89	16	15.71	94	8	86
4006	99.43	3.55[A]	95.88[A]	.13	.32	.12	3	2.97	5	4.95	98	8	90
4007	99.62	2.73[A]	96.89[A]	.15	.21	.02	2	1.98	6	5.95	95	7	88
4008	99.65	4.93[A]	94.72[A]	.23	.08	.04	4	3.89	8	7.78	95	9	86
4009	99.41	1.42[A]	97.99[A]	.17	.27	.15	5	4.91	7	6.87	98	6	92
4010	99.27	5.89[A]	93.38[A]	.13	.30	.30	6	5.97	5	4.97	96	10	86
4011	99.64	2.98[A]	96.66[A]	.21	.13	.02	2	1.99	9	8.96	92	7	85
4012	99.51	1.84[A]	97.67[A]	.13	.19	.17	12	11.85	5	4.94	92	6	86
4013	99.34	10.40	88.94[A]	.12	.37	.17	7	6.75	6	5.79	95	14	81
4014	98.88	2.71[A]	96.17[A]	.46	.42	.24	10	9.70	20	19.40	95	7	88
4015	98.95	1.61[A]	97.34[A]	.27	.61	.17	11	10.78	11	10.78	95	6	89
4016	99.26	2.64[A]	96.62[A]	.27	.34	.13	2	1.97	12	11.80	96	7	89
4017	99.32	1.69[A]	97.63[A]	.19	.28	.21	8	7.89	8	7.89	94	6	88
4018	99.44	2.64[A]	96.80[A]	.20	.22	.14	10	9.48	9	8.53	96	7	89
4019	98.54	10.65	87.89	.30	.80	.36	11	10.30	12	11.24	93	14	79
4020	99.14	6.85[A]	92.29[A]	.34	.27	.25	6	5.89	14	13.73	97	11	86
4021	99.39	4.01[A]	95.38[A]	.16	.33	.12	10	9.59	6	5.75	93	8	85
4022	99.31	1.91[A]	97.40[A]	.24	.37	.08	6	5.67	9	8.51	91	6	85
4023	99.27	1.35[A]	97.92[A]	.23	.21	.29	5	4.84	10	9.67	99	6	93
4024	99.22	9.30[A]	89.92[A]	.14	.31	.33	12	11.50	6	5.75	95	13	82
4025	98.93	18.61[A]	80.32[A]	.10	.59	.38	9	8.77	5	4.87	97	22	75
4026	98.14[A]	20.04[A]	78.10[A]	.22	.92	.72	16	14.91	8	7.46	95	23	72
4027	99.48	14.12	85.36	.10	.21	.21	9	8.78	5	4.88	93	17	76
4028	98.83	17.37[A]	81.46[A]	.41	.33	.43	20	19.17	19	18.21	93	20	73
4029	99.15	8.33[A]	90.82[A]	.37	.29	.19	13	12.54	15	14.47	94	12	82
4030	99.06	14.48	84.58	.29	.48	.17	9	8.78	10	9.75	91	17	74
4031	99.54	68.87[A]	30.67[A]	.02	.36	.08	4	3.96	1	.99	92	65	27
4032	99.07	33.26[A]	65.81[A]	.19	.48	.26	4	3.87	8	7.74	98	36	62
4033	99.50	53.19[A]	46.31[A]	.08	.17	.25	9	8.75	3	2.92	97	54	43
4034	99.04	57.02[A]	42.02[A]	.19	.48	.29	14	13.69	7	6.85	99	59	40
4035	99.67	51.89[A]	47.78[A]	.06	.19	.08	3	2.95	3	2.95	92	50	42
4036	99.26	24.51[A]	74.75[A]	.32	.24	.18	10	9.33	13	12.13	99	28	71
4037	99.50	72.85[A]	26.65[A]	.04	.36	.10	4	3.89	2	1.95	98	73	25

Appendix Table 7. (cont.)

Sample Number	Pure Seed %	Annual Rye-grass %	Perennial Ryegrass %	Other Crop %	Inert Matter %	Weed %	Rattail Fescue	Rattail Fescue by Wgt.	Orchard-grass	Orchard-grass by Wgt.	Germi-nation %	Fluor.	Nonfluor.
4038	99.07	68.41[A]	30.66[A]	.02	.21	.70	17	16.82	1	.99	95	67	28
4039	99.16	80.37[A]	18.79[A]	.02	.19	.63	19	18.50	2	1.95	95	77	18
4040	99.24	67.43[A]	31.81[A]	.06	.24	.46	16	14.92	3	2.80	95	66	29
4041	99.38	67.53[A]	31.85[A]	.04	.28	.30	13	12.95	2	1.99	95	66	29
4042	99.41	80.14[A]	19.27[A]	0	.36	.23	13	12.82	0	0	98	79	19
4043	98.77	0[A]	98.77[A]	.04	.47	.72	31	30.53	0	0	91	4	87
4044	99.22	0[A]	99.22[A]	0	.27	.51	29	27.88	0	0	98	0	98
4045	99.18	0[A]	99.18[A]	0	.30	.52	28	26.24	0	0	93	3	90
4046	99.10	.76[A]	98.34[A]	0	.25	.65	30	29.20	0	0	91	5	86
4047	99.10	.52[A]	98.58[A]	.04	.37	.49	28	26.79	1	.96	95	5	90
4048	99.48	0[A]	99.48[A]	0	.22	.30	15	15.05	0	0	93	2	91
4049	98.77	0[A]	98.77[A]	0	.43	.80	36	34.59	0	0	96	4	92
4050	98.66	0[A]	98.66[A]	.06	.46	.82	41	40.10	0	0	92	1	91
4051	98.16[A]	0[A]	98.16[A]	.09	.65	1.10[A]	54	54.33	0	0	96	4	92
4052	98.65	0[A]	98.65[A]	.08	.52	.75	34	32.91	1	.97	89	4	85
4053	98.78	0[A]	98.78[A]	.12	.53	.57	31	29.58	2	1.91	92	4	88
4054	98.94	.89[A]	98.05[A]	0	.26	.80	40	39.69	0	0	89	5	84
4055	99.01	1.98[A]	97.03[A]	0	.37	.62	29	28.08	0	0	90	6	84
4056	98.78	.70[A]	98.08[A]	.02	.43	.77	32	32.08	1	1.00	92	5	87
4057	99.01	0[A]	99.01[A]	.06	.39	.54	22	22.04	0	0	88	4	84
4058	98.94	1.83[A]	97.11[A]	.04	.30	.72	29	28.51	0	0	92	6	86
4059	98.36	1.09[A]	97.27[A]	.06	.51	1.07[A]	29	28.96	0	0	86	5	81
4060	98.45	1.82[A]	96.63[A]	.08	.67	.80	26	25.38	1	.98	92	6	86
4061	99.30	16.76[A]	82.54[A]	.21	.34	.15	5	4.91	9	8.84	96	20	76
4062	99.07	14.55	84.52	.32	.23	.38	13	12.80	13	12.80	96	18	78
4063	98.99	4.79[A]	94.20[A]	.27	.40	.34	9	8.86	11	10.83	96	9	87
4064	98.87	13.06	85.81	.21	.63	.29	14	13.66	8	7.80	98	17	81
4065	99.56	6.03[A]	93.53[A]	.15	.17	.12	10	9.74	6	5.85	95	10	85
4066	99.15	9.44[A]	89.71[A]	.27	.39	.19	11	10.63	12	11.59	94	13	81
4067	99.04	41.74[A]	57.30[A]	.21	.39	.36	14	13.86	8	7.92	98	44	54
4068	98.94	39.09[A]	59.85[A]	.34	.30	.42	14	13.16	14	13.16	92	39	53
4069	99.15	32.22[A]	66.93[A]	.28	.21	.36	17	17.00	12	12.00	98	35	63
4070	99.33	44.49[A]	54.84[A]	.13	.23	.31	14	13.61	5	4.86	97	46	51
4071	99.32	29.80[A]	69.52[A]	.20	.24	.24	10	9.45	8	7.56	96	32	64
4072	99.15	16.54[A]	82.61[A]	.21	.19	.45	14	13.54	9	8.71	92	19	73
4073	99.77[A]	75.34[A]	24.43[A]	.15	.04	.04	2	1.94	6	5.82	98	74	24
4074	99.46	84.80[A]	14.66[A]	.12	.32	.10	2	1.87	5	4.67	95	81	14

Appendix Table 7. (cont.)

Sample Number	Pure Seed %	Annual Rye-grass %	Perennial Ryegrass %	Other Crop %	Inert Matter %	Weed %	Rattail Fescue	Rattail Fescue by Wgt.	Orchard-grass	Orchard-grass by Wgt.	Germi-nation %	Fluor.	Nonfluor.
4075	99.42	82.00[A]	17.42[A]	.08	.18	.32	16	15.01	3	2.81	97	80	17
4076	99.61	62.26[A]	37.35[A]	.04	.25	.10	3	2.92	2	1.94	98	63	35
4077	99.38	76.37[A]	23.01[A]	.11	.21	.30	7	6.96	4	3.98	95	73	22
4078	99.47	59.47[A]	40.00[A]	.21	.17	.15	4	3.98	9	8.95	94	58	36
4079	99.14	1.83[A]	97.31[A]	.15	.17	.54	28	27.50	6	5.89	92	6	86
4080	98.73	.52[A]	98.21[A]	.08	.64	.55	19	18.81	2	1.98	95	5	90
4081	99.35	21.11[A]	78.24[A]	.15	.31	.19	13	12.63	6	5.83	92	23	69
4082	99.70[A]	40.53[A]	59.17[A]	.10	.10	.10	4	3.86	4	3.86	92	40	52
4083	99.70[A]	47.36[A]	52.34[A]	.11	.11	.08	4	3.93	4	3.93	98	49	49
4084	99.77[A]	60.49[A]	39.28[A]	.08	.02	.13	6	5.89	3	2.94	96	60	36
4085	97.89[A]	0 [A]	97.89[A]	0	.40	1.71[A]	50	49.17	0	0	92	4	88
4086	98.27[A]	.69[A]	97.58[A]	.06	.57	1.10[A]	45	42.67	0	0	92	5	87
4087	98.48	.64[A]	97.84[A]	.10	.45	.97	39	37.40	0	0	93	5	88
4088	99.13	3.14[A]	95.99[A]	0	.44	.43	22	21.29	0	0	90	7	83
4089	98.61	0 [A]	98.61[A]	0	.73	.66	35	33.92	0	0	93	2	91
4090	98.63	.64[A]	97.99[A]	0	.85	.52	34	32.88	0	0	93	5	88
4091	98.34	0 [A]	98.34[A]	0	.89	.77	37	36.69	0	0	90	2	88
4092	98.87	.64[A]	98.23[A]	.02	.48	.63	32	31.10	0	0	93	5	88
4093	97.70[A]	3.66[A]	94.04[A]	0	.93	1.37[A]	50	50.18	0	0	96	8	88
4094	98.24[A]	0 [A]	98.24[A]	.06	.72	.98	34	33.62	0	0	92	3	89
4095	98.50	0 [A]	98.50[A]	.04	.58	.88	30	30.10	0	0	94	3	91
4096	98.85	0 [A]	98.85[A]	.08	.38	.69	34	33.36	0	0	95	4	91
4097	99.25	0 [A]	99.25[A]	0	.33	.42	24	23.26	0	0	96	1	95
4098	99.06	.52[A]	98.54[A]	.06	.42	.46	23	22.61	0	0	95	5	90
4099	99.07	0 [A]	99.07[A]	0	.33	.60	29	28.01	0	0	95	3	92
4100	99.23	3.81[A]	95.42[A]	0	.23	.54	33	32.08	0	0	95	8	87
4101	99.16	3.23[A]	95.93[A]	.02	.29	.53	30	28.50	1	.95	89	7	82
4102	99.17	0 [A]	99.17[A]	0	.28	.55	27	26.88	0	0	94	3	91
4103	98.49	0 [A]	98.49[A]	.02	.68	.81	38	37.66	1	.99	88	4	84
4104	98.86	0 [A]	98.86[A]	0	.41	.73	41	41.16	0	0	90	2	88
4105	99.17	0 [A]	99.17[A]	0	.29	.54	30	29.13	0	0	94	2	92
4106	99.24	1.76[A]	97.48[A]	0	.32	.44	30	29.68	0	0	93	6	87
4107	98.59	2.05[A]	96.54[A]	.13	.83	.45	29	28.86	0	0	89	6	83
4108	99.27	0 [A]	99.27[A]	.06	.23	.44	24	23.29	0	0	88	2	86
4109	99.16	1.55[A]	97.61[A]	.04	.34	.46	17	16.65	1	.98	96	6	90
4110	98.63	0 [A]	98.63[A]	.02	.73	.62	29	29.02	1	1.00	94	4	90
4111	98.98	0 [A]	98.98[A]	0	.45	.57	32	31.83	0	0	90	3	87

Appendix Table 7. (cont.)

Sample Number	Pure Seed %	Annual Rye-grass %	Perennial Ryegrass %	Other Crop %	Inert Matter %	Weed %	Rattail Fescue	Rattail Fescue by Wgt.	Orchard-grass	Orchard-grass by Wgt.	Germi-nation %	Fluor.	Nonfluor.
4112	98.67	1.82[A]	96.85[A]	0	.52	.81	43	40.43	0	0	92	6	86
4113	98.36	2.69[A]	95.67[A]	.02	.40	1.22[A]	48	46.90	0	0	95	7	88
4114	98.16[A]	4.05[A]	94.11[A]	0	.99	.85	49	46.04	0	0	92	8	84
4115	99.14	1.98[A]	97.16[A]	.08	.45	.33	20	19.27	0	0	90	6	84
4116	98.80	0[A]	98.80[A]	0	.66	.54	35	33.89	0	0	93	3	90
4117	99.14	.70[A]	98.44[A]	0	.36	.50	24	22.29	0	0	92	5	87
4118	99.03	0[A]	99.03[A]	0	.57	.40	23	22.59	0	0	88	3	85
4119	99.04	0[A]	99.04[A]	0	.34	.62	24	23.88	0	0	98	4	94
4120	98.79	0[A]	98.79[A]	.06	.45	.70	33	31.79	0	0	90	2	88
4121	98 88	0[A]	98.88[A]	.04	.71	.37	28	27.06	1	.97	92	1	91
4122	98.91	0[A]	98.91[A]	.04	.38	.67	30	29.19	0	0	89	4	85
4123	98.84	0[A]	98.84[A]	0	.52	.64	26	25.13	0	0	96	1	95
4124	99.41	0[A]	99.41[A]	0	.20	.39	20	18.99	0	0	93	2	91
4125	99.19	.96[A]	98.23[A]	.06	.19	.56	24	23.77	0	0	88	5	83
4126	99.64	.58[A]	99.06[A]	.14	.18	.04	2	1.87	6	5.62	94	5	89
4127	99.22	5.78[A]	93.44[A]	.12	.60	.06	6	5.79	6	5.79	97	10	87
4128	99.25	6.12[A]	93.13[A]	.19	.47	.09	6	6.01	6	6.01	94	10	84
4129	99.40	.52[A]	98.88[A]	.09	.47	.04	3	2.98	3	2.98	95	5	90
4130	99.29	0[A]	99.29[A]	.10	.51	.10	2	1.89	4	3.79	99	3	96
4131	99.57	.64[A]	98.93[A]	.11	.30	.02	1	.99	4	3.96	93	5	88
4132	99.51	0[A]	99.51[A]	.12	.35	.02	0	0	5	4.85	97	4	93
4133	99.37	6.13[A]	93.24[A]	.16	.43	.04	4	3.79	8	7.58	94	10	84
4134	99.50	1.62[A]	97.88[A]	.20	.26	.04	4	3.77	7	6.59	95	6	89
4135	99.60	0[A]	99.60[A]	.12	.26	.02	3	2.77	6	5.54	96	3	93
4136	99.65	1.56[A]	98.09[A]	.06	.23	.06	3	2.95	3	2.95	96	6	90
4137	99.25	1.55[A]	97.70[A]	.10	.61	.04	1	.95	4	3.82	96	6	90
4138	99.46	.36[A]	99.10[A]	.16	.32	.06	4	3.72	7	6.51	98	5	93
4139	98.78	0[A]	98.78[A]	.11	.99	.12	4	3.92	4	3.92	96	2	94
4140	99.56	.36[A]	99.20[A]	.18	.24	.02	2	1.89	9	8.53	98	5	93
4141	99.24	1.91[A]	97.33[A]	.13	.57	.06	5	4.92	2	1.97	91	6	85
4142	99.31	1.84[A]	97.47[A]	.16	.45	.08	4	3.82	7	6.69	92	6	86
4143	99.24	.25[A]	98.99[A]	.08	.57	.11	6	5.89	4	3.93	100	5	95
4144	99.37	3.64[A]	95.73[A]	.14	.39	.10	8	7.68	6	5.76	97	8	89
4145	99.48	.52[A]	98.96[A]	.08	.29	.15	10	9.72	3	2.92	95	5	90
4146	99.27	7.50[A]	91.77[A]	.18	.41	.14	10	9.45	7	6.61	92	11	81
4147	99.35	.47[A]	98.88[A]	.12	.49	.04	4	3.78	6	5.67	96	5	91
4148	99.31	0[A]	99.31[A]	.13	.46	.10	8	7.77	6	5.83	92	4	88
4149	99.16	1.91[A]	97.25[A]	.12	.66	.06	5	4.83	5	4.83	91	6	85
4150	99.55	0[A]	99.55[A]	.12	.29	.04	4	3.88	6	5.82	93	3	90

A: Observation in violation of state seed labeling laws only for percentage pure seed, annual ryegrass, perennial ryegrass, other crop, inert matter, and weed factors (see study one).