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Title: PERFORMANCE OF FIVE WINTER WHEAT CULTIVARS WHEN GROWN IN COMPOSITE AND PURE STAND POPULATIONS UNDER DIFFERENT ENVIRONMENTAL STRESSES

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Five genetically and morphologically different winter wheat cultivars, Hyslop (H), Yamhill (Y), Paha (P), Luke (L), and Sprague (S) were blended in all possible combinations. These composites plus the five pure stands were planted in the fall of 1973 at three environmentally diverse locations in Oregon: Hyslop Agronomy Farm, Corvallis; Central Oregon Experiment Station, Madras; and Sherman Experiment Station, Moro. A triple lattice design was selected because of the large number of treatments with five filler cultivars added to balance the experiment.

Eight traits, yield per plot, number of plants per plot, number of tillers per plot, number of heads per plant, yield per plant, number of kernels per head, 1000 kernel weight and plant height, were measured for each treatment. General and relative competitive ability of the cultivars in composite combinations and yield of pure stands

were determined and ranked for all locations. Specific competitive ability was determined for all composite treatments. General and specific competitive ability were defined as the grain yield of the component lines across all composite combinations and within single treatments, respectively. Relative competitive ability was defined as yield of the component lines versus its pure stand in composite combinations. The rank for general and relative competitive ability and yield of pure stands were Y>H>P>L>S, Y>P>H>L>S, and H>Y>L>S>P, respectively at Corvallis. Only Hyslop yielded significantly higher than the mean of five pure stands. However, Yamhill was superior for general and relative competitive ability at this location.

The rank of the component lines for general and relative competitive ability was the same at Madras (P>Y>H>S>L). But the yield rank of pure stands was different (L>H>Y>P>S). Luke and the composites, H+L+S, H+L, and H+Y+P yielded significantly higher than the mean of the five pure stands.

General and relative competitive ability of cultivars when grown at Moro was Y>H>P>L>S and H>Y>P>L>S, respectively. The rank for yield for pure stands was Y>H>L>P>S. Yamhill was superior for general competitive ability and as a pure stand. However, Hyslop was superior for relative competitive ability. Pure stand Yamhill, H+L and H+Y combinations yielded significantly higher than the mean of the five pure stands. The cultivars had the same rank for general competitive ability at Corvallis and Moro.

Significant differences were not found between treatments for yield in a combined analysis of variance. Analysis of variance indicated that treatments responded the same for all traits across all locations.

Paha was very susceptible (80 percent) to leaf rust (*Puccinia recondita*) at Corvallis in 1974. Hyslop was resistant with the other cultivars having a lower percentage of disease than Paha. The 15 composite combinations containing Paha had between 20 and 50 percent leaf rust. The yield of 14 out of 15 composite combinations exceeded that of pure stand Paha. The mean infection of the five pure stands was higher than the mean infection of those composite combinations containing Paha. Composites composed of lines with different sources of resistance to leaf rust reduced the overall amount of disease.

Composite populations were superior under stress or medium stress conditions whereas varieties *per se* were superior under ideal growing conditions. However the performance of a cultivar under pure stand conditions in a given environment is not a direct measure of its yielding ability in a composite. Therefore it will be necessary to test various composite combinations in different locations for several years before recommending a specific composite for commercial production.

Performance of Five Winter Wheat Cultivars When Grown in Composite and Pure Stand Populations Under Different Environmental Stresses

by

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IN DEDICATION TO

my son, wife, and parents

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PERFORMANCE OF FIVE WINTER WHEAT CULTIVARS WHEN GROWN IN COMPOSITE AND PURE STAND POPULATIONS UNDER DIFFERENT ENVIRONMENTAL STRESSES

INTRODUCTION

Historically the production of basic food crops such as cereal grains has been greatly dependent on the environment with large fluctuations occurring between regions and over years. This has resulted in surpluses and deficiencies which have not occurred in a predictable manner thus resulting in famine in many parts of the world. Therefore new approaches are needed by plant breeders for developing cultivars to not only expand but also to stabilize food production. Self-pollinated crops such as wheat have been developed as near pure-line cultivars and as a result, these cultivars are quite homozygous with little or no heterogeneity in the population. Several investigators have suggested that more genetic variability within a self-pollinated cultivar would be advantageous. The theoretical and practical advantages of diversity for self-pollinated crops have been discussed since the early 19th century. The advantages of blending or mixing self-pollinated crop cultivars most frequently cited are greater disease resistance and a wider adaptation with higher and more stabilized yield levels.

The state of Oregon with its great diversity of climatic conditions provides an excellent laboratory to evaluate the potential of using composite varieties versus nearly genetically pure lines. In this study five morphologically different winter wheat cultivars which were mixed in all possible combinations were grown as composite treatments and as pure stands. Three environmentally diverse locations in Oregon were used as the experimental sites.

To better understand the performance of composite populations and specifically the characteristics making up the component varieties, the following objectives are identified for this study:

1. Determine if there were significant differences for eight agronomic traits among all treatments.
2. Determine competitive ability of each cultivar within and across each composite treatment.
3. Compare yield levels of cultivars when grown in pure stands versus composite populations.
4. Determine location effects within and across treatments.

LITERATURE REVIEW

Properties of Composite Varieties

Composite varieties are formed by blending seed of genetically different lines which may or may not be phenotypically similar. Composite lines may be also developed through a series of back-crosses and selfings and then the selected lines are blended to form one desired composite or multiline (Borlaug, 1959). Composite varieties or populations can be characterized as follows: (1) The proportion of the lines in the composite is known, and it is possible to reconstitute the same composite variety or to modify the relative proportion of the component lines; (2) Yield of a composite variety is more stable than a pure line when environmental conditions vary (Poehlman, 1959 and Allard and Bradshaw, 1964); (3) Composites appear to be disease resistant and frequently escape infection (Borlaug, 1959 and Poehlman, 1959); (4) Generally a composite may have lower yields than the best component of composites in a normal season (Poehlman, 1959); (5) It is less expensive than breeding new varieties; (6) Seed certification is difficult with a composite variety due to the heterogeniety of plant type; (7) Pure lines have individual buffering (developmental homeostasis), whereas cross-pollinated crops have both individual and populational buffering (genetic homeostasis) because of different genotypes. Therefore, a composite of pure lines will have both individual and populational buffering due to different genotypes (Briggs and Knowels, 1967). Individual buffering is the ability of a single genotype to develop normally in spite of adverse conditions of the environment. In contrast, populational buffering is the ability of a population to perform in a steady state regardless of adverse conditions of the environment because of differences in the genotypes (ACS 415 course notes, 1973).

The specific and general adaptation of composite populations was noted by Simmonds (1962). Specific adaptation is the association within a limited environment and involves the heterogeneity in a population; whereas, general adaptation is stability of performance across a number of environments and is associated with heterogeneity. Both imply productive interactions among lines which compose the composite population. Simmonds (1962) noted that the performance of a composite is equal to the means of the respective varieties when grown in pure stands. Composites can exceed the mean yield of pure stand varieties and in some instances will yield more than the highest yielding variety. They rarely yield less than the mean of the pure stands. Specific adaptation will exist when the performance of a composite is superior to the mean of the pure stand varieties. An example of a composite which has specific adaptation is the cotton composite variety, Malwa (Hutchinson and Ghose, 1937). Malwa is a composition of several strains of diploid Desi (*Gossipium arboreum*) and an American tetraploid, Upland (*G. hirsutum*).

Effect of Natural Selection, Performance and Stability on Yield in Composite Populations

Barley

In a frequently cited study involving natural selection, 11 barley cultivars were grown as composites (Harlan and Martini, 1938). Some lines of the composite were known to be well adapted to certain areas and other lines of the composite were known to be poorly adapted. The 11 barley lines were blended in equal amounts of seed. The composite was tested at ten different locations for four to twelve years. A total of 500 plants for each year's planting were utilized to determine the relative proportion of each line in the composite. The effect of natural selection and competitive ability of the barley cultivars were determined by comparing actual and theoretical values of number of plants over a period of years. In general, the number of plants of the best adapted line at a particular location increased while the number of plants of the less adapted cultivars decreased in the composites. The success of a line in a composite could then be used as a measure of yielding ability and adaptation under commercial conditions when grown in a pure stand.

In another study, seed of four commercially grown barley cultivars were blended in equal amounts and tested for nine years in California (Suneson and Wiebe, 1942). A pure stand of each cultivar was also planted as adjacent plots to the composites. After eight years, the percentage of the cultivars in the composite was 63.2, 17.3, 8.3 and 11.3 percent and the mean yield of the pure stands for the same period was 73, 69.9, 70 and 79 Bu/A for the respective cultivars. In contrast to the results of Harlan and Martini, the dominant variety in a composite can not serve as a criterion of predicting the yielding ability of a cultivar when grown in a pure stand. Natural selection greatly influences the relative proportion of the lines making up the composite.

The yield of barley composites was studied in Denmark by Sandfaer (1954). Seed of four barley cultivars were blended in equal amounts. Six different combinations were tested. Five combinations exceeded the mean yield of the pure components by approximately four percent. Only one of the combinations yielded higher than the component lines grown in pure stands.

Competitive ability of F_1 barley hybrids was reported by Sakai and Gotch (1954). Five barley cultivars were compared with their ten F_1 hybrids for competitive ability by means of a composed planting with each of two testers. Characters compared were heading date, length of culm, dry plant weight, number of culms and weight of the individual spikes. The five parents were superior in competitive ability to the two testers for the traits studied. However, the F_1 hybrids were inferior for plant weight, number of culms, and weight of individual spikes but were superior for height, number of culms and weight of individual spikes when compared to the testers.

Odessa barley and Richland oat cultivars were blended in different proportions to make nine combinations (Klages, 1936). Pure stands of each cultivar and proportions of components in the composites were compared in terms of yield for both cultivars. The pure stand oats yielded higher than the pure stand of barley. However, the barley yielded more than the oats in the composites. Stem rust did not attack the oats; however, the barley was 30 percent infected at maturity. The growth habit of barley was more rapid than the oat cultivar due to a very favorable growing season. Because of the rapid vegetative development in barley, oat plants could not compete.

Through the collection of diverse seed stocks, hybridization, bulking of the resulting F_1 progenies, and the use of natural selection to identify superior progeny, the evolutionary plant breeding method by Suneson (1956) was developed. Four composite crosses (II, V, XII, and XIV) were studied extensively. The F_1 seeds of each composite cross were blended within each composite cross and four F_1 composite populations were obtained. Each group of composite populations were compared with Atlas as a check because Atlas was a parent in each of the four composite crosses. Composite crosses II, V, XII, and XIV were grown for 29, 15, 14, and 12 generations, respectively. Artificial selection was not made in any of the generations. Composite bulk II yielded lower than Atlas in the early generations. After fifteen generations, its yield exceeded the yield of Atlas. The yield of the other three composite bulk populations was also inferior in terms of yield when compared to Atlas in early generations. But in later generations, their yield almost equaled that of Atlas. The reason for higher yields in later generations in these three composite crosses was that there had been sufficient time for natural selection to operate.

Oats

In Nebraska, the competitive ability of two oat cultivars was examined for two years by Montgomery (1912). Garton No. 70 and Swedish Select oat cultivars were planted at different planting rates as a pure stand and a composite. The mean yield of Garton No. 70 for two years was higher than the Swedish Select oat in pure stands, but the Swedish Select performed much better in a composite. It was concluded that "one yielding best alone will not always be the one surviving under competition."

The yield superiority of the composites was reported by Sandfaer (1954) in Denmark. Three composite combinations of Danish oats were made. They yielded approximately five percent more than the mean yield of pure stands and one composite exceeded the best pure component.

General and specific yield superiority of composites was reported by Jensen (1965). Specific composite superiority is defined as higher yields than the mean yield of component lines and other commercial cultivars; whereas, general yield superiority implies only higher yield than the mean yield of component lines. To determine general yield superiority of composites over the mean yield of component lines, 124 composite combinations were utilized. For the determination of specific yield superiority, 12 oat cultivars and one composite were used. The composite was made up of five lines. In the first experiment, the general yield superiority was 3.2 percent because the composite produced significantly more yield per acre than the mean yield of the pure stand lines. In the second experiment, a composite of five cultivars yielded more than the lines grown in pure stands and seven other commercial cultivars. Specific yield superiority of the composite was 7.3 percent. The composite significantly yielded more than the mean yield of its pure stand lines and seven commercial oat cultivars. Both experiments were continued for eight years. It was concluded that "the yield superiority of composite genotype populations may be utilized for variety development." According to this conclusion, high yielding composite varieties could be developed by selecting proper component lines for a composite.

Wheat

The competitive ability of winter wheat was examined by Montgomery (1912) when grown under Nebraska conditions. Big Frame and Turkey Red varieties were sown as pure stands and as composites in 1908 and 1911. An equal number of seed was planted from each variety in a pure stand and in competition. In 1908, Big Frame yielded more than Turkey Red in pure stands, but when grown in competition with Turkey Red, it yielded much less. In 1911, Turkey Red yielded 18 percent more in a pure stand and 33 percent more in a composite than Big Frame. Actual gain of Turkey Red due to its competitive ability could be computed by subtracting yield difference of pure stand Turkey Red from the yield difference of Turkey Red when grown in a composite. The actual gain of Turkey Red was 15 percent in 1911.

The performance of six combinations of four wheat cultivars was reported by Nuding (1936). This experiment was conducted at three locations over a three year period. Each combination had an equal amount of seed of two wheat cultivars. The mean yield of composites was significantly better than the mean yield of pure stands. The yield of all composites exceeded the mean yield of their components.

The effect of natural selection in varietal composites of winter wheat was examined by Laude and Swanson (1942). Two different composites were made which included Kanred and Harvest Queen, and Kanred and Currell. These were tested at two locations for seven and nine years, respectively. At the end of the study, the percentage of Kanred plants was found to make up 92 and 88 percent of the populations at the two locations, respectively. The competitive ability of Kanred was higher hence crowding out the less adapted Harvest Queen and Currell cultivars in the composite plots.

Competition in wheat cultivars under different planting dates and different sources of the component lines were studied at North Dakota by Waldron (1944). Five cultivars (Group B) were selected under North Dakota conditions and five other cultivars (Group A) were selected from outside the area. Group A yielded higher than Group B under pure stand conditions. However, Group B wheats yielded better than Group A wheats when planted in alternate rows. The competitive effect of Group B wheats was higher than the Group A wheats at the two earlier planting dates than the last planting date.

The competitive ability of near isogenic wheat lines was reported by Suneson and Ramage (1962). Awned and awnless Onas wheat varieties were obtained by reciprocal backcrossing and blended in a 2:1 ratio. After seven years of continued planting and harvesting, the ratio was found to remain the same.

The reaction of four hard red winter wheat cultivars were evaluated as a composite and pure stands when grown at four different locations between 1952 and 1958 (Hadwiger, 1959 and Schlehuber, 1961). Composites were made from the equal number of seed of each variety. The cultivars were selected on the basis of certain morphological traits and for their importance as a commercial cultivar. A significant varietal shift in the composite was observed at the end of the study at each location. Mean yield of the composite over several years (5-7) did not exceed the mean yield of pure stands at three locations. It was, however, slightly higher at one location. Some varieties were superior in pure stands, but they did not dominate their respective composites.

Competing ability of adjacent rows were reported by Jensen and Federer (1965). Four wheat cultivars were found to be significantly different when they were planted in adjacent rows.

The relationship of yield among parents, the resulting F_2 generation and composite of parents were reported by Qualset (1968). The F_2's were obtained from a diallel cross of seven wheat cultivars. Twenty-one composite combinations were obtained by blending seven parents in pairs in a 1:1 ratio. Most of the F_2 populations yielded more than the composites and generally higher than their respective mid-parents. The significant difference between F_2 and composite populations was 4.4 percent. Composite populations generally were not higher than the respective midparents for yield. However, three F_2 populations and three composites which had the same parental components exceeded the midparental values. One F_2 population yielded significantly higher than the best parent. The author concluded that the yield of the F_2 was better than the composite and parents which were equal for yield.

The cultivars Ramona and Baart 46 were blended in five different proportions. These composites along with pure stands were planted during two different years using different seeding rates to find out the effect of planting rate and genotypic frequency on yield and seed size of composites (Chapman, Allard, Adams, 1969). The yield increased steadily with the higher population density. The mean yield of Baart 46 and Ramona for two years was 345 and 358 grams per plot, respectively, in pure stands. The mean yield of all composites for two years exceeded the yield of Ramona and Baart 46 in pure stands. The mean yield of all composites for two years decreased steadily as the proportion of Baart 46 increased in the composite. The seed size of Baart 46 was slightly heavier than Ramona for two years in pure stands. Seed size was significantly larger at the lower seeding rates in composites and pure stands.

Disease Resistance

Jensen and Kent (1963) suggested it is not necessary that a population be 100 percent resistant. If 40 percent of the population is resistant, that population may escape serious yield reduction. For this reason, the concept behind designing a composite population is to combine and properly balance many plant characters into a composite combination.

Multiline varieties were developed by Borlaug (1959) to reduce losses from diseases and to produce higher yields. Four commercial wheat varieties were chosen as a recurrent parent based on their yielding ability. A large number of donor parents were chosen for their degree of resistance to different stem rust races. The pedigree method was used for selection in segregating material. The selected lines were classified for their stem rust reaction, yield and other traits and the desirable types were bulked. Because this multiline variety had resistance to different common races of stem rust, it had more resistance than the individual pure lines. In this study, the mean yield of multilines was 2.8 percent higher than the mean yield of pure stands. Borlaug (1959) suggested that "this kind of multiline will probably provide at least partial protection for the farmer whenever new races become prevalent and up until the time the varietal composition can be modified, since it is quite improbable that all genotypes of the multilineal variety will be completely susceptible to such a new race." Borlaug also suggested that a multiline variety should be composed of 8 to 16 phenotipically similar lines which differ genotypically for stem rust resistance.

Browning, Frey and Grindland reported disease resistance in oat multiline varieties in 1964. The backcross method was used and three multiline varieties were obtained. The susceptible recurrent parent reached an epidemic leaf rust level in 23 days; whereas, the multiline took 27 days before leaf rust reached epidemic proportions. The multiline delayed the epidemic four days which is very important because grain yield will increase five percent a day when not under disease stress. It was suggested that a rust epidemic could be delayed more than four days if more than two donor parents were used in the backcross.

Klages (1936) noted the changes in the proportion of the components within composites during severe stem rust epidemics. Three hard red spring wheat varieties, susceptible to stem rust, and a durum wheat variety, resistant to this rust, were blended in different proportions. The durum wheat was blended with each spring wheat cultivar. The proportions of the cultivar varied from 0 to 100 percent in each composite. The yield of different combinations of the composite was decreased in all cases as the proportion of spring wheat increased. Development of rust occurred less rapidly on durum and hence it had an advantage in the composite.

In self-pollinated crops, varieties usually are developed as pure lines. A pure line variety is developed by self fertilized progeny from a single, true breeding plant. In recent years the idea of developing extremely uniform pure lines has changed; however, most recently developed varieties are still very narrow in their genetic base. Composite varieties and multiline varieties have different genotypes and variability. This variability could result in advantages such as greater adaptability, more stable yields and greater protection against disease.

MATERIALS AND METHODS

The experimental material consisted of five genetically and morphologically different winter wheat cultivars: Hyslop (H), Yamhill (Y), Sprague (S), Paha (P), and Luke (L). These cultivars are adapted to the growing conditions observed in the high rainfed and dryland areas of the Pacific Northwest and are currently in commercial production. They differ in a number of agronomic traits including the primary components of yield. The pedigrees and descriptions are presented in the appendix.

The experiment was conducted at three locations in Oregon: Hyslop Agronomy Farm, Corvallis; Sherman Branch Experiment Station, Moro; and The Central Oregon Experiment Station, Madras. These locations differ in rainfall, temperature and soil type.

Rainfall at the Sherman Station was 357.85 mm during the 1973-74 growing season. The soil type of this station is classified as a Walla Walla silt loam. The soil type at Corvallis is a Woodburn silt loam and the total rainfall was 1717.8 mm during the 1973-74 growing season. Madras soil is classified as a Madras loam. The amount of rainfall was 276 mm during the growing season with an additional 558.8 mm applied through irrigation for a total of 834.8 mm. A summary of climatic data for all sites are presented in Appendix Table 10.

Prior to seeding, 123 kg/ha ammonium nitrate (33% N) was applied at all three locations with an additional 120 kg/ha of urea (46% N) applied during mid tillering and early tillering stage at Corvallis and Madras, respectively.

Treatments consisted of five cultivars and all possible composite combinations plus five filler wheat cultivars for a total of 36 entries (Table 1). Five filler strains were used to complete the experimental design. Germination tests were conducted for all cultivars and found to be high (98-100%). Kernels were treated with Vitavax + Thiram.

An equal number of seed from each cultivar was used to prepare composite combinations. The number of seed used for each cultivar was varied according to number of component cultivars in the composite plots. Total number of seed planted in a plot were the same in all plots. Seeding rate was 64.8 kg/ha at Sherman and 97.2 kg/ha at Corvallis and Madras.

A triple lattice design with three replications was selected due to the large number of treatments. In addition, a greater estimate of the variation due to soil heterogeneity was possible. The plot size was represented by four rows spaced 30.5 cm apart and 5 m in length.

The following measurements were made: (1) The number of plants of each cultivar were counted by pulling mature individual plants from each composite and pure stand plot. To avoid a possible

Table 1. The five cultivars grown in pure stand and twenty-six composites including five filler cultivars utilized in the experiment.

Treatment Number	Components of Treatment*
1	H+L+P
2	L+S+P
3	H+P
4	H+Y+L+S+P
5	H+L+S
6	H+S
7	H+Y+L+P
8	H+Y+S
9	S
10	Y+L+S
11	S+P
12	Filler
13	Y
14	Filler
15	L+S
16	H+L+P
17	L
18	H+L
19	Y+L+S+P
20	H+Y+L+S
21	Y+S
22	H+L+S+P
23	L+P
24	Filler
25	H+Y
26	Filler
27	H
28	Filler
29	Y+P
30	H+Y+S+P
31	P
32	Y+S+P
33	H+S+P
34	Y+L
35	H+Y+P
36	H+Y+L

* H = Hyslop L = Luke
S = Sprague Y = Yamhill
P = Paha

border effect, only 3.28 m of two center rows ($2m^2$) were harvested; (2) Number of tillers for both the pure stand and for each component of the composites was counted on a plot basis; (3) Four height measurements (cm) were taken for each component cultivar in the composite plots as well as for the pure stands; (4) Yield data of the component in each composite and pure stand were obtained by weighing the threshed kernels. The yields of composite plots were computed by summing the yield of each component in the composite plots; (5) The number of heads per plant for the pure stands and composite plots was calculated in the following manner, respectively:

$$\text{Number of heads per plant} = T/P$$

where T = number of total tillers per plot and P = number of total plants per plot.

$$\text{Number of heads per plant} = T_1/P_1 \text{ or } T_n/P_n$$

where T_1 = number of tillers of first component in the composite plot, P_1 = number of plants of first component in the composite plot, T_n = number of tillers of the nth component in the composite plot, and P_n = number of plants of the nth component in the composite plot.

(6) Yield per plant was calculated for pure stands by dividing the total yield of pure stands by the number of plants for the area measured. Similarly, yield per plant was calculated for composites by the number of plants for each component of the composite; (7) Estimates of 1000 kernel weight were obtained by weighing 300 kernels from each

cultivar; (8) Number of kernels per head was determined using the following formula:

$$\text{Number of kernels per head} = \frac{1000 \text{ x } Y/K}{H}$$

where 1000 = constant (for 1000 kernel weight), Y = yield per plant, K = 1000 kernel weight, and H = number of heads per plant; (9) The contribution of each component for 1000 kernel weight, number of kernels per head and plant height were different in the composite plots. To determine the mean values of composite plots for these three traits, the contribution of each component was calculated as follows:

$$\text{Mean 1000 kernel weight} = \frac{W_1+Y_1}{100} + \frac{W_2+Y_2}{100} + \ldots + \frac{W_n+Y_n}{100}$$

where W_1 = 1000 kernel weight of a cultivar which existed in that composite, Y_1 = the yield percentage of the same cultivar in the composite. Similarly other letters represent the value of cultivars which are in the same composite plot.

$$\text{Mean number of kernels per head} = \frac{K_1 x T_1}{100} + \frac{K_2 x T_2}{100} + \ldots + \frac{K_n x T_n}{100}$$

where K_1 = the average number of kernels per head of a cultivar which existed in the composite, T_1 = the tiller percentage of the same cultivar in the composite plot. Similarly other letters represent the other cultivars which are in the same composite plot.

$$\text{Mean plant height} = \frac{H_1 x P_1}{100} + \frac{H_2 x P_2}{100} + \ldots + \frac{H_n x P_n}{100}$$

where H_1 = the average plant height of a cultivar which existed in the composite, P_1 = the plant percentage of the same cultivar in the composite plot. Similarly, other letters represent the other cultivars which are in the same composite plot.

Statistical Methods

1. The eight traits were analyzed as a triple lattice design for three locations separately and as a randomized block design for three sites together.

2. The F test was used to determine if significant differences existed among treatments and Student Newman Keuls' test was used to determine significant differences among component lines within treatments. Least Significant Difference test was used to determine significant differences among treatments, and between treatment means and mean of five pure stands.

3. The competition of every component within each composite plot was determined by analyzing each treatment separately for eight agronomic traits for three locations and together. This gave the specific competitive ability of cultivars. The total yield contribution of each yield component of 26 composites gave the general competitive ability of each cultivar.

EXPERIMENTAL RESULTS

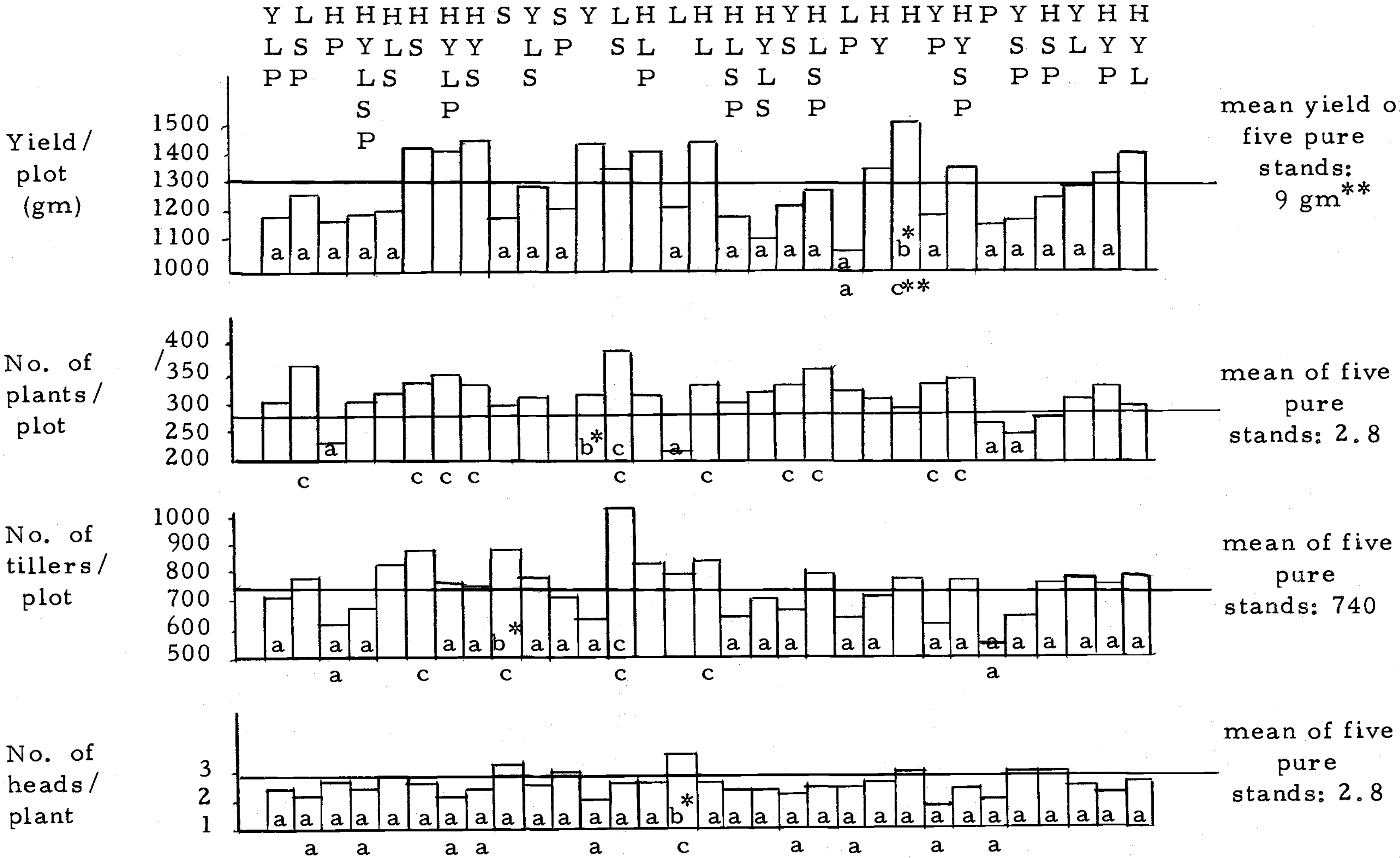
Performance of All Treatments

Corvallis

There was a significant difference among treatments for all traits at Corvallis (Appendix Table 2). Composite treatments were compared with the best pure stand for each trait and significant levels determined. Treatment means and the mean of the five pure stands were also compared statistically for each trait (Figures 1 and 2). Because yield per plot is the major criterion, only the performance of the best yielding treatments with regard to the other agronomic traits was considered. The significantly highest yielding treatment was Hyslop. Hyslop exceeded the mean of the five pure stands for number of plants per plot, 1000 kernel weight, number of heads per plant, and yield per plant.

Each trait was evaluated independently and the best treatment identified, whether it be a composite or a pure stand. For number of plants per plot and number of tillers per plot, L+S was superior. Luke was significantly higher than all other treatments for number of heads per plant and was superior for yield per plant. Paha was significantly different from all other treatments for number of kernels per head and plant height. For 1000 kernel weight, Yamhill and H+Y+S performed better than all the other treatments.

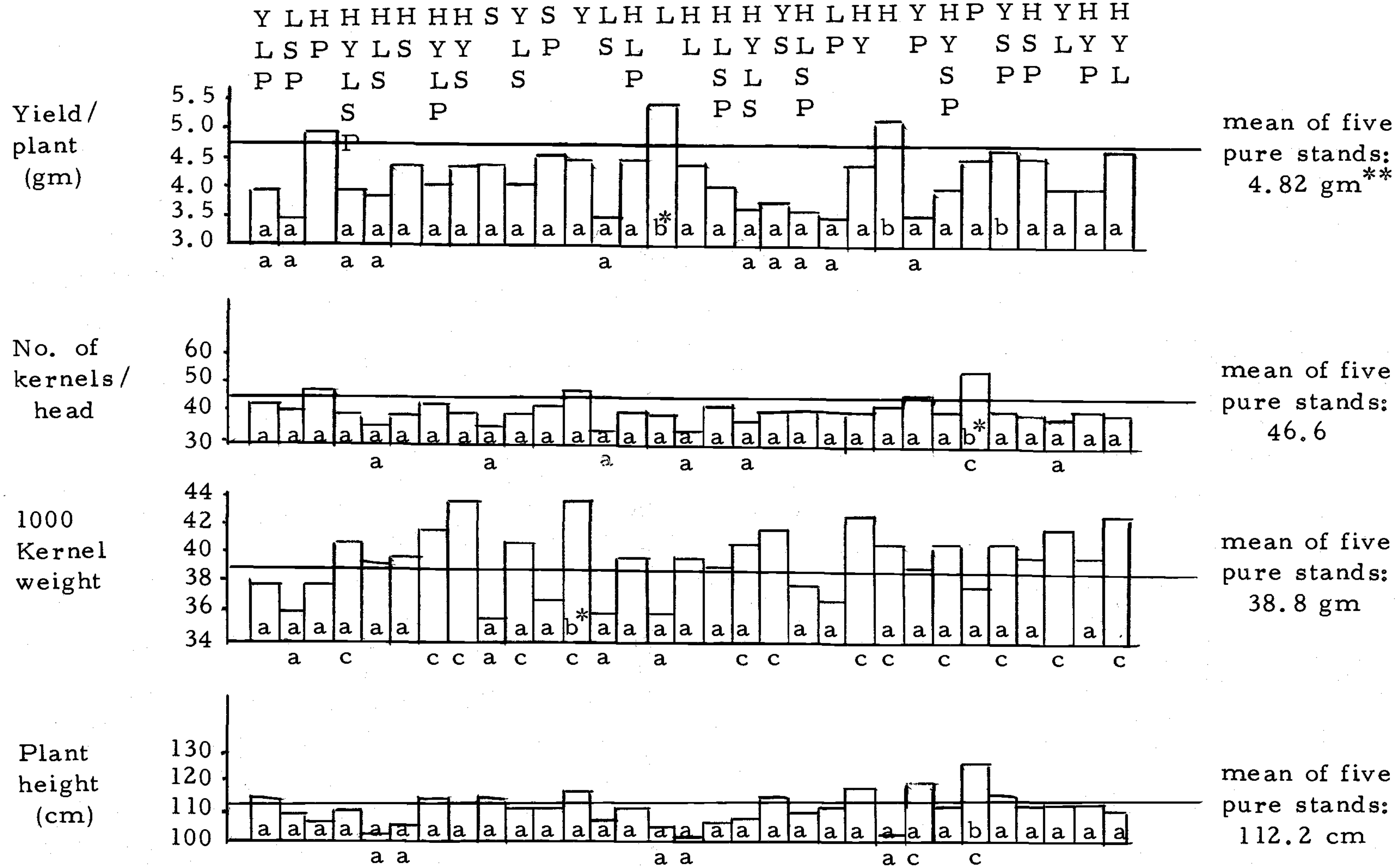
Figure 1. The relative performance of 31 treatments for four traits examined at Corvallis, Oregon in 1974.



*The highest mean value of a pure stand is accepted as a check for LSD at the 5% level.

**The mean yield of five pure stands is accepted as a check for LSD at the 5% level.

Figure 2. The relative performance of 31 treatments for four traits examined at Corvallis, Oregon in 1974.



*The highest mean value of a pure stand is accepted as a check for LSD at the 5% level.

**The mean of five pure stands is accepted as a check for LSD at the 5% level.

Pure stands were compared with each other and ranked in order of superiority for yield and other agronomic traits (Table 2). There was no apparent cultivar that was consistently outstanding. Paha had the lowest yield per plot while Sprague, in general, was the most inferior cultivar for all traits.

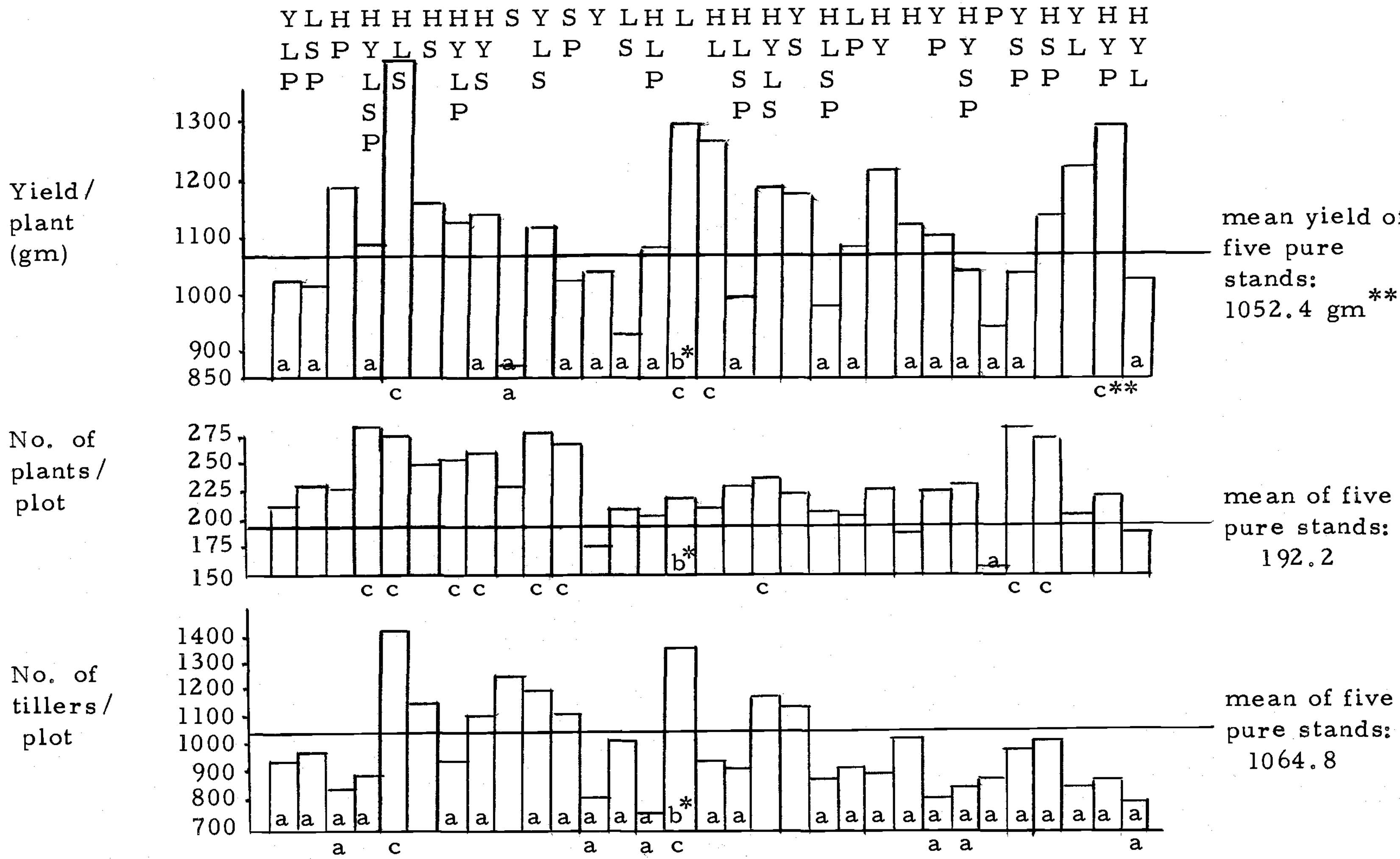
Table 2. The relative performance involving eight traits of five cultivars when grown in pure stands at Corvallis, Oregon in 1974.

Traits	Rank
1. Yield/plot	H > Y > L > S > P
2. No. of plants/plot	Y > H > S > P > L
3. No. of tillers/plot	S > L > H > Y > P
4. No. of heads/plant	L > S > H > P > Y
5. Yield/plant	L > H > Y = P > S
6. No. of kernels/head	P > Y > H > L > S
7. 1000 Kernel weight	Y > H > P > L > S
8. Plant height	P > Y > S > L > H

Madras

There was a significant difference among treatments for all traits except plant height at Madras (Appendix Table 3). However, a significant difference was found using the LSD test for plant height. The best yielding treatments, those significantly higher than the mean of the five pure stands, were H+L+S, Luke, H+Y+P and H+L (Figures 3 and 4). These four treatments also exceeded the mean of five pure stands for number of plants per plot. H+L+S and Luke also

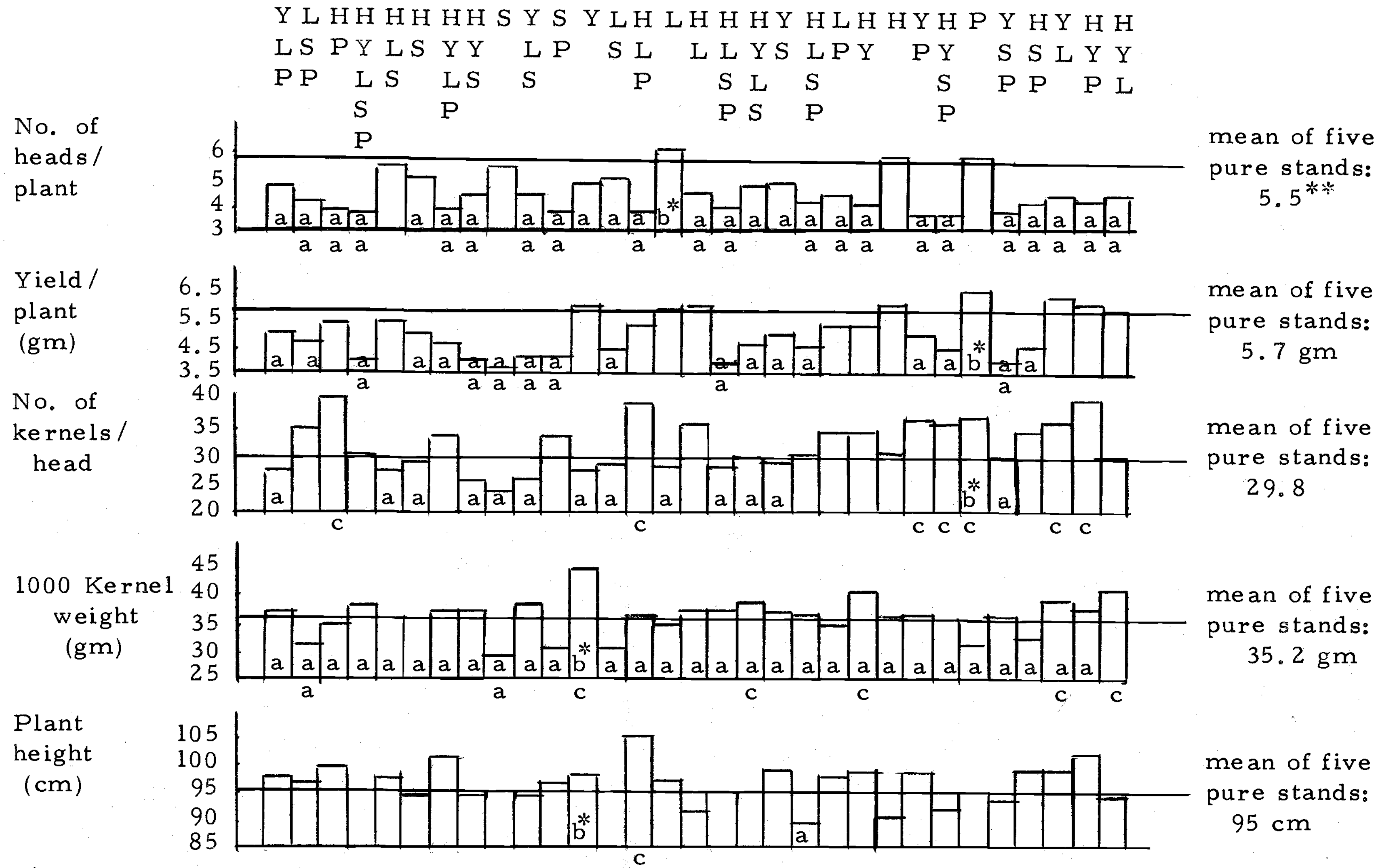
Figure 3. The relative performance of 31 treatments for three traits examined at Madras, Oregon in 1974.



*The highest mean value of a pure stand is accepted as a check for LSD at the 5% level.

**The mean yield of five pure stands is accepted as a check for LSD at the 5% level.

Figure 4. The relative performance of 31 treatments for five traits examined at Madras, Oregon in 1974.



*The highest mean value of a pure stand is accepted as a check for LSD at the 5% level.
**The mean yield of five pure stands is accepted as a check for LSD at the 5% level.

exceeded the mean of five pure stands for number of tillers per plot. Luke was the only treatment which exceeded the mean of five pure stands for number of heads per plant. Except for H+L+S, the other three treatments exceeded the mean of five pure stands for yield per plant. H+L and H+Y+P also exceeded the mean of five pure stands for number of kernels per head. Except for Luke and H+L, the other treatments exceeded the mean of the five pure stands for 1000 kernel weight and plant height, respectively.

Each trait was evaluated independently and the superior treatment identified. For number of plants per plot, H+Y+L+S+P was superior. H+L+S was highest for number of tillers per plot. Luke was significantly higher than 21 other treatments for number of heads per plant. Paha was the best for yield per plant among all treatments. For number of kernels per head, H+P was superior. Yamhill had a heavier 1000 kernel weight than all other treatments. The tallest treatment was H+Y+P.

The pure stands were compared and ranked for each trait (Table 3). Luke was the superior cultivar at Madras and Sprague performed as poorly at this location as at Corvallis.

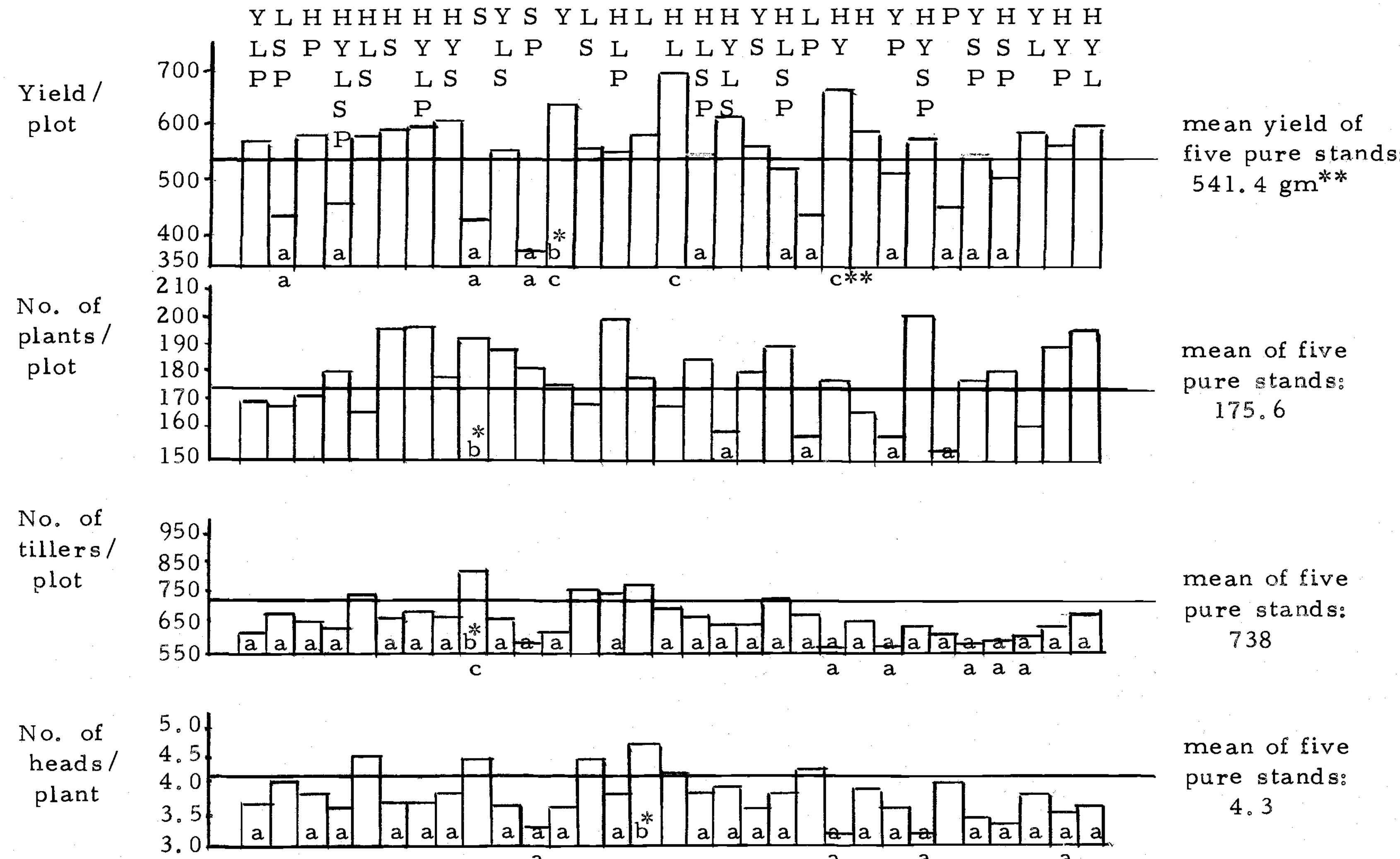
Table 3. The relative performance involving eight traits of five cultivars when grown in pure stands at Madras, Oregon in 1974.

Traits	Rank
1. Yield/plot	L > H > Y > P > S
2. No. of plants/plot	L > S > H > Y > P
3. No. of tillers/plot	L > S > H > P > Y
4. No. of heads/plant	L > H = P > S > Y
5. Yield/plant	P > H > Y > L > S
6. No. of kernels/head	P > H > L > Y > S
7. 1000 Kernel weight	Y > H > L > P > S
8. Plant height	Y > L > P = S > H

Moro

There was a significant difference among treatments for all traits except number of plants per plot at Moro (Appendix Table 4). However, four of the 31 treatments showed significant differences using the LSD test for number of plants per plot. Treatments were compared with the mean of five pure stands and with the best pure stand (Figures 5 and 6). The significantly highest yielding treatments were H+L, H+Y and Yamhill. However, they did not differ significantly from each other. These highest yielding treatments exceeded the mean of the five pure stands for yield per plant, number of kernels per head and 1000 kernel weight. Yamhill and H+Y exceeded the mean value of five pure stands for number of plants per plot. However, none of the highest yielding treatments exceeded the mean of five pure stands for number of tillers per plot. The only treatment

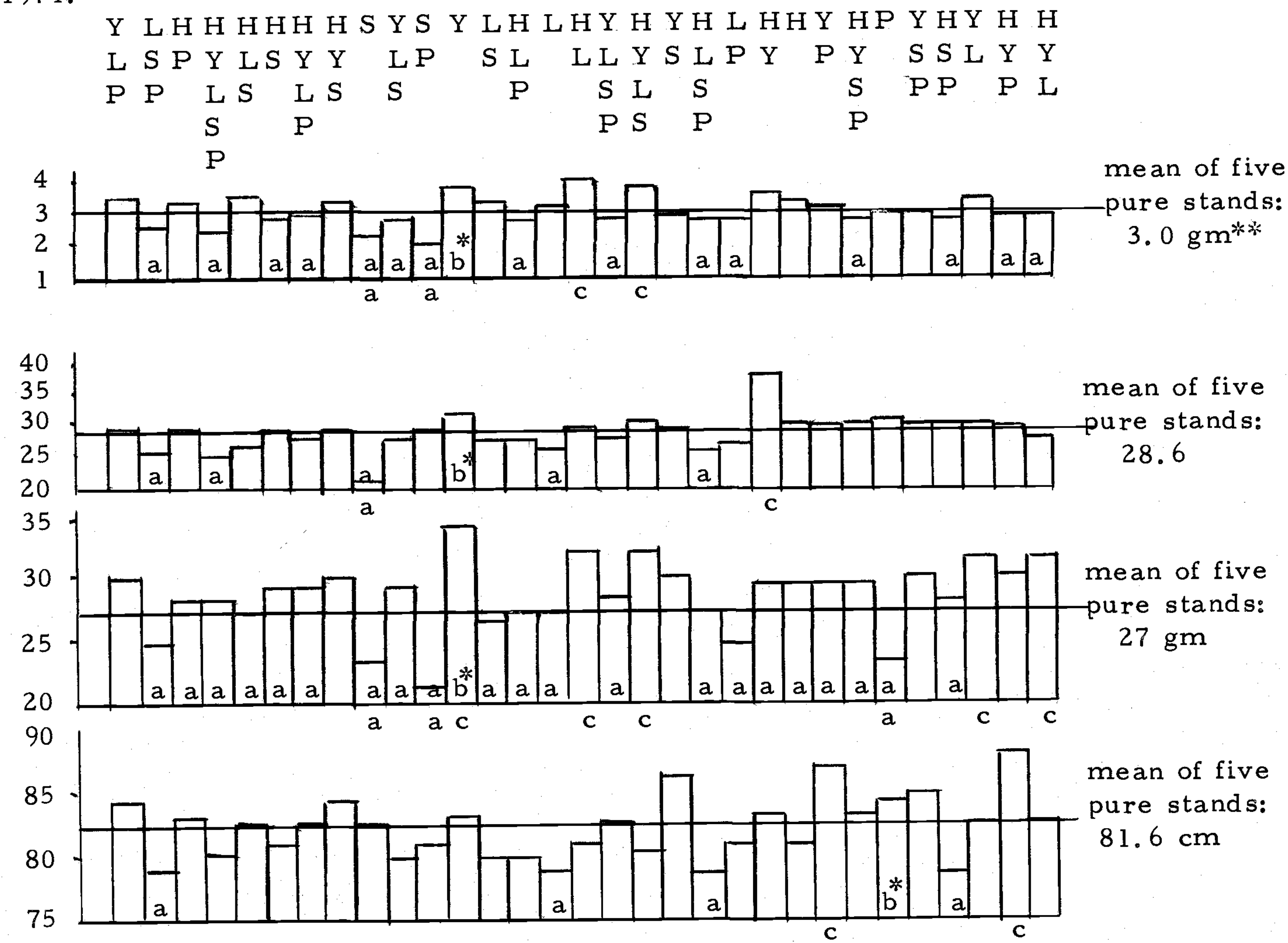
Figure 5. The relative performance of 31 treatments for four traits examined at Moro, Oregon in 1974.



*The highest mean value of a pure stand is accepted as a check for LSD at the 5% level.

**The mean yield of five pure stands is accepted as a check for LSD at the 5% level.

Figure 6. The relative performance of 31 treatments for four traits examined at Moro, Oregon in 1974.



*The highest mean value of a pure stand is accepted as a check for LSD at the 5% level.
**The mean of five pure stands is accepted as a check for LSD at the 5% level.

which exceeded the mean of five pure stands for number of heads per plant was H+L. Yamhill and H+Y exceeded the mean of five pure stands for plant height.

Each trait was also evaluated and the best treatment for that trait identified. H+Y+S+P was highest for number of plants per plot. For number of tillers per plot Sprague was superior. Luke had the largest number of heads per plant and was significantly higher than most of the other treatments. For yield per plant H+L was highest. For number of kernels per head H+Y was superior. Yamhill had the heaviest kernels among all treatments. The tallest treatment was H+Y+P.

Pure stands were compared with each other and ranked for yield and the other agronomic traits (Table 4). No order in rank occurred more than once. Yamhill was superior for yield per plot and Sprague was the poorest. Yamhill occurred first more often than any other cultivar for these traits.

Table 4. The relative performance involving eight traits of five cultivars when grown in pure stands at Moro, Oregon in 1974.

Traits	Rank
1. Yield/plot	Y > H > L > P > S
2. No. of plants/plot	S > L > Y > H > P
3. No. of tillers/plot	S > L > H > P > Y
4. No. of heads/plant	L > S > P > H > Y
5. Yield/plant	Y > H > L > P > S
6. No. of kernels/head	Y > P > H > L > S
7. 1000 Kernel weight	Y > H > L > S = P
8. Plant height	P > Y > S > H > L

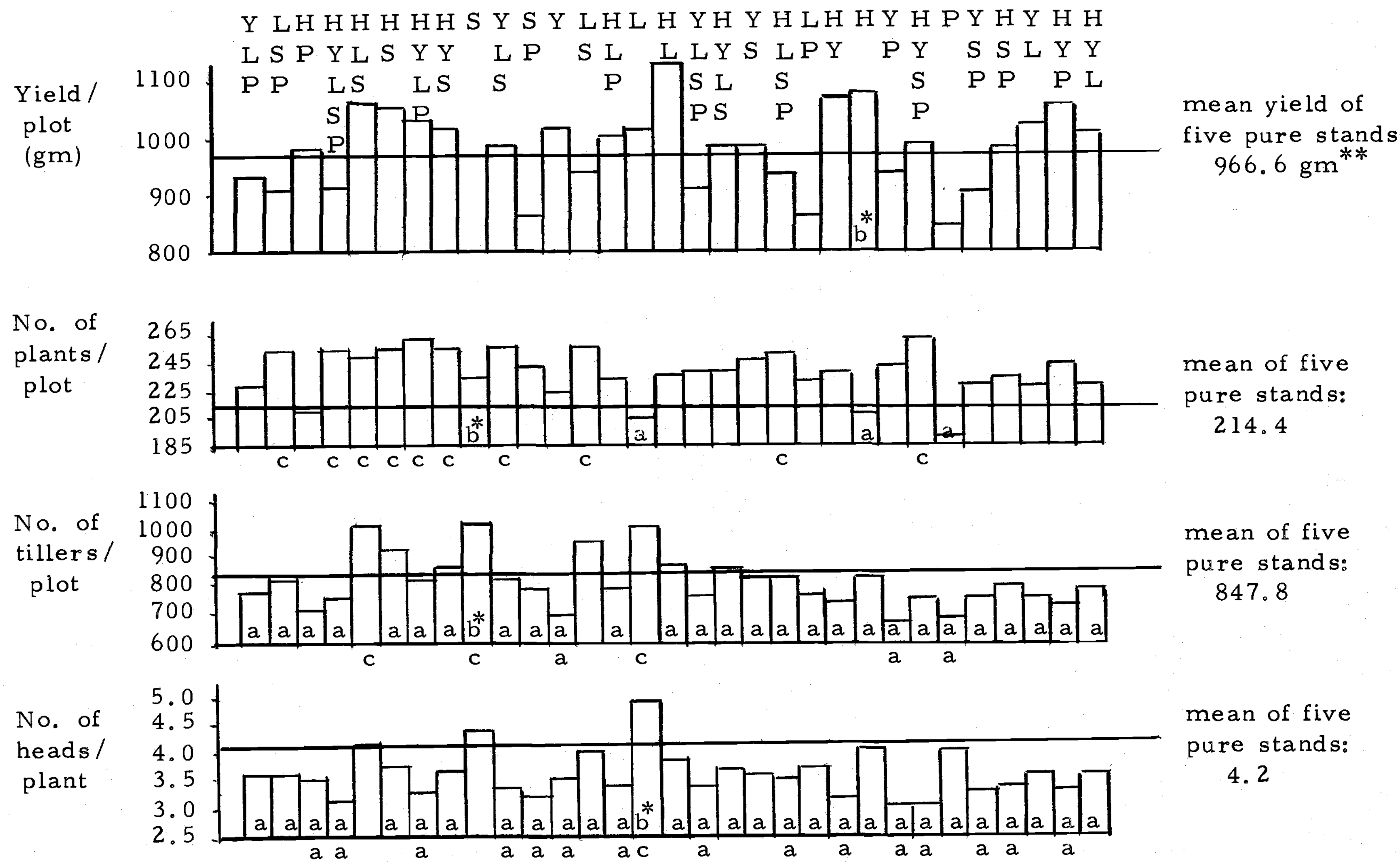
Combined Locations

A randomized block design was used in the combined analysis of three experiment sites for all traits (Tate, W., Washington State University; Peterson, R. and Frakes, R., Oregon State University, personal communication).

Treatment means of three locations did not show significant differences for yield per plot or a location X treatment interaction (Appendix Table 5). Significant differences were observed among treatments for number of tillers per plot, number of heads per plant, number of kernels per head and 1000 kernel weight. In addition, the LSD test showed some significant differences for number of plants per plot and yield per plant as well. Treatment means were compared with the best pure stand and with the mean of five pure stands for all traits and the significance level determined (Figures 7 and 8). No treatment was significantly higher than the mean yield of the five pure stands. Nineteen treatments exceeded the mean yield of the five pure stands, 16 of which were composites.

Each trait was evaluated independently and the superior treatment identified for that specific trait. H+Y+L+P had the highest number of plants per plot among all treatments. Sprague was superior for number of tillers per plot. Luke was best for number of heads per plant. Hyslop had the highest mean value for yield per plant. Paha was superior for number of kernels per head and plant height. Yamhill had the heaviest seeds.

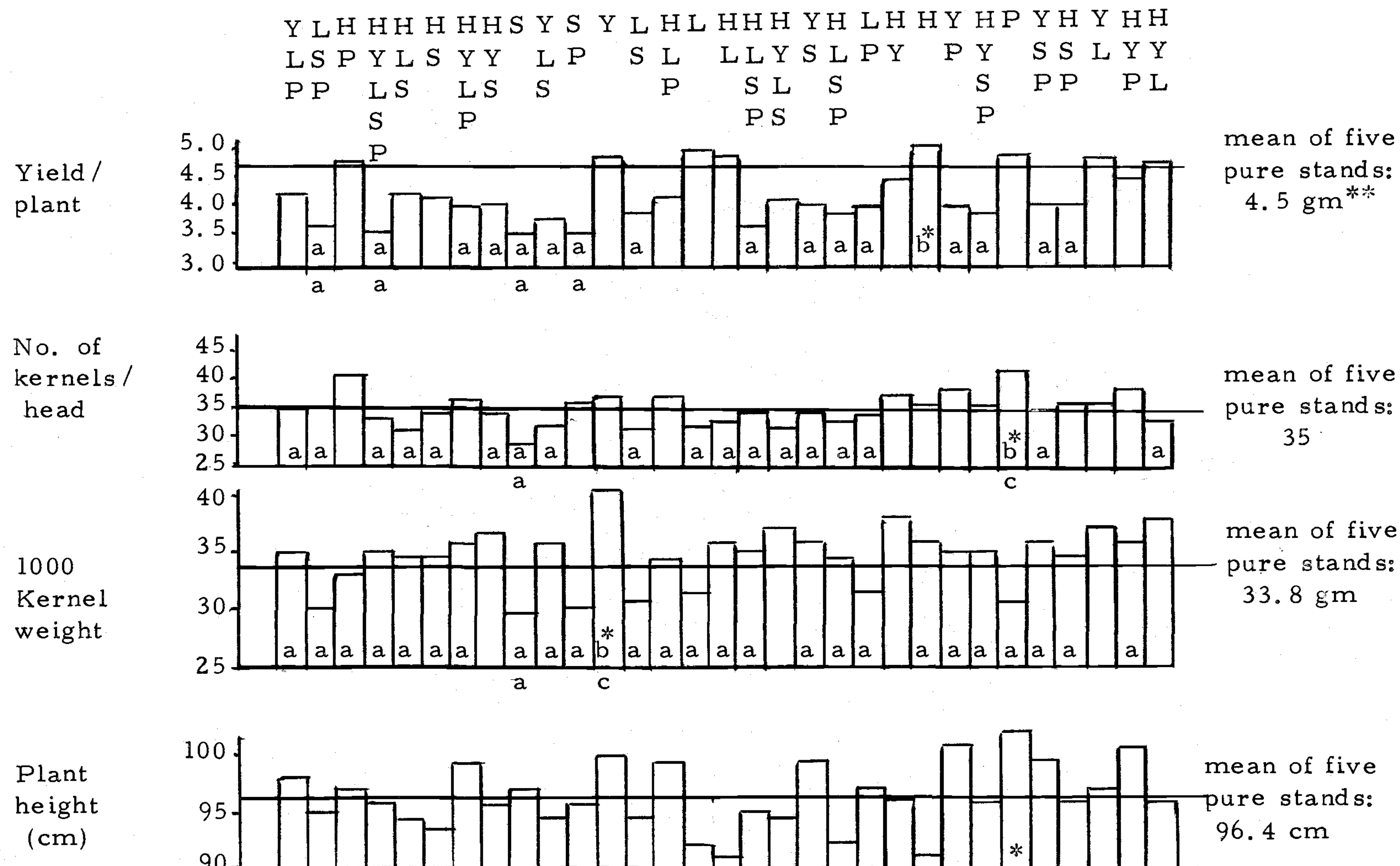
Figure 7. The relative performance of 31 treatments for four traits examined for combined locations in Oregon in 1974.



*The highest mean value of a pure stand is accepted as a check for LSD at the 5% level.

**The mean yield of five pure stands is accepted as a check for LSD at the 5% level.

Figure 8. The relative performance of 31 treatments for four traits examined for combined locations in Oregon in 1974.



*The highest mean value of a pure stand is accepted as a check for LSD at the 5% level.

**The mean of five pure stands is accepted as a check for LSD at the 5% level.

There was consistency in the performance of certain treatments for specific traits. Luke and Yamhill were superior for yield per plant and 1000 kernel weight, respectively at all three locations. Paha was the dominant treatment for plant height at Corvallis and in those treatments which were superior for plant height, Paha was a component line.

When comparing the performance of the pure stands, rank of the cultivars varied for each trait (Table 5). Hyslop was best for yield per plant. Sprague was better than other pure stands for number of plants and number of tillers per plot. Yamhill was superior for 1000 kernel weight. Paha had the highest values for number of kernels per head and plant height. Luke was superior for number of heads per plant.

Table 5. The relative performance involving eight traits of five cultivars when grown in pure stands for combined locations in Oregon in 1974.

Traits	Rank
1. Yield/plot	H > Y > L > P > S
2. No. of plants/plot	S > Y > H > L > P
3. No. of tillers/plot	S > L > H > Y > P
4. No. of heads/plant	L > S > H > P > Y
5. Yield/plant	H > L > Y = P > S
6. No. of kernels/head	P > Y > H > L > S
7. 1000 Kernel weight	Y > H > L > P > S
8. Plant height	P > Y > L > S > H

General and Specific Competitive Ability

Corvallis

Competition among component lines within a treatment is a measure of their specific competitive ability. At Corvallis, Hyslop, as a pure stand, was the significantly highest yielding treatment. Because there was no composite treatment that yielded significantly more than the mean of the five pure stands, specific competitive ability was not determined. However, the analysis of variance for within treatments showed there were significant differences among the component lines for some of the agronomic traits (Appendix Table 6).

General competitive ability is a measure of yielding ability (yield per plot) of each component line across treatments. The other yield components (i.e., yield per plot, 1000 kernel weight, etc.) may have a direct, indirect or no affect on general competitive ability. To determine general competitive ability and the performance of the other traits across composite combinations, the contribution of each component line was computed for each trait. For example, the total yield of a single composite treatment is considered to be 100 percent. Because there are 26 composite treatments, the total yield percentage would be 2600 percent. The total yield percentage contributed by a single component line would be determined by summing the percentage values of each component line and dividing by 26. Cultivars were ranked for general competitive ability (yield per plot) as well as for the other traits (Table 7) based on percentage values (Table 6).

The performance of the component lines for number of plants per plot, yield per plant and 1000 kernel weight were the same. Yamhill was superior for yield per plot (general competitive ability), number of plants, number of tillers per plot, yield per plant and 1000 kernel weight. Hyslop was superior for number of heads per plant, and Paha had the highest values for number of kernels per head and plant height.

The relative contribution of each component line across composite treatments was determined for all traits based on total yield percentages. Because there were five component lines, the theoretical contribution of each component line was 20 percent. If a component line exceeded this theoretical value, its relative contribution was great for that trait. Yamhill exceeded this theoretical value for all traits (Figure 9). Hyslop also exceeded this value for seven traits with the exception of plant height. Paha exceeded the theoretical value for yield per plot, yield per plant, number of kernels per head and plant height. Luke exceeded this value only for number of heads per plant. Sprague was lower than the theoretical value for seven traits, with only plant height being equal to this value.

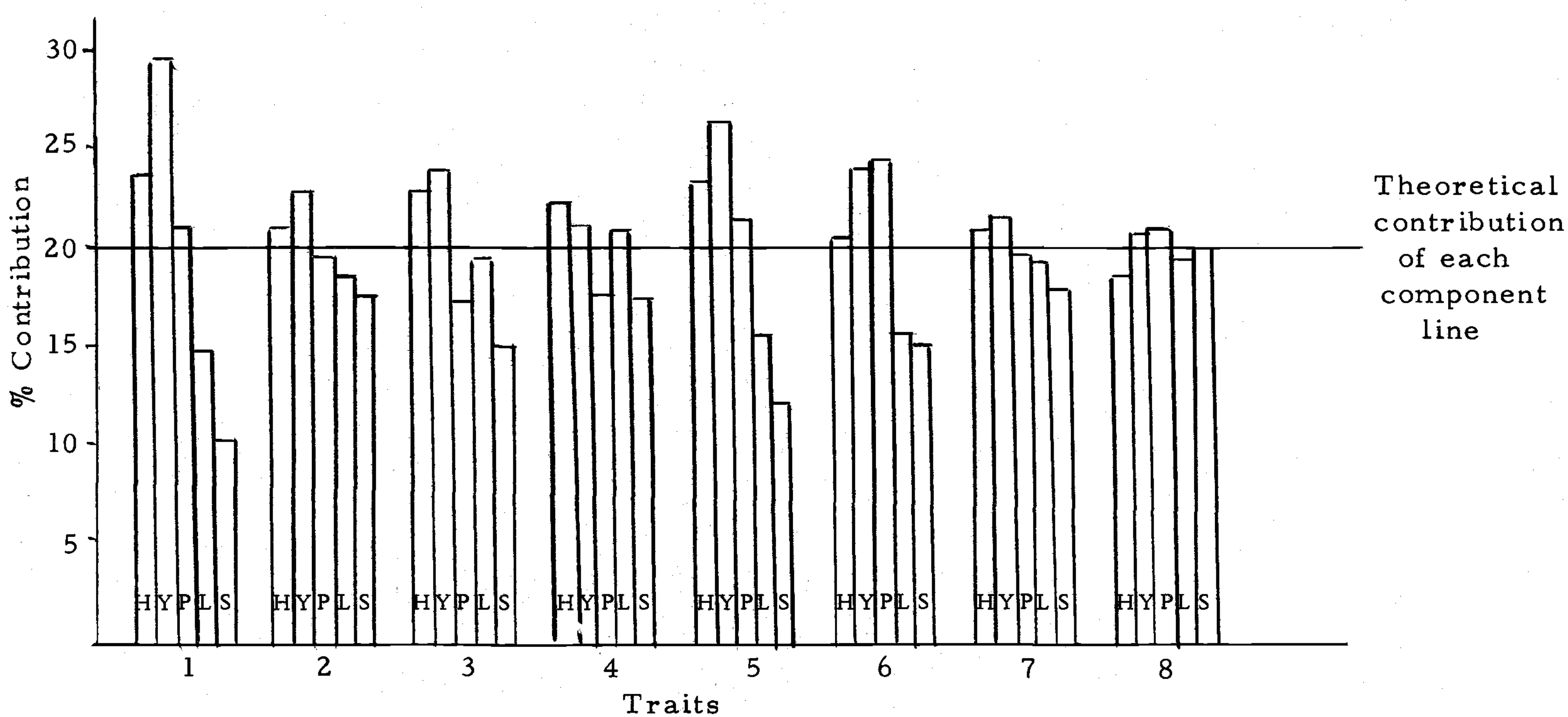
Table 6. Total yield percentage for eight traits for each component line grown at Corvallis, Oregon in 1974.

Traits	Cultivars (%)				
	Hyslop	Yamhill	Paha	Luke	Sprague
1. Yield/plot	630	776	538	382	274
	24.2	29.8	20.7	14.7	10.6
2. No. plants/plot	540	604	509	489	458
	20.8	23.2	19.6	17.8	17.6
3. No. tillers/plot	601	638	455	509	397
	23.2	24.5	17.5	19.6	15.2
4. No. heads/plant	581	551	466	540	462
	22.3	21.2	17.9	20.8	17.8
5. Yield/plant	617	693	562	412	316
	23.7	26.7	21.6	15.8	12.2
6. No. kernels/head	528	629	636	410	397
	20.3	24.2	24.5	15.8	15.2
7. 1000 Kernel wt.	549	564	513	507	467
	21.1	21.7	19.7	19.5	18.0
8. Plant height	488	540	547	504	521
	18.8	20.8	21.0	19.4	20.0

Table 7. The ranking of component lines for general competitive ability and other traits at Corvallis, Oregon in 1974.

Traits	Rank
1. Competitive ability (yield/plot)	Y > H > P > L > S
2. No. plants/plot	Y > H > P > L > S
3. No. tillers/plot	Y > H > L > P > S
4. No. heads/plant	H > Y > L > P > S
5. Yield/plant	Y > H > P > L > S
6. No. kernels/head	P > Y > H > L > S
7. 1000 Kernel weight	Y > H > P > L > S
8. Plant height	P > Y > S > L > H

Figure 9. The total relative contribution of each component line for eight traits when compared with the theoretical contribution value at Corvallis, Oregon in 1974.



1 Yield/plot
2 No. of plants/plot
3 No. of heads/plant
4 No. of heads/plant
5 Yield/plant
6 No. of kernels/head
7 1000 Kernel weight
8 Plant height

Madras

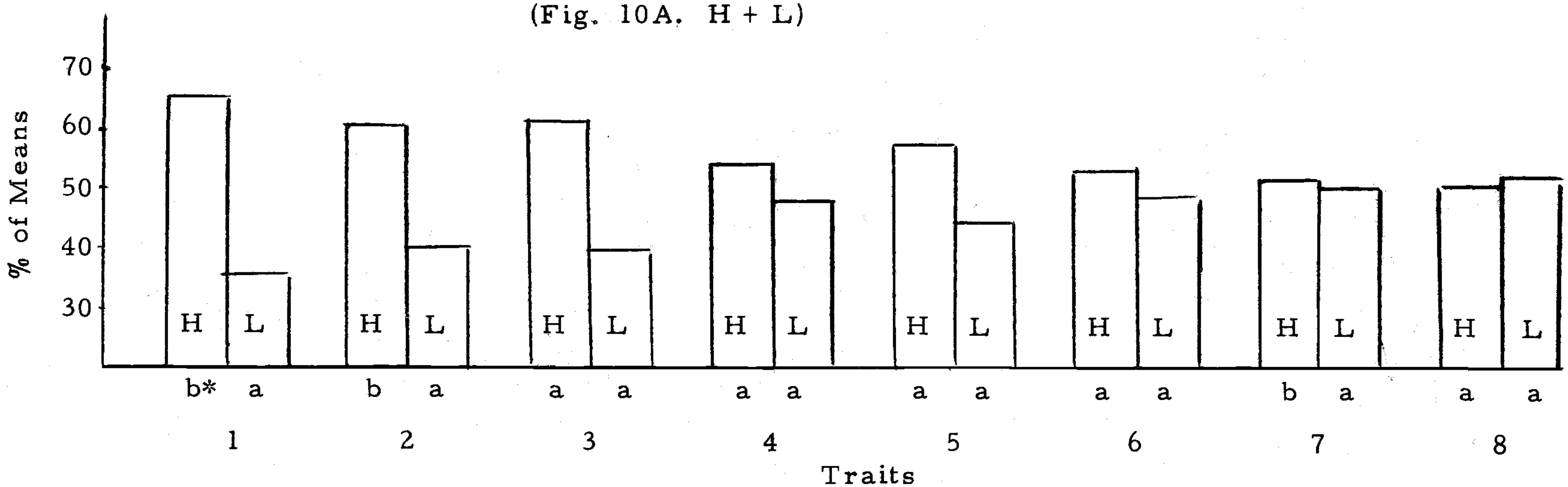
The significantly highest yielding treatments at Madras were H+L+S, Luke, H+Y+P and H+L. There were significant differences among the component lines within these composite treatments for some traits (Appendix Table 7). In composite treatments H+L and H+L+S, Hyslop is the dominant cultivar for most of the traits and is considered to have good specific competitive ability in those treatments (Figure 10A and B). However, in treatment H+Y+P, Hyslop had poor specific competitive ability because Yamhill and Paha were superior for seven of the eight traits (Figure 10C).

To determine the general competitive ability of the component lines, the contribution of each component line was computed for each trait across treatments (Table 8). Component lines were ranked for general competitive ability as well as for the other individual traits which directly or indirectly influence competitive ability (Table 9).

There was no consistent pattern in the rank of the cultivars at this location as there was at Corvallis. Paha was superior for general competitive ability, number of plants per plot, number of kernels per head and plant height. Yamhill was superior for yield per plant and 1000 kernel weight. Sprague had the highest mean values for number of tillers per plot and number of heads per plant.

Figure 10. Percentage of means as a measure of specific competitive ability for eight traits within three treatments at Madras, Oregon in 1974.

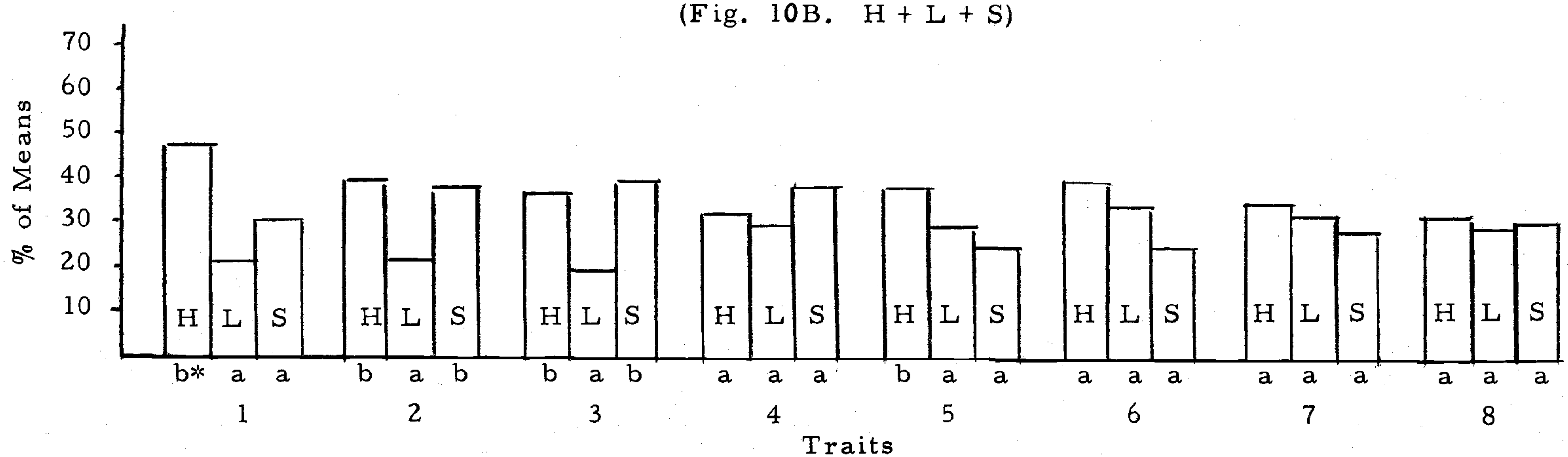
(Fig. 10A. H + L)



*Student Newman Keuls' Test - The columns having the same letter are not significantly different at the 5% probability level.

1 Yield/plant
2 No. plants/plot
3 No. tillers/plot
4 No. heads/plant
5 Yield/plant
6 No. kernels/head
7 1000 Kernel weight
8 Plant height

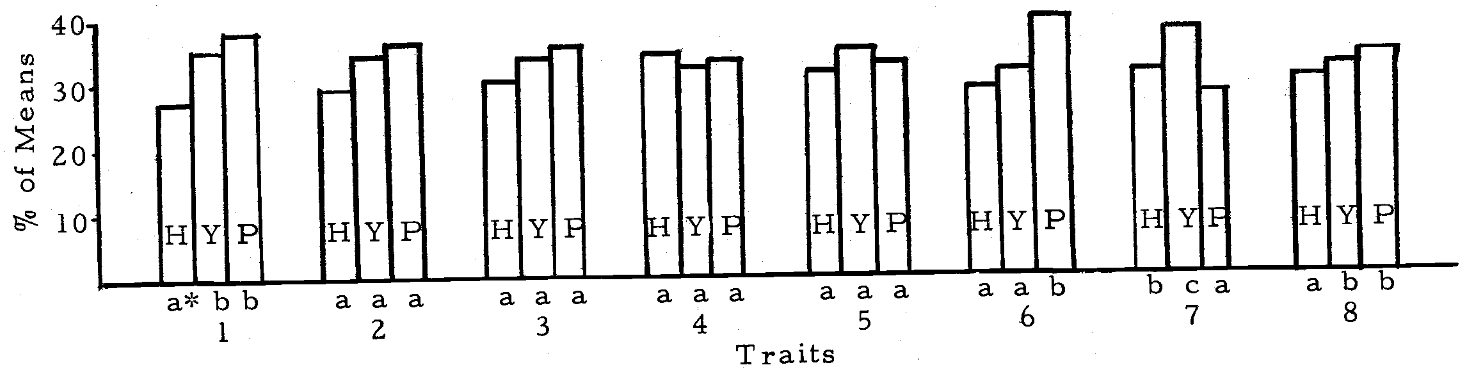
(Fig. 10B. H + L + S)



*Student Newman Keuls' Test - The columns having the same letter are not significantly different at the 5% probability level.

1 Yield/plot
2 No. plants/plot
3 No. tillers/plot
4 No. heads/plant
5 Yield/plant
6 No. kernels/head
7 1000 Kernel weight
8 Plant height

(Fig. 10C. H + Y + P)



*Student Newman Keuls' Test - The columns having the same letter are not significantly different at the 5% probability level.

1 Yield/plot
2 No. plants/plot
3 No. tillers/plot
4 No. heads/plant
5 Yield/plant
6 No. kernels/head
7 1000 Kernel weight
8 Plant height

Table 8. Total yield percentages for eight traits for each component line grown at Madras, Oregon in 1974.

Traits	Cultivars (%)				
	Hyslop	Yamhill	Paha	Luke	Sprague
1. Yield/plot	558	650	652	332	408
	21.5	25.0	25.1	12.8	15.6
2. No. plants/plot	526	553	573	389	559
	20.2	21.3	22.0	15.0	21.5
3. No. tillers/plot	546	509	549	404	592
	21.0	19.6	21.1	15.5	22.8
4. No. heads/plant	540	477	493	536	554
	20.8	18.3	19.0	20.6	21.3
5. Yield/plant	549	625	604	438	384
	21.1	24.1	23.2	16.8	14.8
6. No. kernels/head	515	590	668	434	393
	19.8	22.7	25.7	16.7	15.1
7. 1000 Kernel wt.	539	597	486	508	470
	20.7	23.0	18.7	19.5	18.1
8. Plant height	507	530	537	511	515
	19.5	20.4	20.7	19.6	19.8

Table 9. Ranking of component lines for general competitive ability and other traits at Madras, Oregon in 1974.

Traits	Rank
1. Competitive ability (yield/plot)	P > Y > H > S > L
2. No. of plants/plot	P > S > Y > H > L
3. No. of tillers/plot	S > P > H > Y > L
4. No. of heads/plant	S > H > L > P > Y
5. Yield/plant	Y > P > H > L > S
6. No. of kernels/head	P > Y > H > L > S
7. 1000 Kernel weight	Y > H > L > P > S
8. Plant height	P > Y > L > H > S

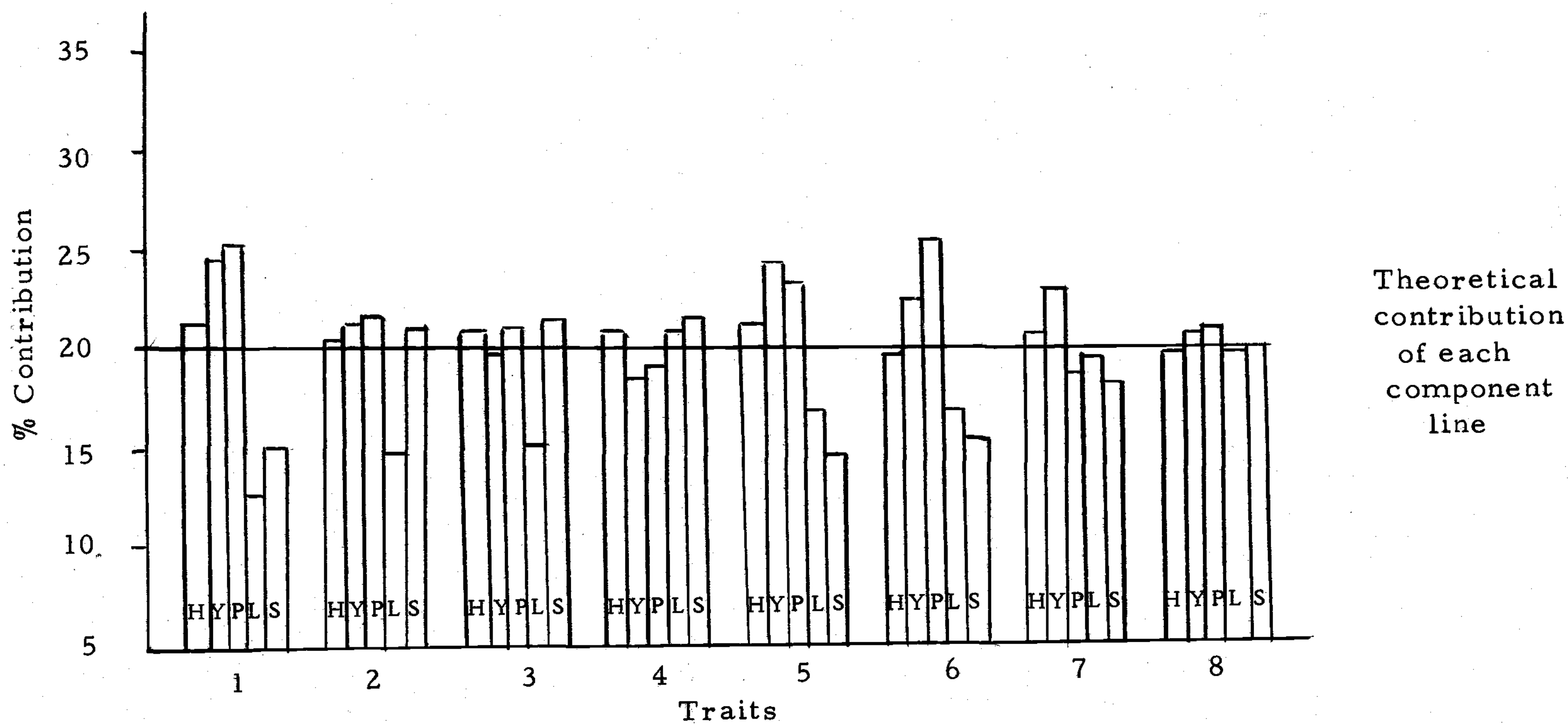
The relative competitive contribution of each component line across coposite treatments was determined. Hyslop exceeded this theoretical value (20 percent) for six traits except number of kernels per head and plant height (Figure 11). Yamhill also exceeded this value for six traits with the exception of number of tillers per plot and number of heads per plant. Paha exceeded the theoretical value for all traits except number of heads per plant and 1000 kernel weight. Luke did not exceed the theoretical value except for number of heads per plant. Sprague exceeded this value for only three traits which were number of plants per plot, number of tillers per plot and number of heads per plant.

Moro

The significantly highest yielding treatments at Moro were H+L, Yamhill and H+Y. Depending on the trait, there were significant differences between component lines within these two treatments (Appendix Table 8). In composite H+L, Hyslop was superior for specific competitive ability for all traits (Figure 12A). This same relationship held true at Madras. The specific competitive ability of Hyslop and Yamhill was similar in the treatment H+Y with neither cultivar being outstanding (Figure 12B).

The general competitive ability of component lines was computed in order to rank the cultivars (Tables 10 and 11). The rank of

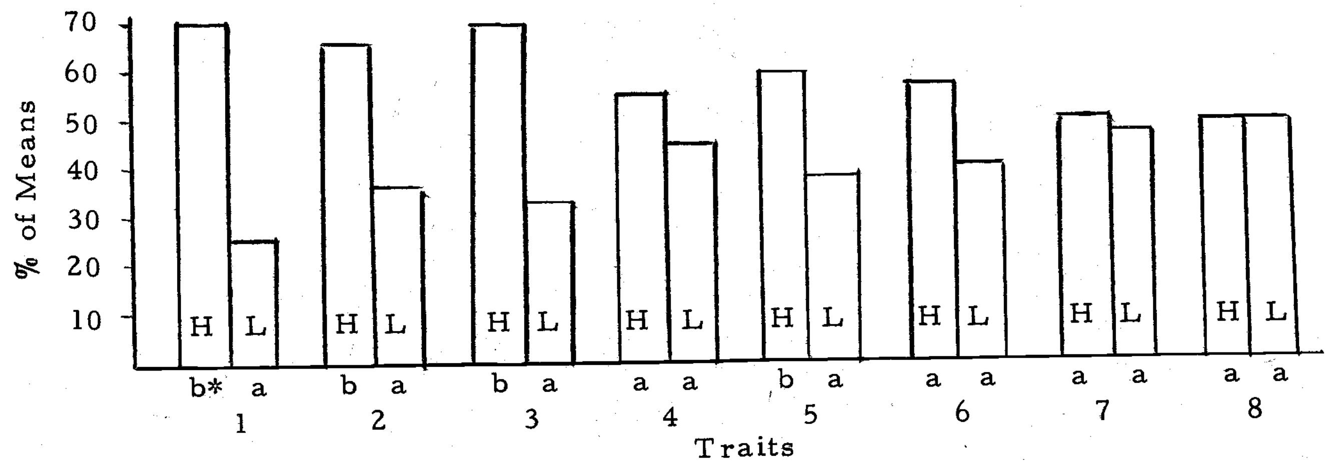
Figure 11. The total relative contribution of each component line for eight traits when compared with the theoretical contribution value at Madras, Oregon in 1974.



1 Yield/plot
2 No. plants/plot
3 No. tillers/plot
4 No. heads/plant
5 Yield/plant
6 No. kernels/head
7 1000 Kernel weight
8 Plant height

Figure 12. Percentage of means as a measure of specific competitive ability for eight traits within two treatments at Moro, Oregon in 1974.

(Fig. 12A. H + L)



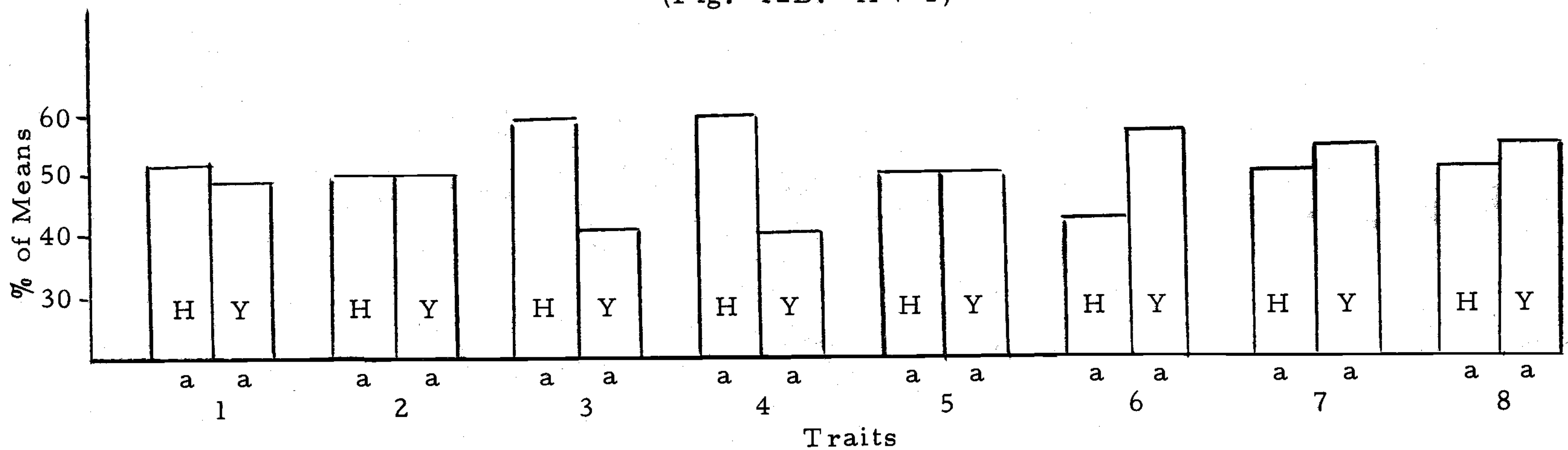
*Student Newman Keuls' Test - The columns having the same letter are not significantly different at the 5% probability level.

1 Yield/plot
2 No. plants/plot
3 No. tillers/plot

4 No. heads/plant
5 Yield/plant
6 No. kernels/head

7 1000 Kernel weight
8 Plant height

(Fig. 12B. H + Y)



*Student Newman Keuls' Test - The columns having the same letter are not significantly different at the 5% probability level.

1 Yield/plot
2 No. plants/plot
3 No. tillers/plot

4 No. heads/plant
5 Yield/plant
6 No. kernels/head

7 1000 Kernel weight
8 Plant height

Table 10. Total yield percentage for eight traits for each component line grown at Moro, Oregon in 1974.

Traits	Cultivars (%)				
	Hyslop	Yamhill	Paha	Luke	Sprague
1. Yield/plot	740	776	510	342	232
	28.5	29.8	19.6	13.2	8.9
2. No. plants/plot	593	608	513	411	475
	22.8	23.4	19.7	15.8	18.3
3. No. tillers/plot	698	618	483	427	374
	26.8	23.8	18.6	16.4	14.4
4. No. heads/plant	615	533	495	537	420
	23.7	20.5	19.0	20.7	16.1
5. Yield/plant	679	695	537	433	256
	26.1	26.7	20.7	16.7	9.8
6. No. kernels/head	546	631	614	421	388
	21.0	24.3	23.6	16.2	14.9
7. 1000 Kernel wt.	548	579	474	519	480
	21.1	22.3	18.2	20.0	18.4
8. Plant height	510	531	539	508	512
	19.6	20.3	20.6	19.5	20.0

Table 11. Ranking of component lines for general competitive ability and for other traits at Moro, Oregon in 1974.

Traits	Rank
1. Competitive ability (yield/plot)	Y > H > P > L > S
2. No. of plants/plot	Y > H > P > S > L
3. No. of tillers/plot	H > Y > P > L > S
4. No. of heads/plant	H > L > Y > P > S
5. Yield/plant	Y > H > P > L > S
6. No. of kernels/head	Y > P > H > L > S
7. 1000 Kernel weight	Y > H > L > S > P
8. Plant height	P > Y > S > H > L

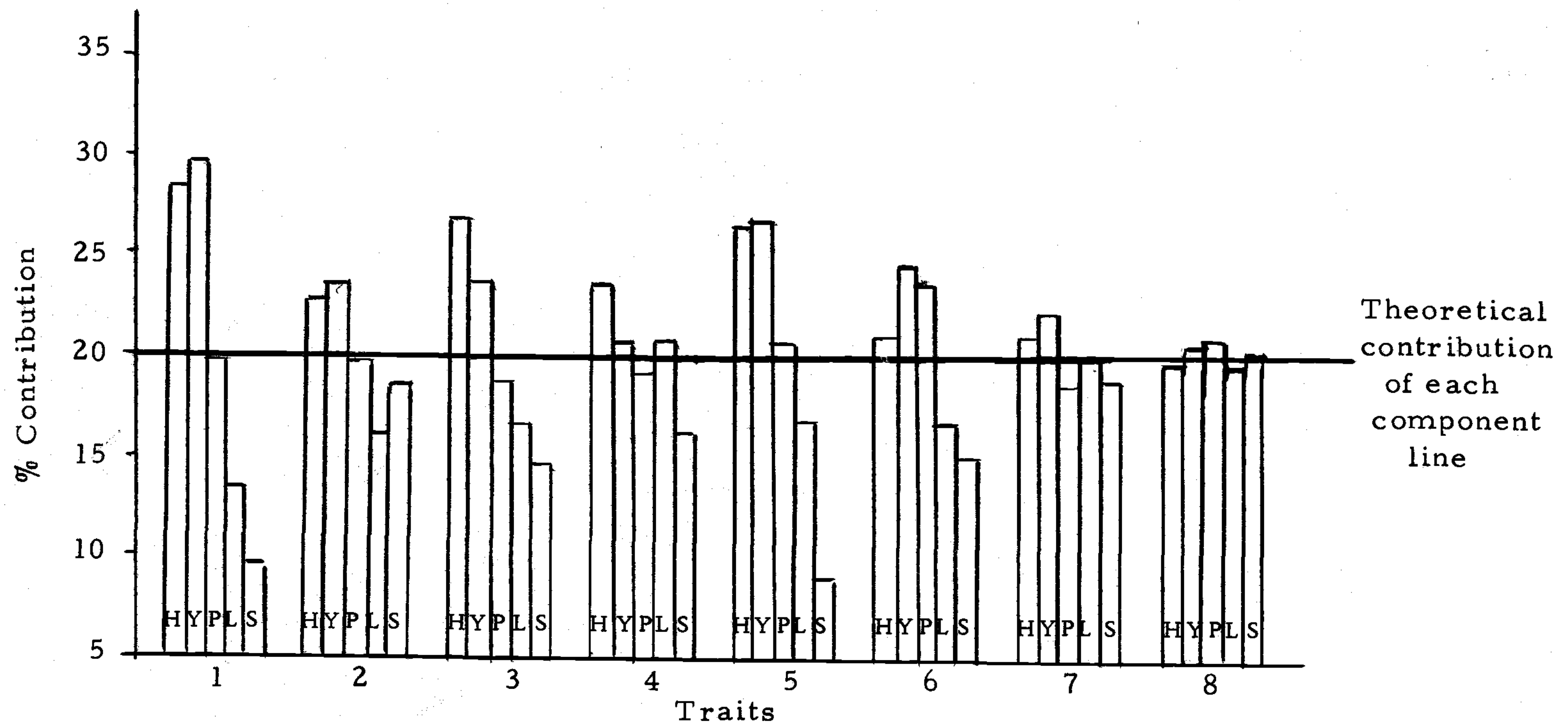
cultivars for general competitive ability and yield per plant was the same. Yamhill was superior for general competitive ability, number of plants per plot, yield per plot, number of kernels per head and 1000 kernel weight. Hyslop was superior for number of tillers per plot and number of heads per plant. Paha was the tallest component line.

The relative contribution of each component line was also determined (Figure 13). Hyslop and Yamhill exceeded the theoretical contribution for all traits except for plant height at Moro. Paha exceeded the theoretical contribution for only yield per plant, number of kernels per head and plant height. The relative contribution of Luke exceeded this value for only yield per plant and they were similar for 1000 kernel weight. Sprague did not exceed the theoretical contribution value for any trait and for plant height they were similar.

Combined Locations

Though there was no significant difference among treatments for yield, the analysis of variance showed that there were significant differences among the component lines within treatments for some traits across three locations (Appendix Table 9). The contribution of the component lines was computed for each trait across treatments and general competitive ability of the component lines was determined (Table 12).

Figure 13. The total relative contribution of each component line for eight traits when compared with the theoretical contribution value at Moro, Oregon in 1974.



1 Yield/plot
2 No. plants/plot
3 No. tillers/plot
4 No. heads/plant
5 Yield/plant
6 No. kernels/head
7 1000 Kernel weight
8 Plant height

Table 12. Combined total yield percentage for all traits for each component line grown at three sites in Oregon in 1974.

Traits	Cultivars (%)				
	Hyslop	Yamhill	Paha	Luke	Sprague
1. Yield/plot	624 24.0	724 27.8	575 22.0	355 13.7	320 12.3
2. No. plants/plot	551 21.2	592 22.8	522 20.0	442 17.0	493 19.0
3. No. tillers/plot	608 23.4	579 22.3	496 19.0	441 17.0	476 18.3
4. No. heads/plant	580 22.3	513 19.7	485 18.7	541 20.8	481 18.5
5. Yield/plant	605 23.3	665 25.6	572 22.0	430 16.5	328 12.6
6. No. kernels/head	533 20.5	612 23.5	646 24.8	418 16.1	391 15.1
7. 1000 kernel wt.	548 21.1	576 22.2	496 19.0	509 19.6	471 18.1
8. Plant height	499 19.3	534 20.5	539 20.7	508 19.5	520 20.0

Component lines also were ranked for general competitive ability and for the other traits (Table 13).

General competitive ability and yield per plant for pure stands were the same in terms of their ranking. Yamhill was superior for general competitive ability, number of plants per plot, yield per plant and 1000 kernel weight. Hyslop was superior for number of tillers per plot and number of heads per plant. Paha had the highest general competitive ability for number of kernels per head and plant height.

Table 13. Ranking of component lines for general competitive ability and other traits in combined analysis at three sites in Oregon in 1974.

Traits	Rank
1. General competitive ability (yield)	Y > H > P > L > S
2. No. of plants/plot	Y > H > P > S > L
3. No. of tillers/plot	H > Y > P > S > L
4. No. of heads/plant	H > L > Y > P > S
5. Yield/plant	Y > H > P > L > S
6. No. of kernels/head	P > Y > H > L > S
7. 1000 Kernel weight	Y > H > L > P > S
8. Plant height	P > Y > S > L > H

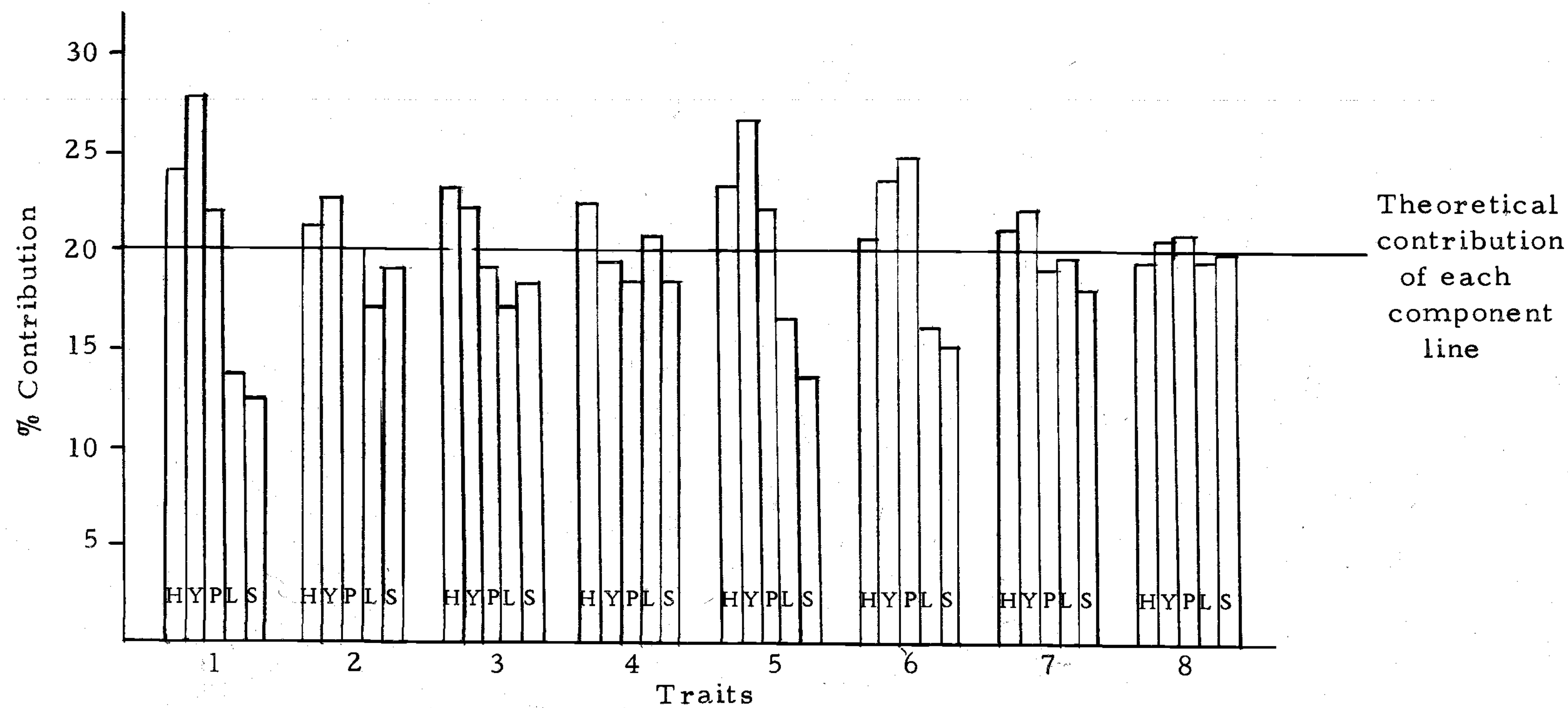
The relative competitive contribution of each component line also was determined. Hyslop exceeded the theoretical contribution value for all traits except plant height (Figure 14). Yamhill also exceeded this contribution value for seven traits with number of heads per plant being the exception. The theoretical contribution for general competitive ability, yield per plant, number of kernels per head and plant height was also higher for Paha. They were equal for number of plants per plot. Luke was higher than would be expected based on the theoretical expectation for only number of heads per plant. Sprague was inferior for seven traits.

Relative Competitive Ability

Corvallis

The yielding ability of each cultivar when grown under

Figure 14. The total relative contribution of each component line for eight traits when compared with the theoretical contribution value in a combined analysis of three sites in Oregon in 1974.



1 Yield/plot
2 No. plants/plot
3 No. tillers/plot
4 No. heads/plant
5 Yield/plant
6 No. kernels/head
7 1000 Kernel weight
8 Plant height

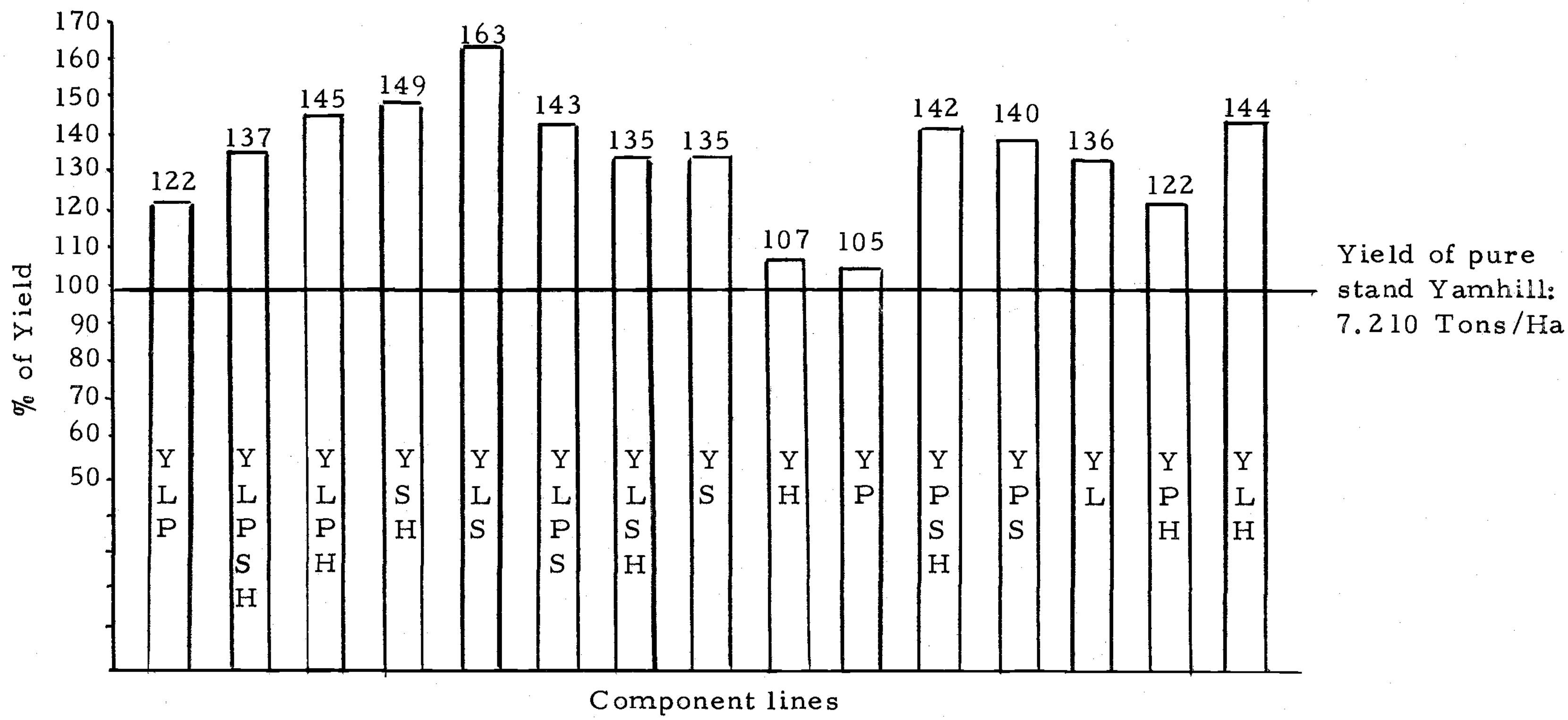
competitive conditions and compared with its pure stand counterpart is referred to as relative competitive ability. If the yield of a pure stand cultivar is assumed to be 100 percent, the relative competitive ability of each cultivar across treatments can be assessed. Relative competitive ability was computed by subtracting the sum of the yield loss from the sum of the yield gain for those treatments having a common component line and dividing by the total number of treatments. This is referred to as a percent of grain yield per composite plot.

The yield of Yamhill in all composite plots exceeded that of pure stand Yamhill at Corvallis (Figure 15). In one treatment (Y+L+S) Yamhill yielded 63 percent more than pure stand Yamhill. Yamhill was fairly competitive yield-wise in almost all composite combinations. The average yield gain of Yamhill per composite plot was 35 percent.

In 10 out of 15 composite combinations containing Paha, Paha out-yielded its pure stand counterpart (Figure 16). The maximum yield increment was 59 percent. The average yield gain for Paha per composite treatment was 12.3 percent.

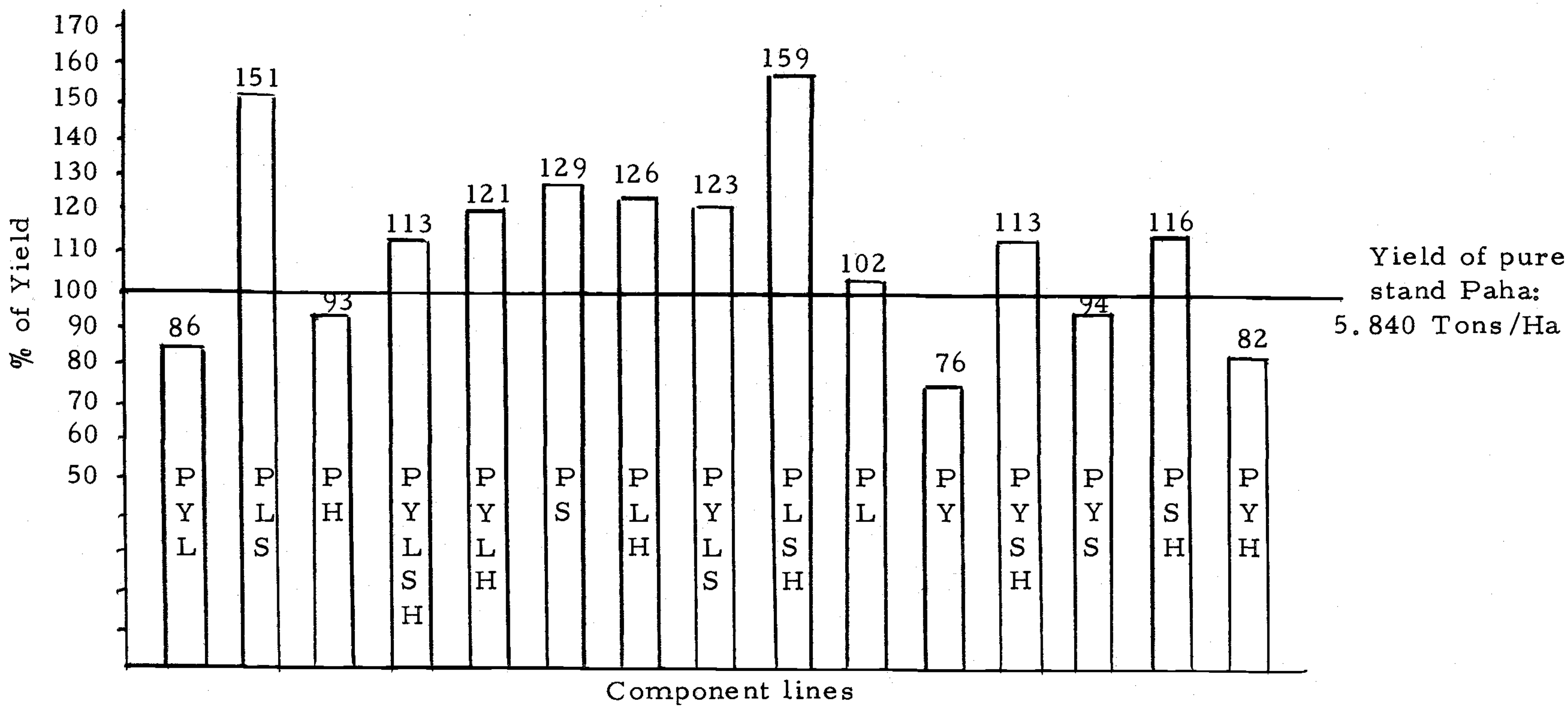
Paha at Corvallis was very susceptible to leaf rust (causal agent, Puccinia recondita). Of the five cultivars that were grown, Paha had the highest degree of attack (80 percent). The degree of attack was lower in the composite populations containing Paha than pure stand Paha (Figure 17). Grain yield and infection percentage of

Figure 15. The yield comparison of Yamhill with Yamhill in 15 different composite combinations at Corvallis, Oregon in 1974.



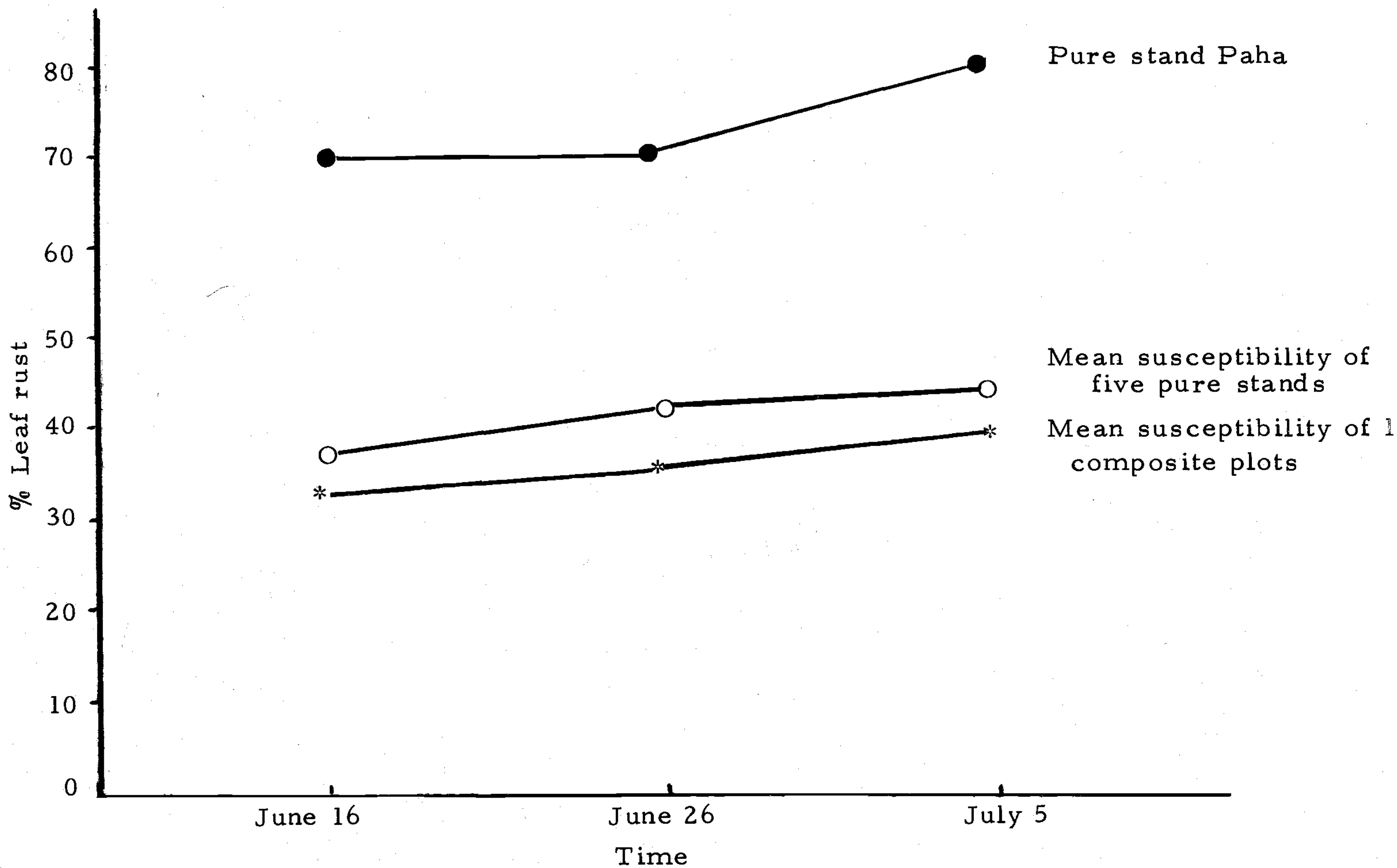
Maximum increase: 63%
Average gain: 35%

Figure 16. The yield comparison of Paha with Paha in 15 different composite combinations at Corvallis, Oregon in 1974.



Maximum increase: 59%
Maximum decrease: 24%
Average gain: 12.3%

Figure 17. A comparison of percent leaf rust in a pure stand of Paha and 15 composite plots containing Paha at three different times at Corvallis, Oregon in 1974.



pure stand Paha and composite populations containing Paha were compared (Figure 18). Fourteen of the 15 composite lines exceeded the yield of Paha grown in a pure stand. The higher yields of these composites may be due, in part, to the lower amount of disease observed in the composites.

Hyslop, when grown under competition, exceeded the yield of pure stand Hyslop in eight composites and performed poorly in six (Figure 19). In one treatment (Y+L+H) the yield of Hyslop equaled that of its pure stand. The maximum yield increase for Hyslop was 41 percent with the maximum yield decrease being 24 percent. The average yield gain for Hyslop per composite treatment was 4.8 percent.

In only one treatment (L+S) did Luke exceed the mean yield of its pure stand. The yield increase was only 23 percent. The maximum yield decrease for Luke was 50 percent. Average yield loss for Luke per composite treatment was 25.3 percent (Figure 20).

The yield of Sprague when grown in a composite exceeded the mean yield of its pure stand in only one treatment and by only one percent (Figure 21). Sprague, when grown as a pure stand, outyielded Sprague when grown under competition in 14 treatments. The maximum yield loss for Sprague was 67 percent with the average loss of 44.9 percent.

Figure 18. Yield comparison of pure stand Paha with different composites containing Paha at Corvallis, Oregon in 1974.

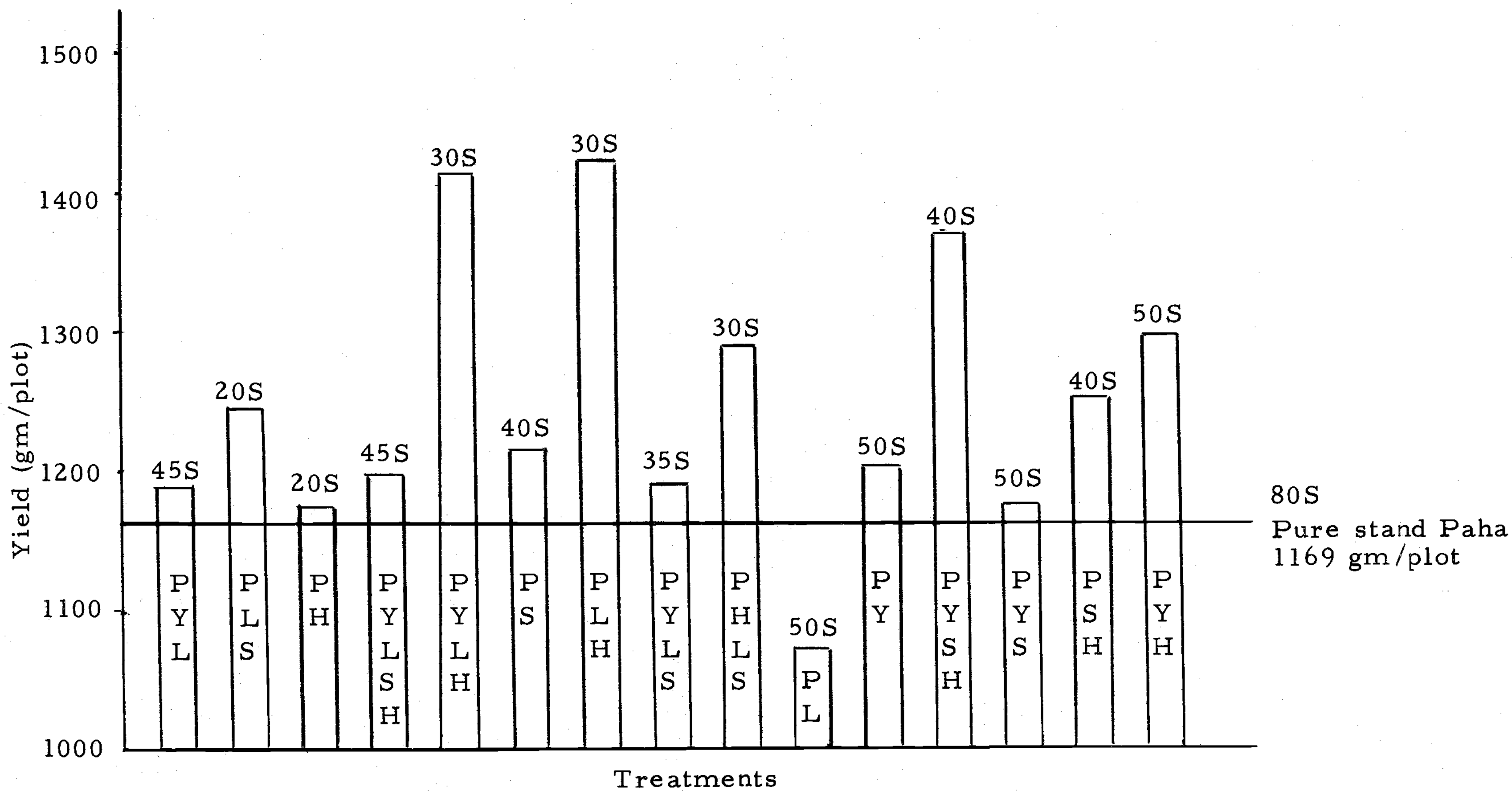
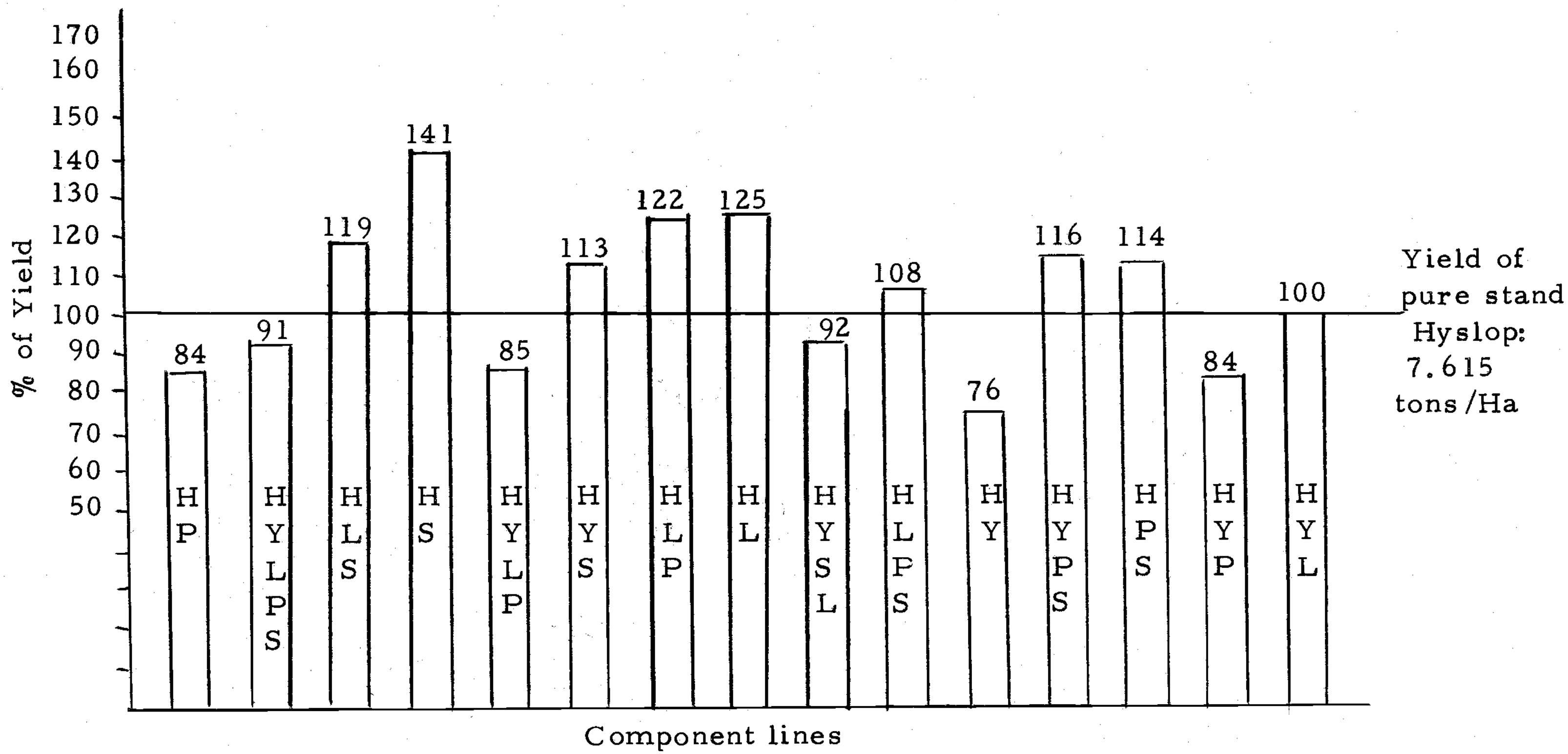
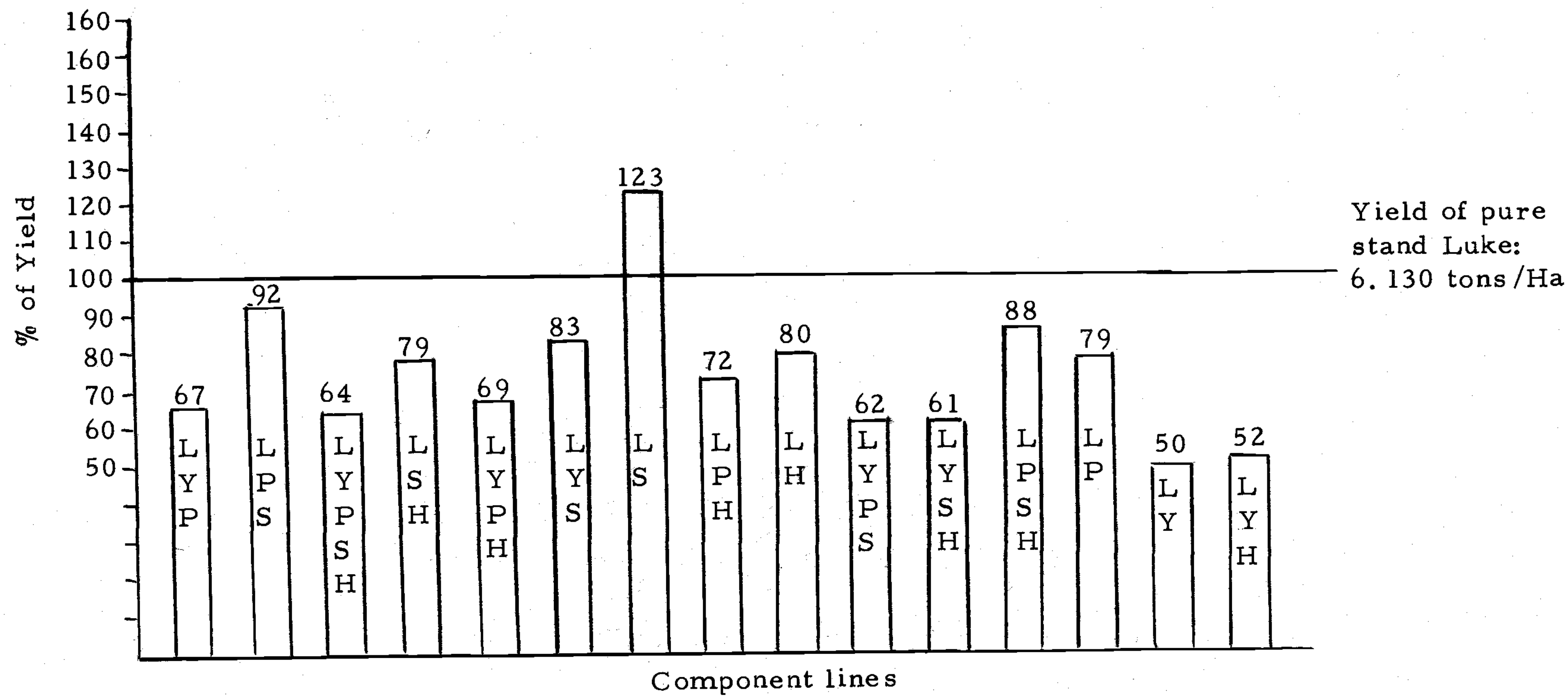


Figure 19. The yield comparison of Hyslop with Hyslop in 15 different composite combinations at Corvallis, Oregon in 1974.



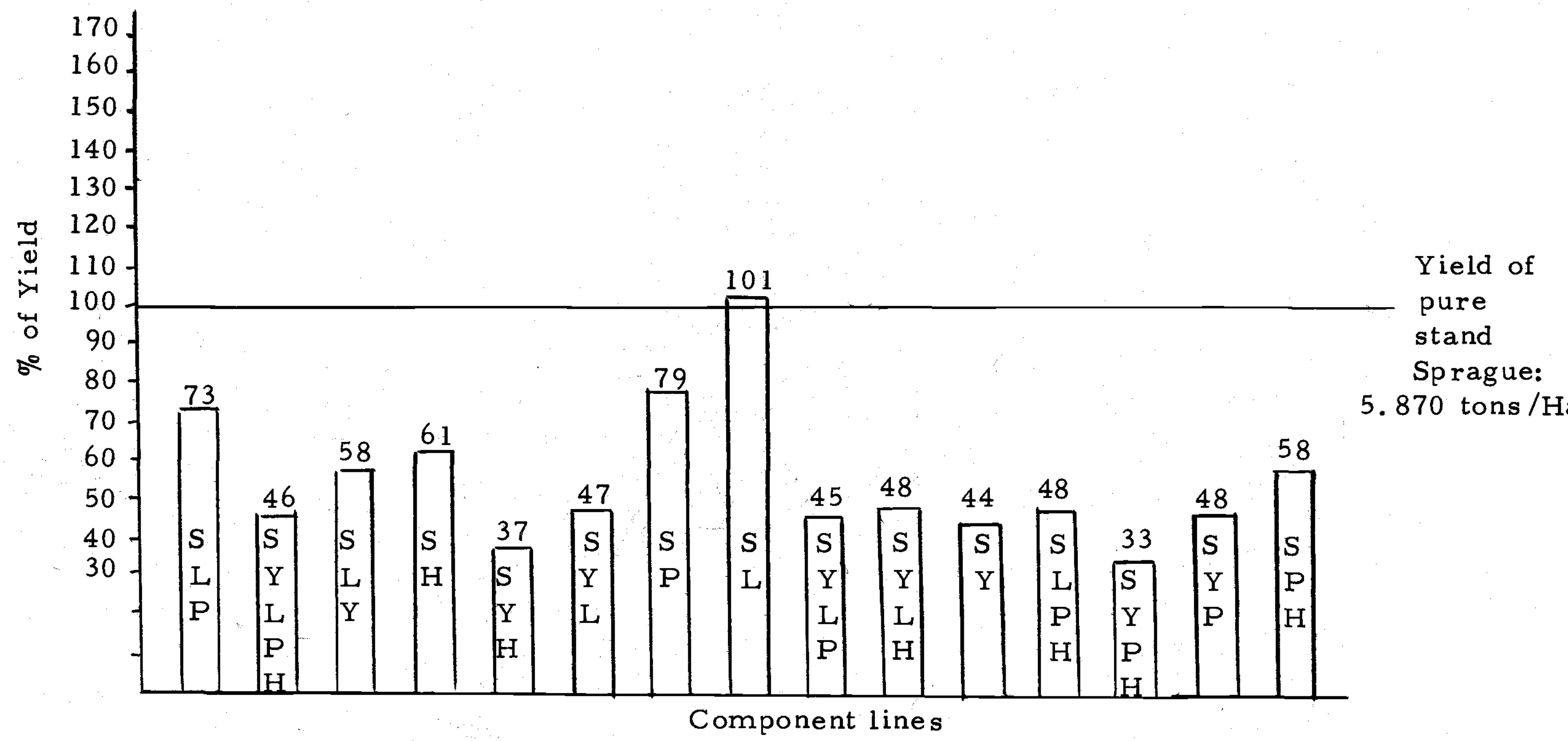
Maximum increase: 41%
Maximum decrease: 24%
Average gain: 4.8%

Figure 20. The yield comparison of Luke with Luke in 15 different composite combinations at Corvallis, Oregon in 1974.



Maximum increase:	23%
Maximum decrease:	50%
Average loss:	25.3%

Figure 21. The yield comparison of Sprague with Sprague in 15 different composite combinations at Corvallis, Oregon in 1974.



Maximum increase:	1%
Maximum decrease:	67%
Average loss:	44.9%

Madras

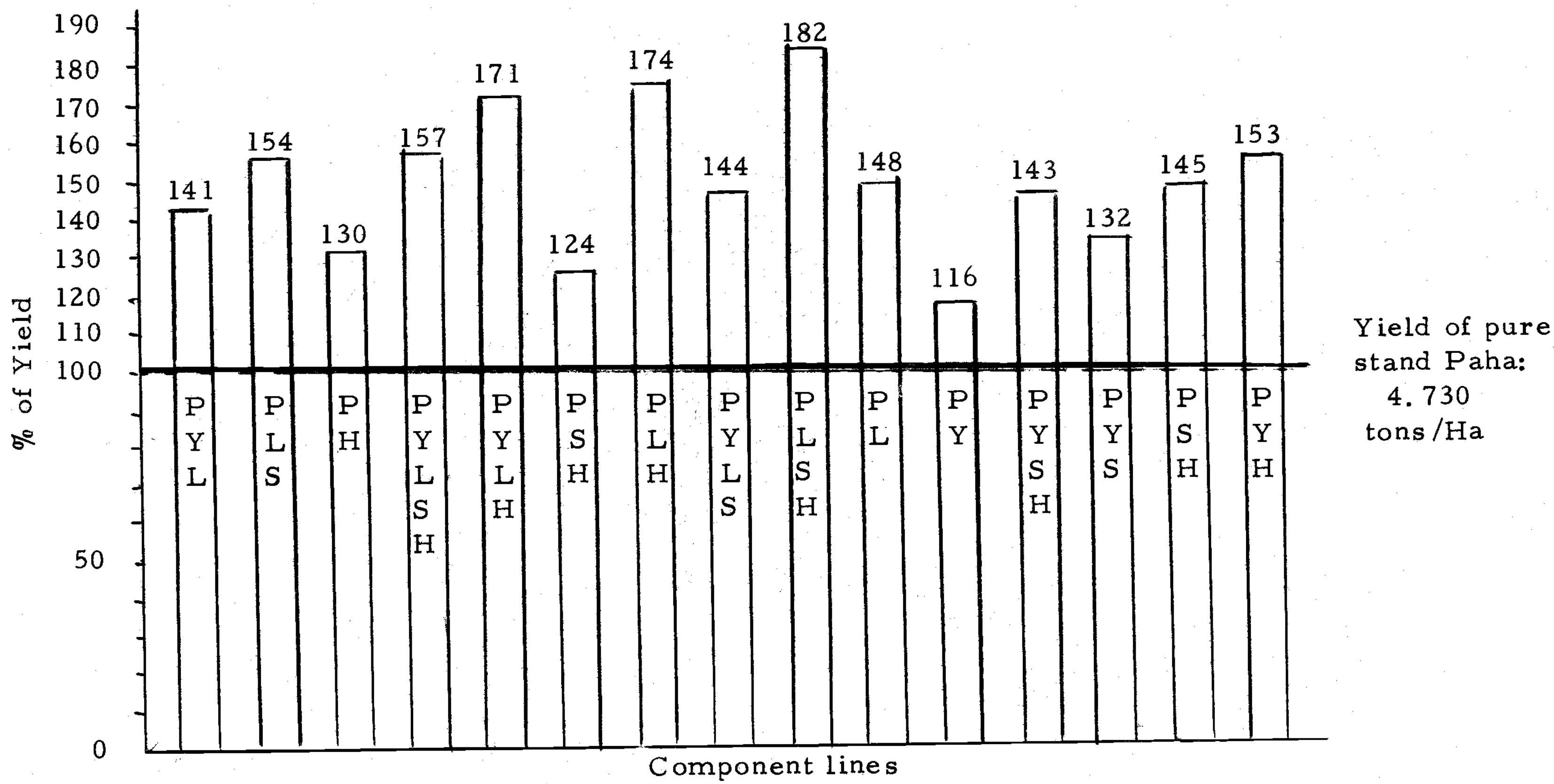
The yield of Paha in all composite plots exceeded that of pure stand Paha at Madras (Figure 22). In one treatment (L+P+S+H), Paha yielded 82 percent more than pure stand Paha. The average yield gain of Paha per composite plot was 47.6 percent.

Yamhill grown in 15 composites also exceeded the yield of pure stand Yamhill (Figure 23). Yamhill yielded 59 percent more than pure stand Yamhill in one treatment (L+Y+S). The average yield gain of Yamhill per composite treatment was 35.5 percent.

Hyslop, when grown under competition, exceeded the yield of pure stand Hyslop in seven composites and performed poorly in eight composites (Figure 24). In one treatment (S+L+H), maximum yield increase was 84 percent more than its pure stand. Maximum yield decrease was 20 percent in another treatment (S+Y+P+H). The average yield gain for Hyslop per composite treatment was 10.7 percent.

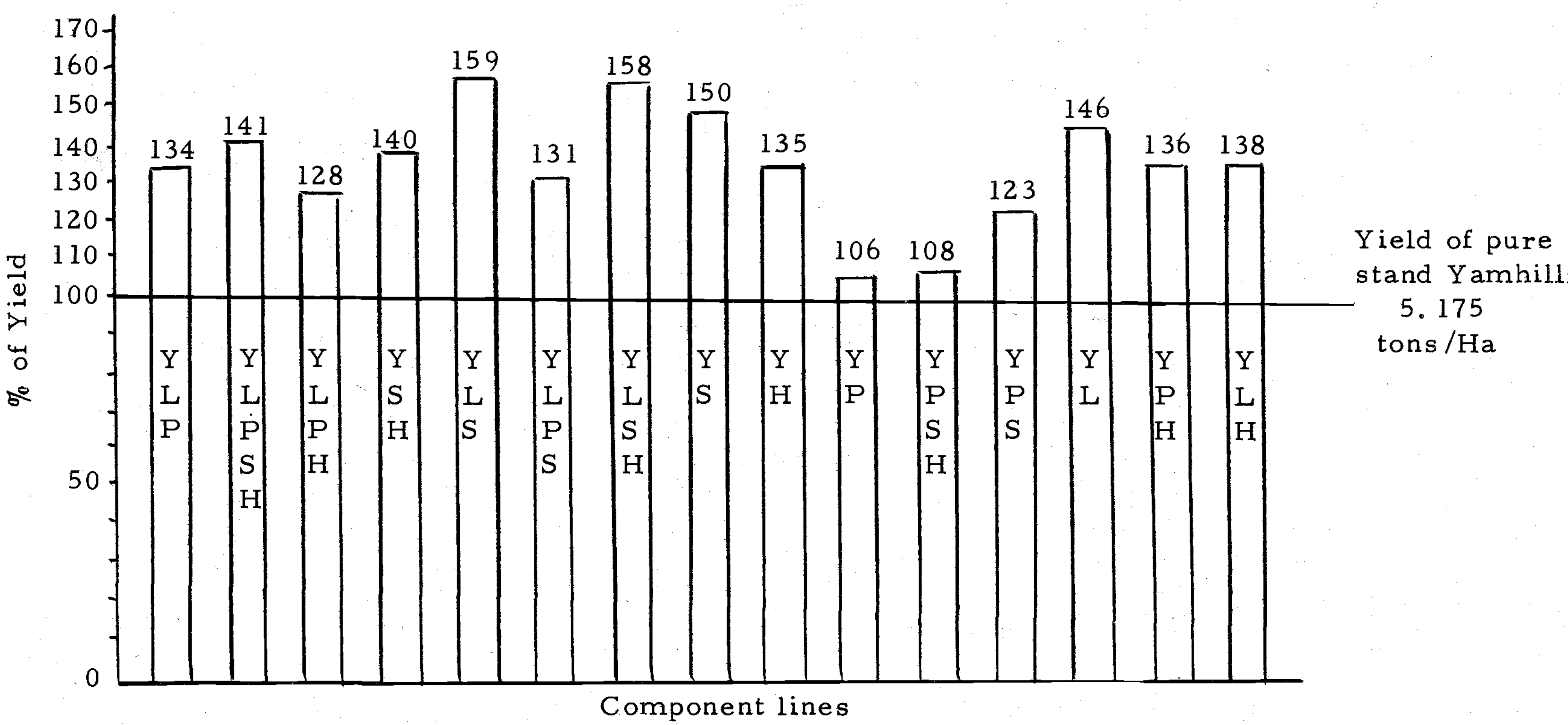
Sprague when grown in composites exceeded the mean yield of its pure stand in six treatments (Figure 25). The maximum yield increase of Sprague was 42 percent in one treatment (S+L+H). A maximum yield decrease calculated was 32 percent. Average yield loss for Sprague per composite treatment was 2.6 percent.

Figure 22. The yield comparison of Paha with Paha in 15 different composite combinations at Madras, Oregon in 1974.



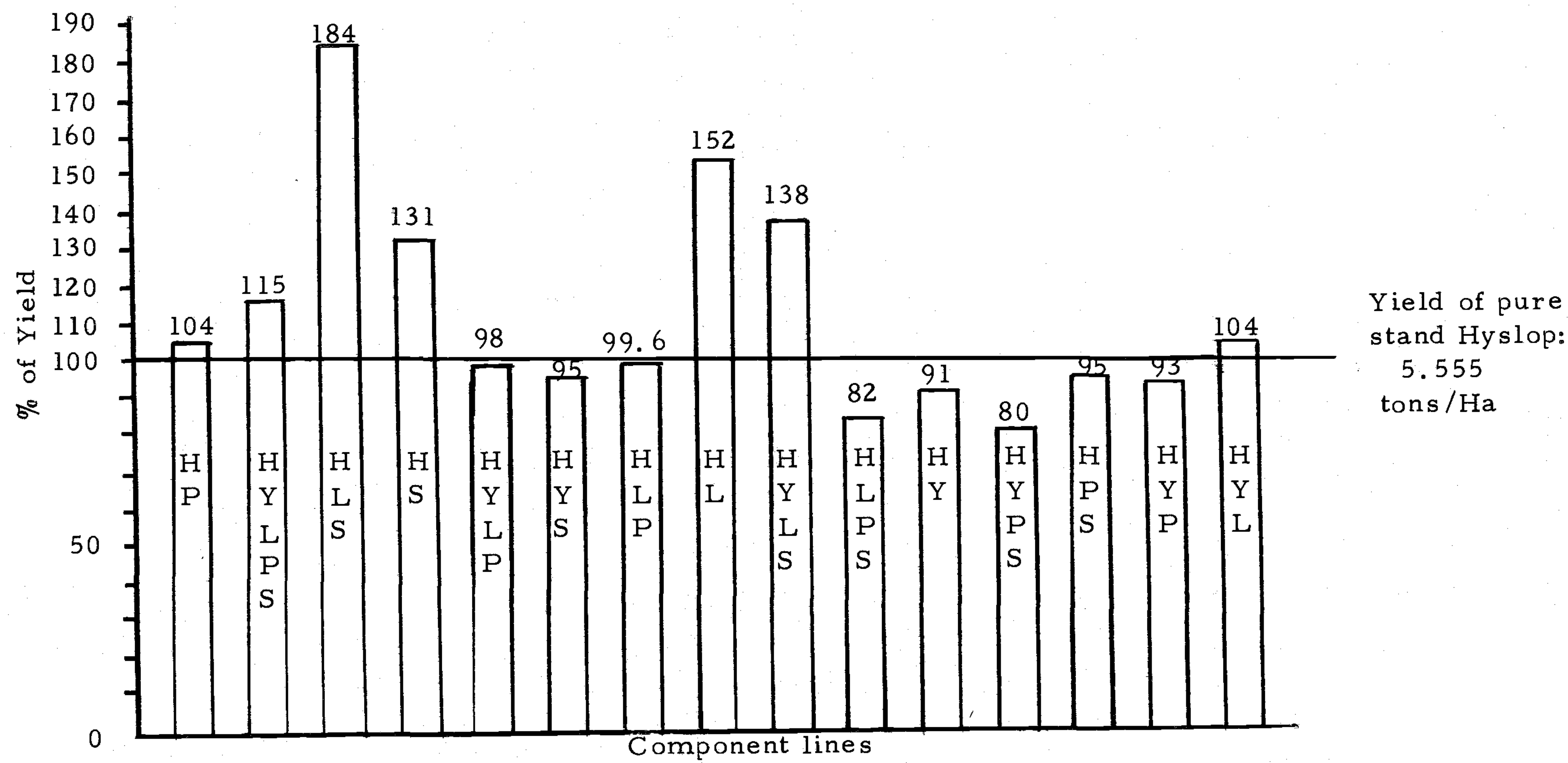
Maximum increase: 82%
Maximum gain: 47.6%

Figure 23. The yield comparison of Yamhill with Yamhill in 15 different composite combinations at Madras, Oregon in 1974.



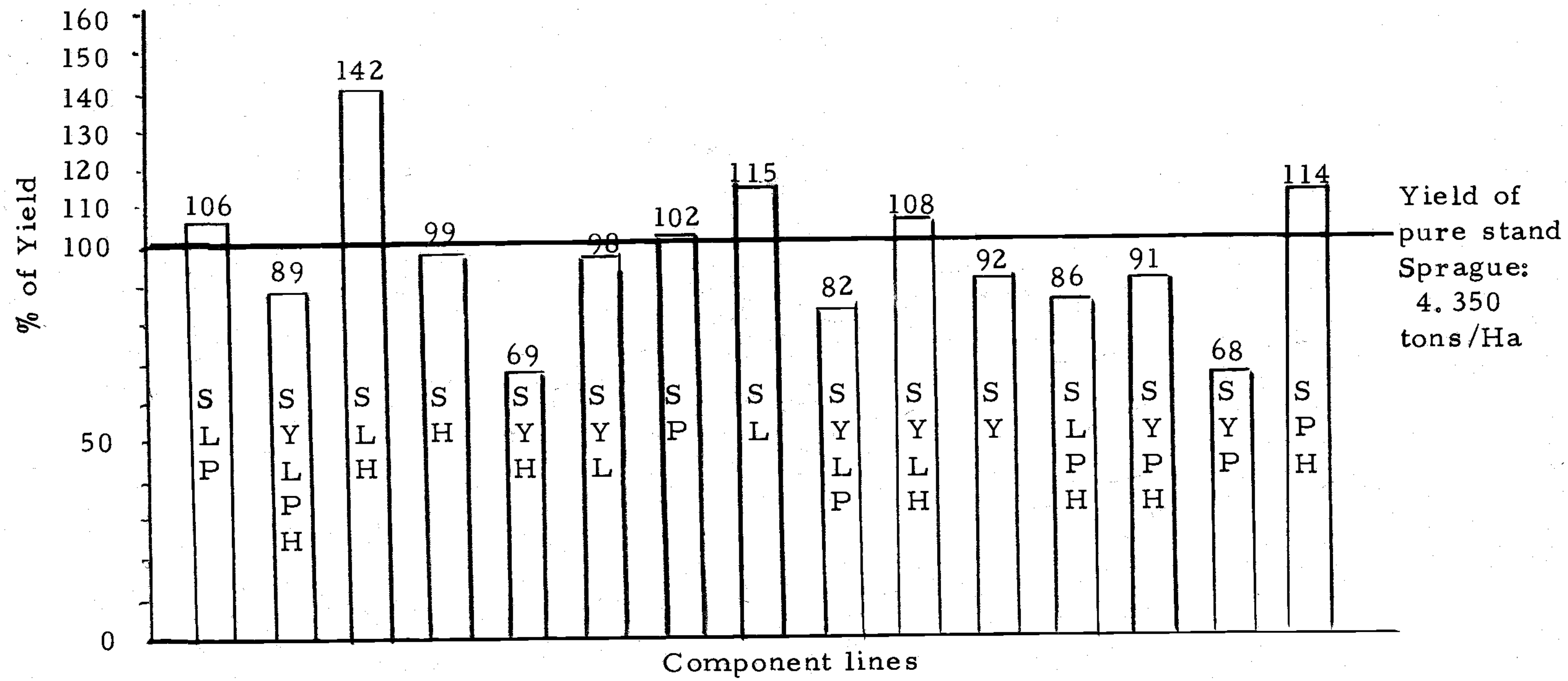
Maximum increase: 59%
Average gain: 35.5%

Figure 24. The yield comparison of Hyslop with Hyslop in 15 different composite combinations at Madras, Oregon in 1974.



Maximum increase: 84%
Maximum decrease: 20%
Average gain: 10.7%

Figure 25. The yield comparison of Sprague with Sprague in 15 different composite combinations at Madras, Oregon in 1974.



Maximum increase: 42%
Maximum decrease: 32%
Average loss: 2.6%

Luke when grown in composites was inferior to its pure stand in all treatments (Figure 26). The maximum yield decrease of Luke was 86 percent in one treatment (L+Y). Average yield loss for Luke was 51.7 percent.

Moro

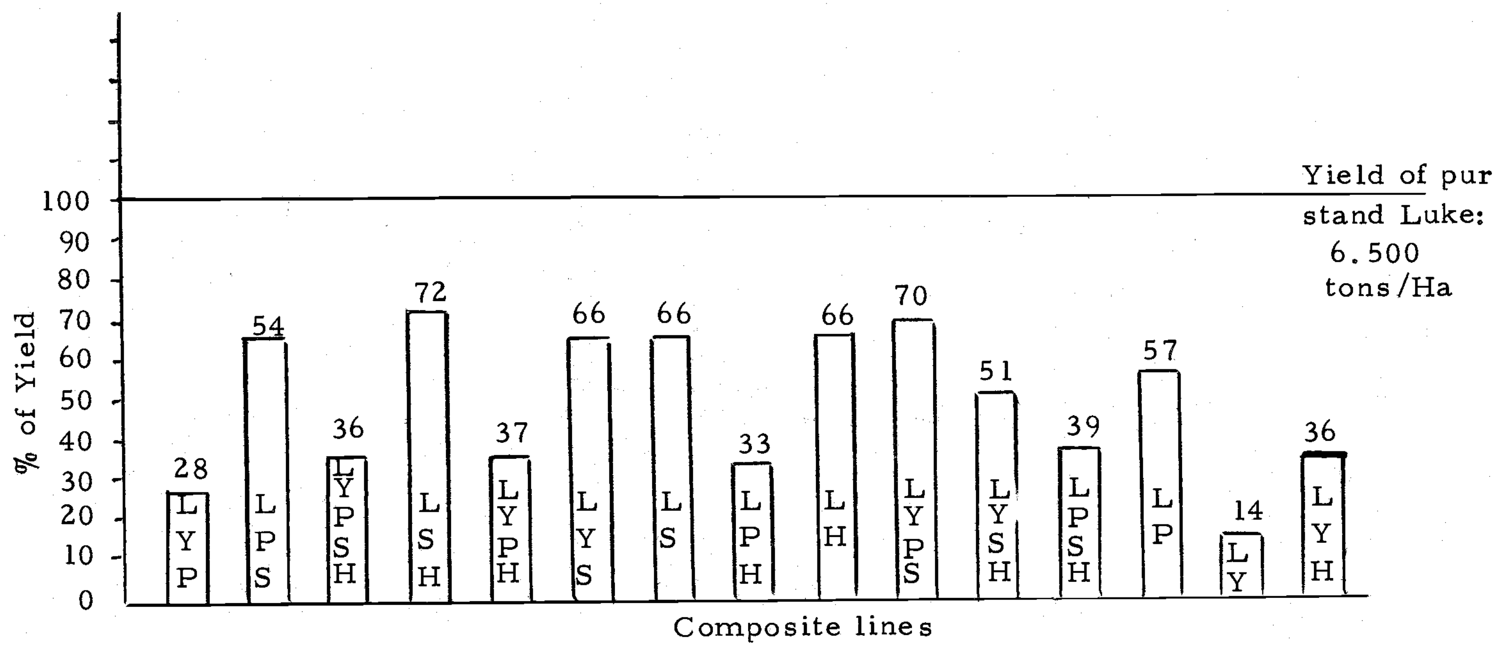
The yield of Hyslop in 14 composite plots exceeded its pure stand (Figure 27). Hyslop yielded 75 percent more than its pure stand in one treatment (L+H). The average yield gain of Hyslop per composite plot was 39.5 percent.

Yamhill exceeded its pure stand in all composite combinations (Figure 28). The maximum yield increase of Yamhill was 65 percent in one treatment (L+Y+S+H). Average yield gain of Yamhill per composite plot was 33.8 percent.

Paha grown in competition exceeded the yield of its pure stand in 12 composite plots (Figure 29). The maximum yield decrease was 30 percent. The average yield gain of Paha per composite plot was 9.1 percent.

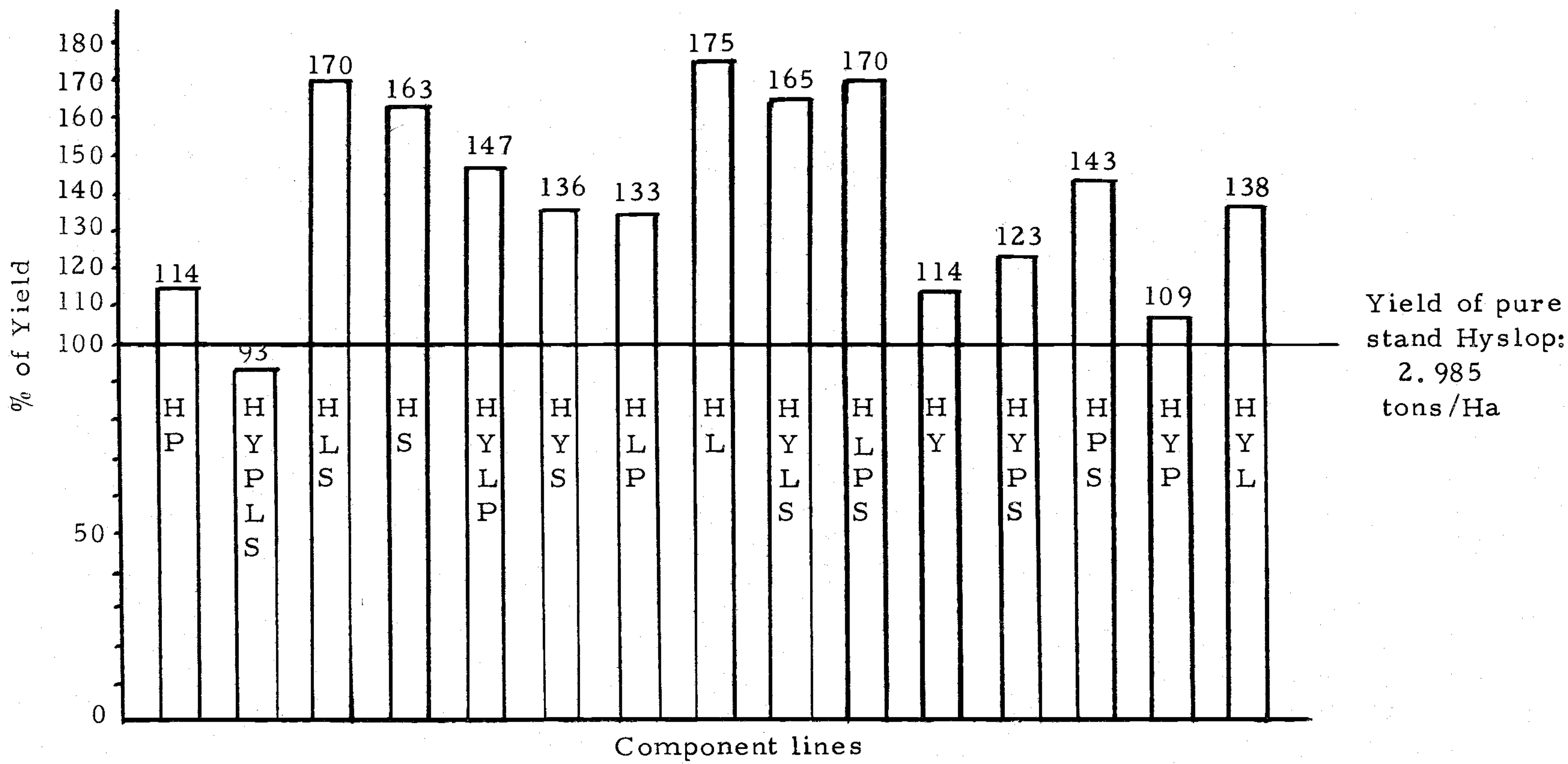
Luke exceeded the yield of its pure stand in only 2 percent in one treatment (Figure 30). Maximum yield decrease was 71 percent in the treatment, L+Y+P+S+H. The average yield loss per composite plot was 40.7 percent.

Figure 26. The yield comparison of Luke with Luke in 15 different composite combinations at Madras, Oregon in 1974.



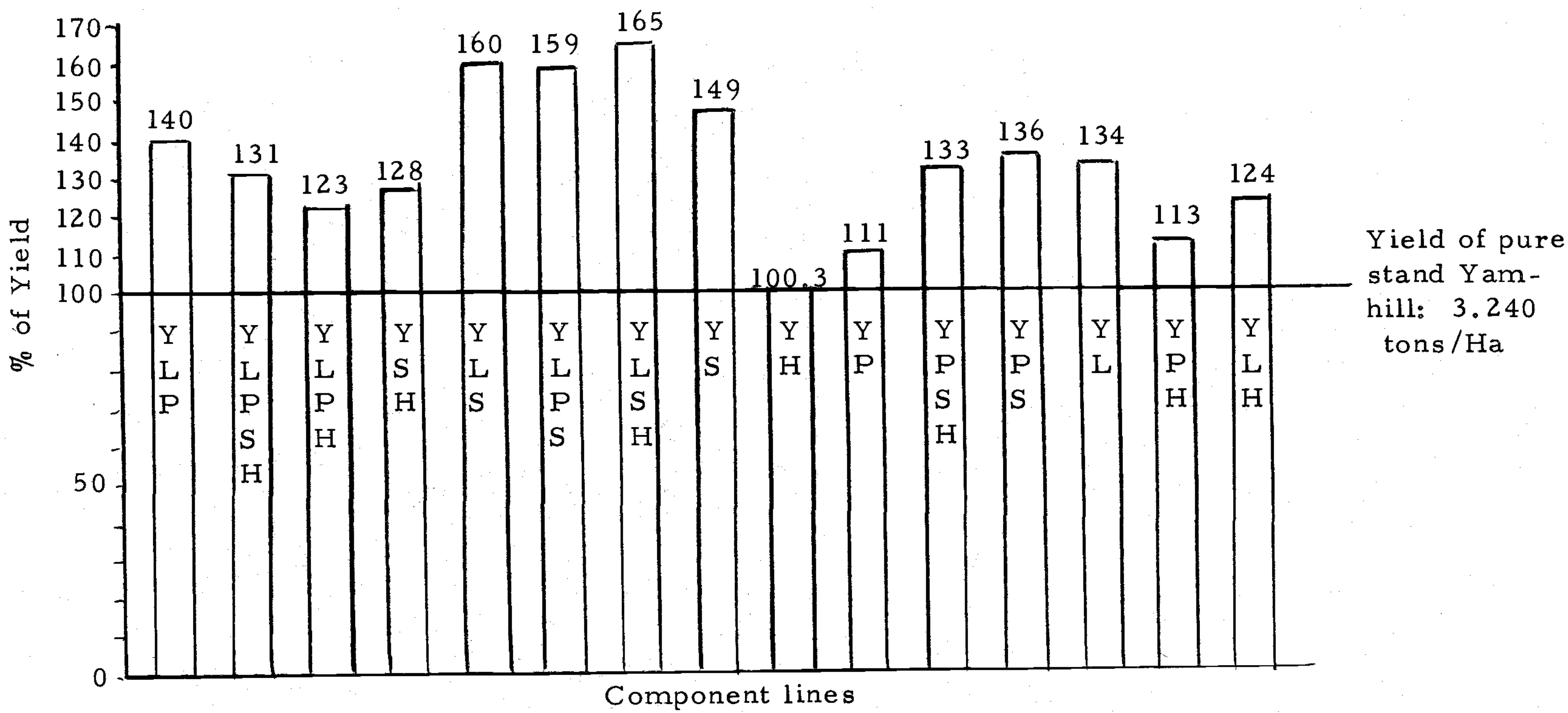
Maximum decrease: 86%
Average loss: 51.7%

Figure 27. The yield comparisons of Hyslop with Hyslop in 15 different composite combinations at Moro, Oregon in 1974.



Maximum increase: 75%
Maximum decrease 7%
Average gain: 39.5%

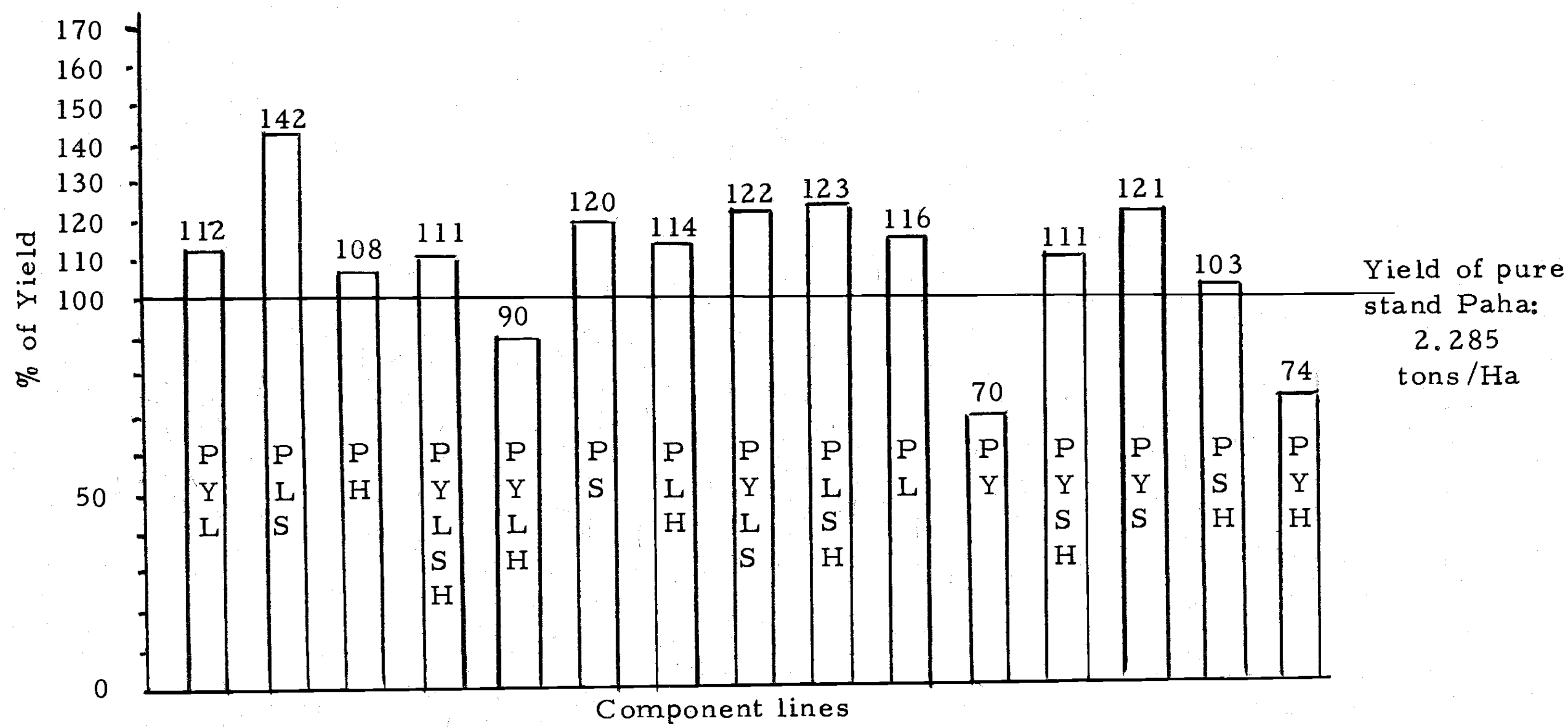
Figure 28. The yield comparison of Yamhill with Yamhill in 15 different composite combinations at Moro, Oregon in 1974.



Maximum increase: 65%

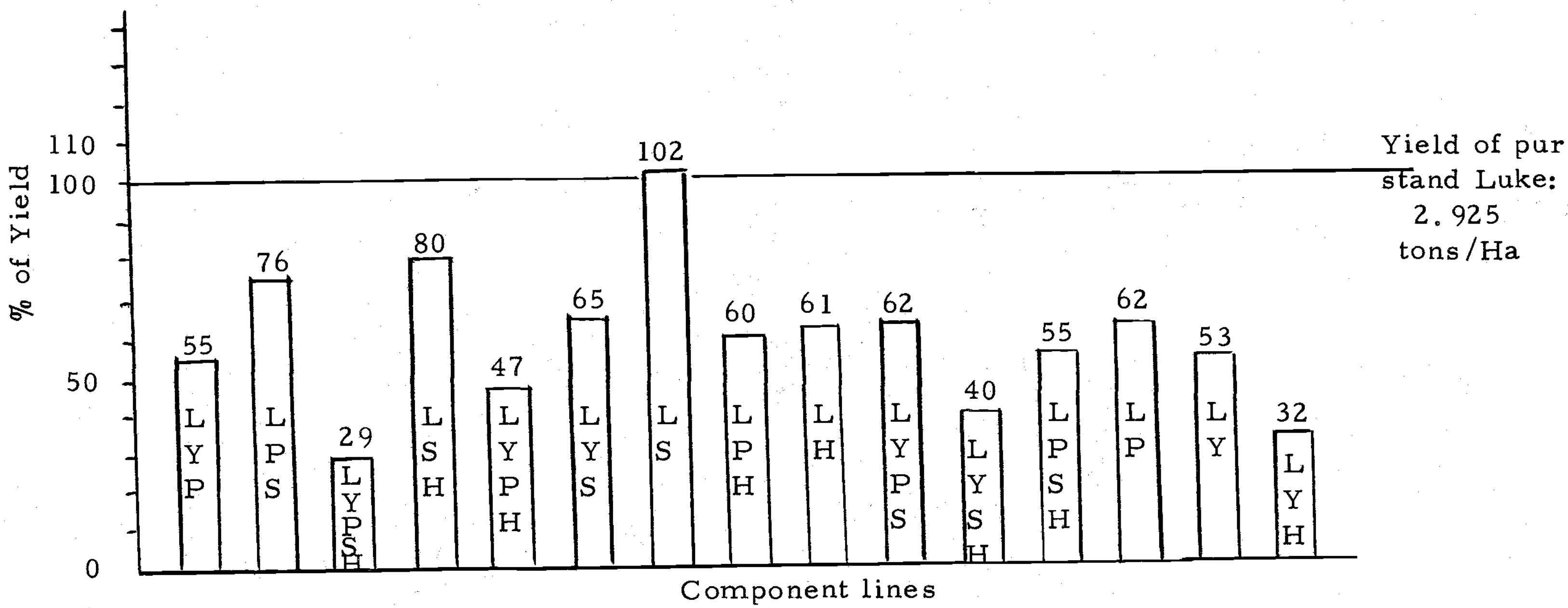
Average gain: 33.8%

Figure 29. The yield comparison of Paha with Paha in 15 different composite combinations at Moro, Oregon in 1974.



Maximum increase: 42%
Maximum decrease: 30%
Average gain: 9.1%

Figure 30. The yield comparison of Luke with Luke in 15 different composite combinations at Moro, Oregon in 1974.



Maximum increase: 2%

Maximum decrease: 71%

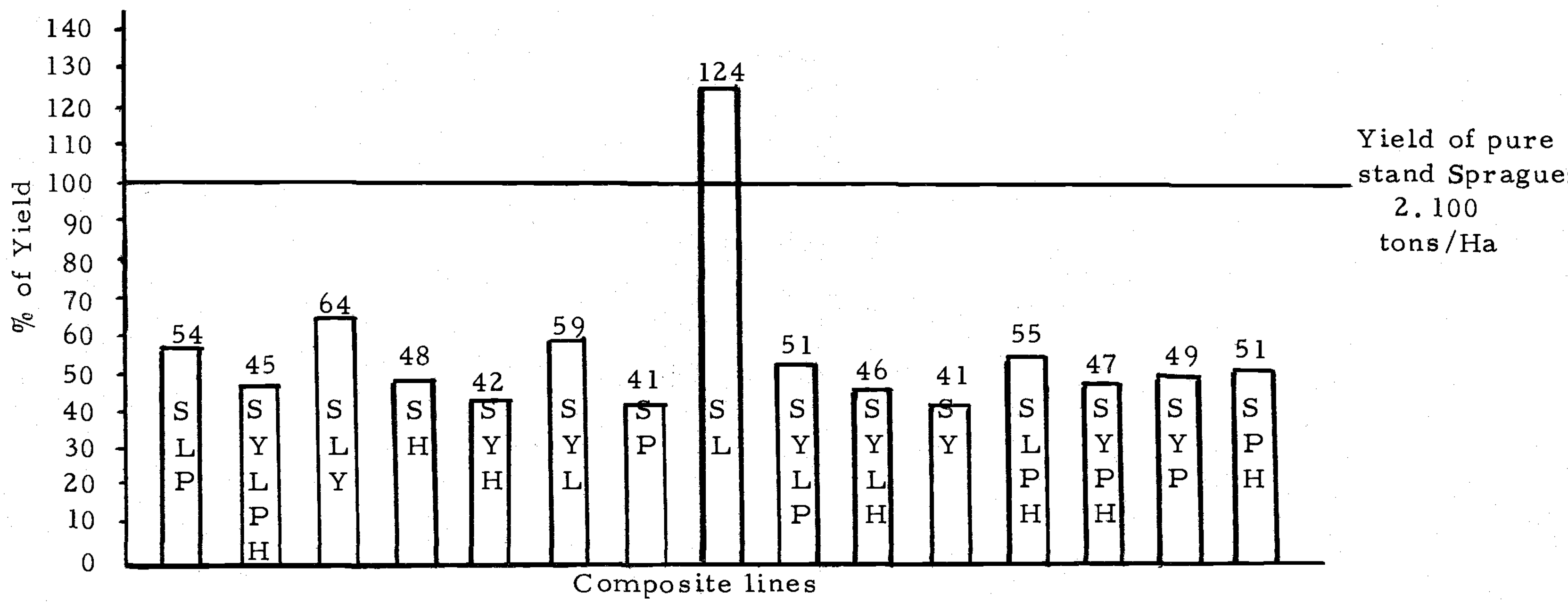
Average loss: 40.7%

Sprague also exceeded the yield of its pure stand in only one treatment (Figure 31). Maximum yield decrease of Sprague was 59 percent (S+P). Average yield loss per composite plot was 45.5 percent.

Combined Locations

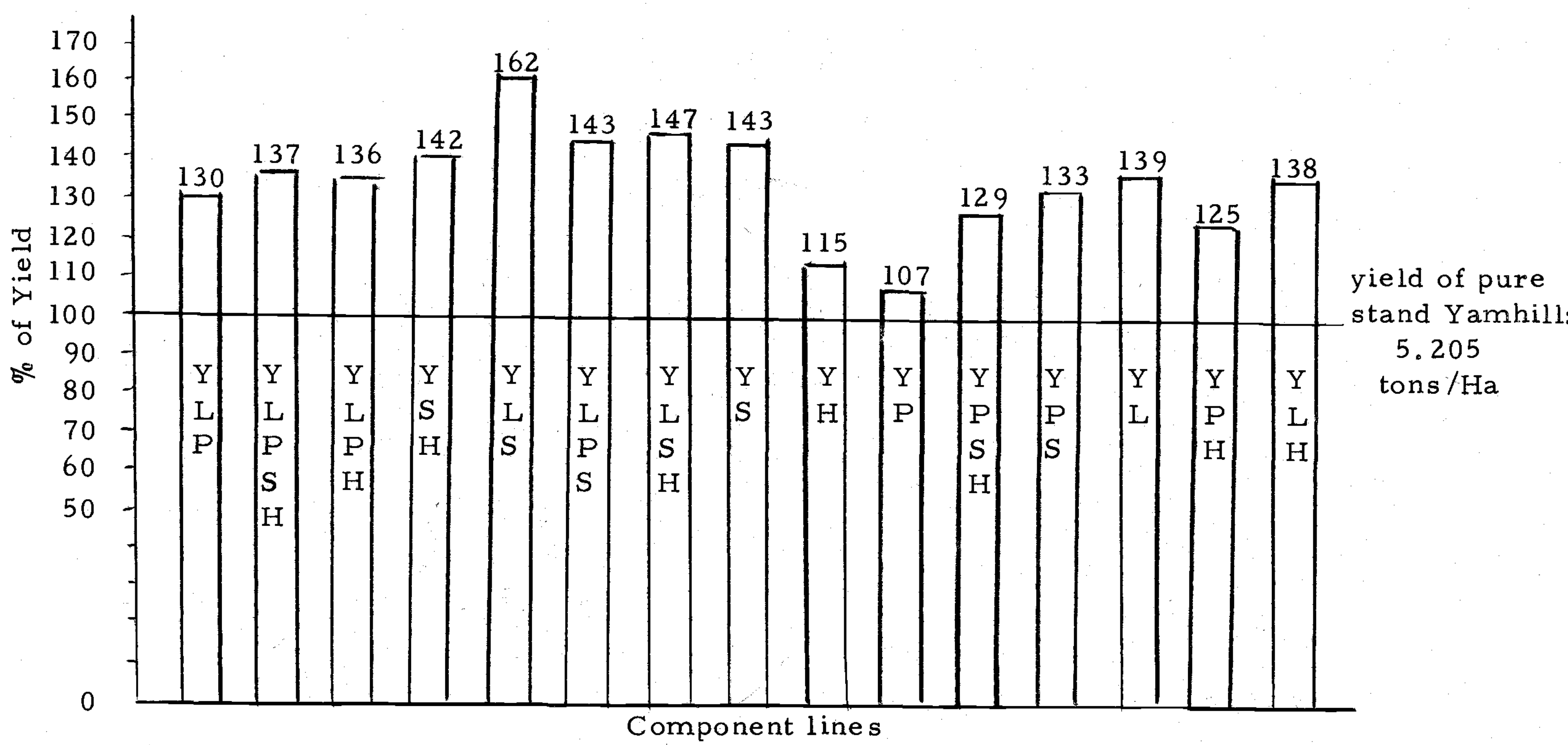
The yield of the component lines was averaged for three locations to determine the average relative competitive ability of each cultivar. Yamhill exceeded the mean yield of its pure stand in all composite combinations (Figure 32). The average yield gain of Yamhill per composite plot was 35 percent. Paha exceeded the yield of its pure stand in 14 composite treatments (Figure 33). The average yield gain was 24.8 percent per composite plot for Paha. Hyslop exceeded its pure stand in 12 composite treatments for yield (Figure 34). Yield gain per composite plot was 13.4 percent. Sprague exceeded the yield of its pure stand by 10 percent in only one treatment (S+L) (Figure 35). The average yield loss per composite plot was 29.9 percent. Luke was very poor in competition and it did not exceed the yield of its pure stand in any treatments (Figure 36).

Figure 31. The yield comparison of Sprague with Sprague in 15 different composite combinations at Moro, Oregon in 1974.



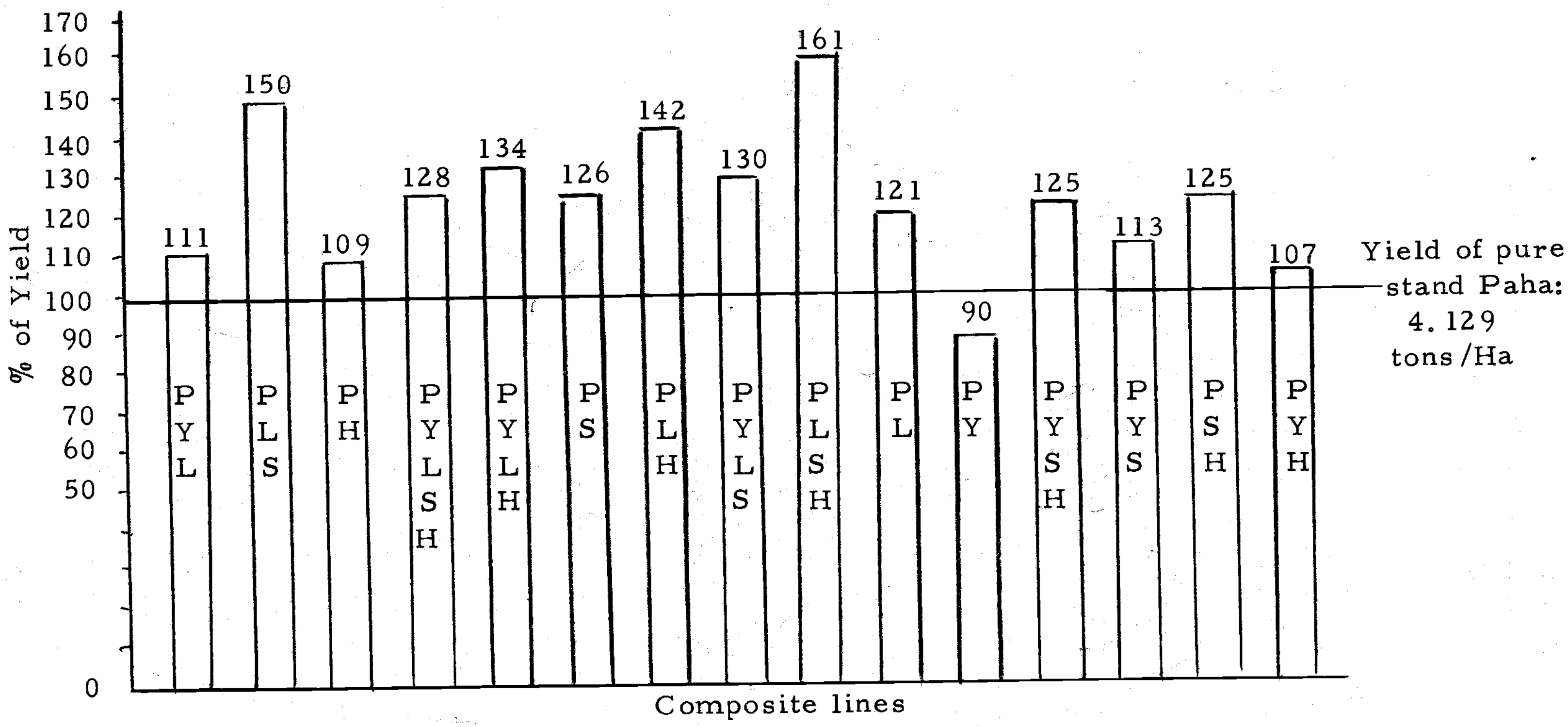
Maximum increase: 24%
Maximum decrease: 59%
Average loss: 45.5%

Figure 32. The combined yield performance of Yamhill compared with Yamhill grown in 15 different composite combinations at three locations in Oregon in 1974.



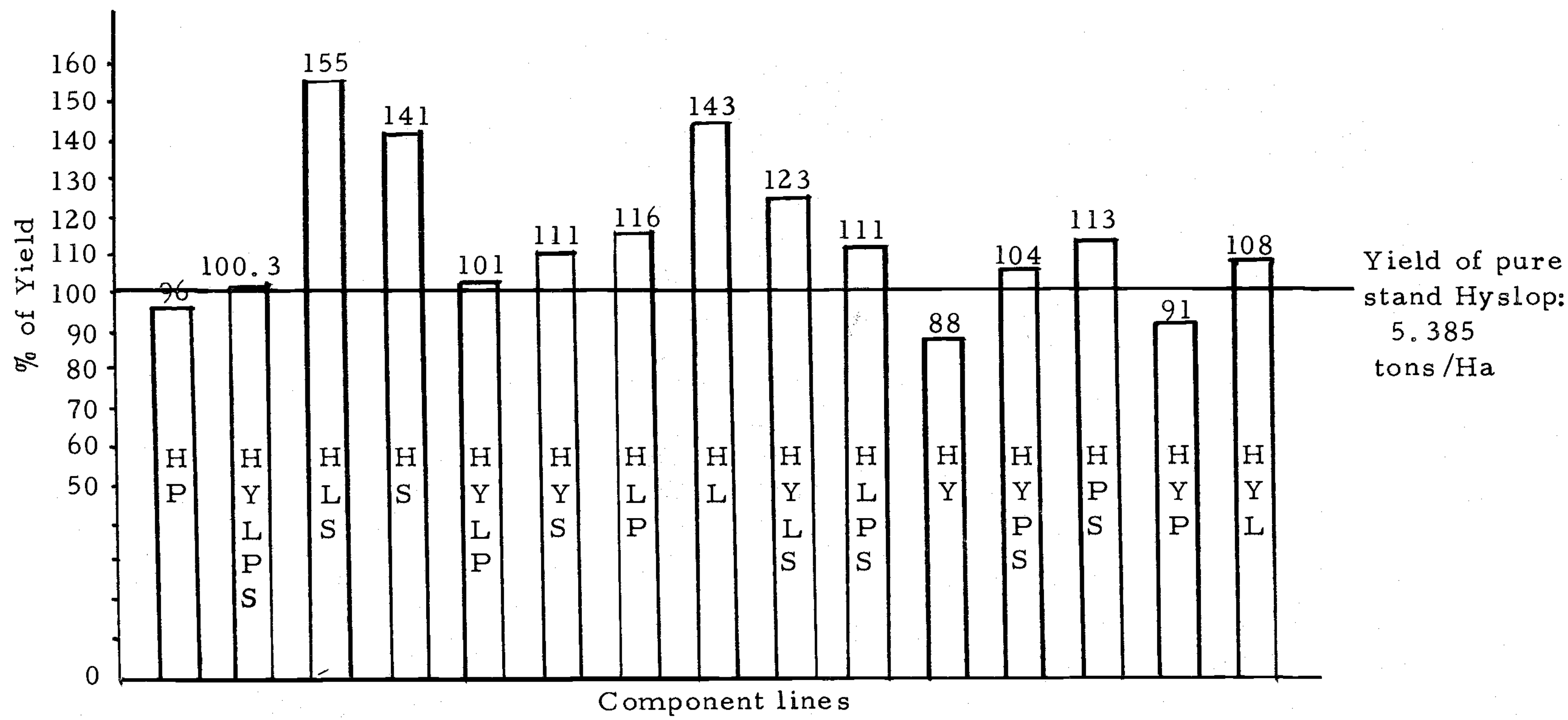
Maximum increase: 62%
Average gain: 35.1%

Figure 33. The combined yield performance of Paha compared with Paha grown in 15 different composite combinations at three locations in Oregon in 1974.



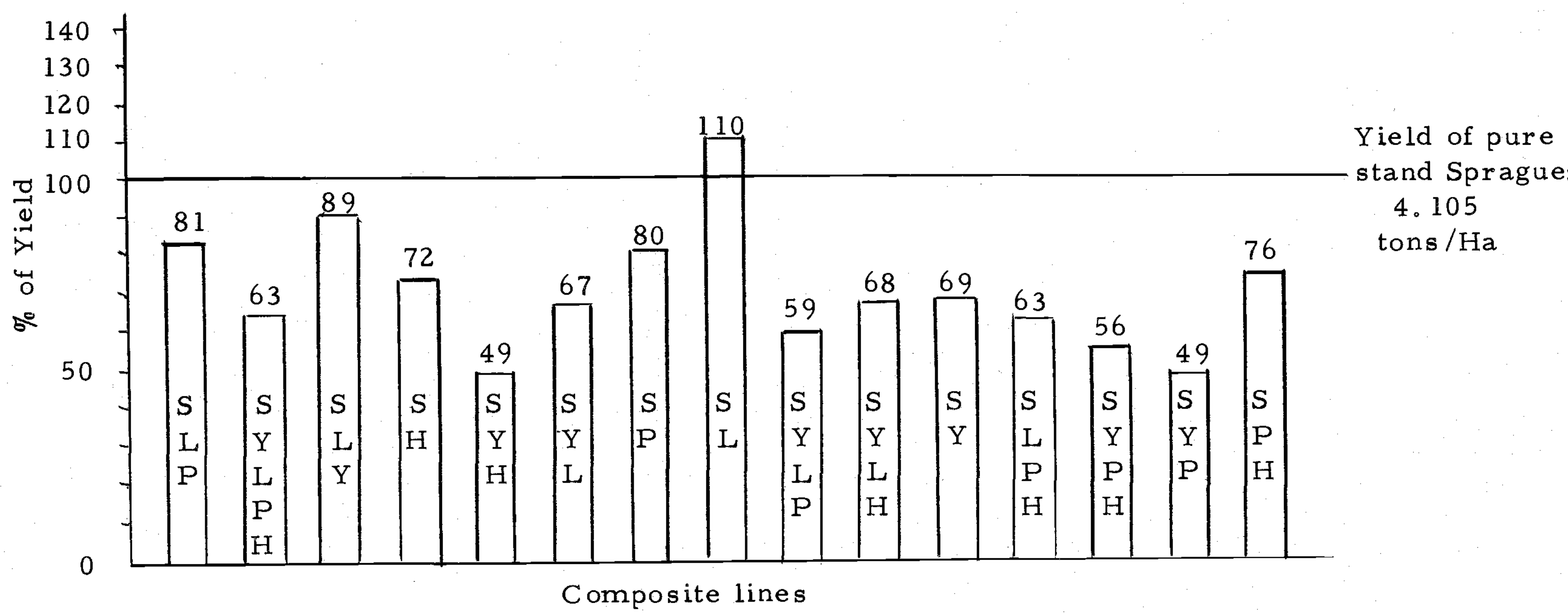
Maximum increase: 61%
Maximum decrease: 10%
Average gain: 24.8%

Figure 34. The combined yield performance of Hyslop compared with Hyslop grown in 15 different composite combinations at three locations in Oregon in 1974.



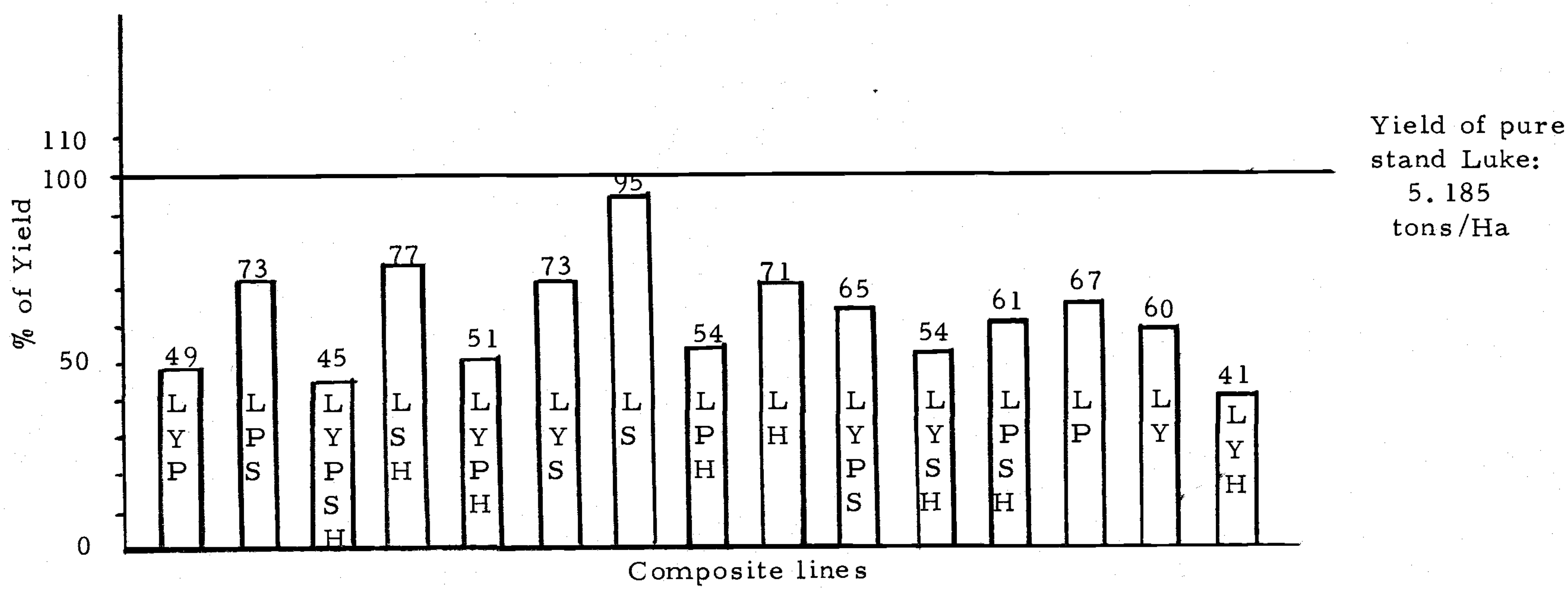
Maximum increase: 55%
Maximum decrease: 12%
Average gain: 13.4%

Figure 35. The combined yield performance of Sprague compared with Sprague grown in 15 different composite combinations at three locations in Oregon in 1974.



Maximum increase:	10%
Maximum decrease:	51%
Average loss:	29.9%

Figure 36. The combined yield performance of Luke compared with Luke grown in 15 different composite combinations at three locations in Oregon in 1974.



Maximum decrease: 59%
Average loss 37.6%

DISCUSSION

Plant breeders have and will continue to play a very important role in helping to solve the world food shortage. Success can be achieved through creating and maintaining genetic diversity as well as using this variation to increase crop production per hectare. Such variation is mandatory if food production is to be increased and year to year fluctuations avoided. Variation can be created through hybridization or by blending of different genotypes. This is extremely important in self-pollinating species such as wheat which is a major food crop.

Many scientists have suggested that through the development of composite populations, a wide genetic base could be maintained; thereby providing greater adaptation and more stable production. Since composite populations have been reported generally to yield less than the highest yielding component of the composite, the question is, how much diversity and resulting lower yields can be tolerated for the sake of adaptation.

Since an increase in the yield level along with yield stability are the primary objectives of most breeding programs, the yielding ability of pure stands versus composites was studied under three diverse environmental conditions in Oregon. Oregon has a broad spectrum of growing conditions with different soil types, rainfall and diseases. This diversity permits an evaluation of the performance of composites and pure stands as well as the competitive ability of each component line within and across treatments. Because all possible combinations of five winter wheat cultivars were utilized, different levels of diversity were also present in the composite populations.

Hyslop, Yamhill, Paha, Luke and Sprague are soft white winter wheat cultivars that are currently being grown in the Pacific Northwest. Yamhill is restricted to the Willamette Valley because of its lack of smut resistance. It was included, however, because of its high yielding potential. These cultivars were also selected on the basis of different agronomic and morphological properties.

The highest yielding pure stands were Hyslop at Corvallis, Luke at Madras and Yamhill at Moro. In general, these cultivars performed differently when put under composite competition.

At Corvallis, little or no stress was observed during the growing season other than low winter temperatures. The latter condition did not influence the plant development, however. Hyslop in a pure stand was superior for yield. However, the best yielding cultivar in composite competition was Yamhill. Yamhill also ranked first for number of plants per plot, number of tillers per plot, yield per plant and 1000 kernel weight. In fact, where Yamhill did not rank first, under composite competition, it ranked second for the other traits. Yield comparisons of Yamhill when grown in a pure stand were made against the yield of Yamhill grown in different composite combinations. The yield of Yamhill was increased over its pure stand counterpart in all composite combinations. In fact, the average increase in yield was 35 percent. Therefore, the ability of Yamhill to compete under composite competition is outstanding. Its performance was far superior when compared to any other cultivar. Sprague, on the other hand, consistently failed to compete favorably for any trait. It was the poorest cultivar for competitive ability and yield performance when compared against its pure stand.

Paha's performance in the pure stand was average in comparison to the other cultivars for all traits except number of kernels per head where it was superior. A high number of kernels per head is very characteristic of club wheats like Paha and occurred consistently under all environments. Another characteristic of Paha is its susceptibility to the races of leaf rust. During 1974 this disease was important at Corvallis and was very prevalent on cultivars that were susceptible. Of the five cultivars that were grown, Paha had the highest degree of attack (80 percent). The disease response of the other four cultivars was lower with Hyslop having only a trace. The mean susceptibility of the pure stand cultivars was approximately 40 percent (Figure 15). However, the mean susceptibility of those composites containing Paha was lower (36 percent) than the average of the pure stands. Theoretically, the mean susceptibility of these two situations should be the same. There was an actual reduction in the amount of disease in a composite when compared with the average amount of disease for all pure stands and in no composite treatment did the amount of disease approach that of pure stand Paha. These results are in agreement with those reported by Klages (1936) in which he showed that composites containing high proportions of more resistant varieties exdeeded the yield of the other composite populations. This observation points out the importance of composite populations in terms of their genetic diversity in controlling diseases. In this study, there were different sources of resistance to leaf rust present in the composite populations and as a consequence, not only was there less disease on Paha but also on the other susceptible component lines in the composite as well.

The yield of each composite containing Paha was compared with that of pure stand Paha (Figure 16). In all composites except one (P+L), the yield of the composites was superior to that of Paha. The increase in yield observed in these composites may be due, in part, to the lower percentage of leaf rust; however, the actual effect of the disease on yield in these composites is not known. The poor performance of the P+L combination may be due to: (1) the high amount of disease in the composite (both cultivars are very susceptible) and (2) Luke is a very poor competitor.

In general, the cultivars when grown under composite competition at Corvallis performed differently than their respective pure stands for general competitive ability and for the other agronomic traits. Only for number of kernels per head, 1000 kernel weight and plant height did the pure stands and component lines perform similarly.

The Madras site, even though irrigated, did offer a moderate moisture stress during the growing season. The yield performance of Luke at this site was superior on a pure stand basis. However, when Luke was subjected to competition, its yielding ability was suppressed in all treatments and as a result it was not a good competitor. Paha had the best general competitive ability at this location and was superior for number of plants per plot, number of kernels per head and plant height. Yamhill and Sprague were superior for two traits each. The latter cultivar, however, performed very poorly for four traits. As at Corvallis, Sprague was identified as having poor competitive ability. The increase in yield of Paha grown under competition over its pure stand was 47.6 percent. Yamhill was second with an average gain of 35.5 percent. No other cultivar increased its yield as dramatically as did Paha when grown as part of a composite. The yielding ability of Sprague and particularly Luke, was reduced under competition. Luke realized a 51.7 percent yield reduction under competition when compared with its pure stand.

Except for 1000 kernel weight, the component lines when grown under competition versus pure stand conditions responded differently for general competitive ability and for the other traits.

Moro represented the site where the greatest moisture stress was observed. Yamhill was the superior pure stand cultivar and was one of the best treatments at this location. In addition to being a superior yielder as a pure stand, it was also the best competitor for yield per plot (general competitive ability), number of plants per plot, yield per plant, number of kernels per head and 1000 kernel weight. Hyslop was superior for number of tillers per plot and number of heads per plant. Sprague, again, had very poor competitive ability for most of the agronomic traits. The relative competitive ability of Yamhill is reflected in its yielding ability in competition versus pure stand performance. In all composite combinations, the yield of Yamhill exceeded that of its pure stand with the average gain being 35 percent.

The performance of these cultivars in relationship to one another in either competition or as a pure stand was the same for number of kernels per head, 1000 kernel weight and plant height. This same relationship held true at Corvallis and only for 1000 kernel weight at Madras. In the combined analysis, the ranking remained the same for the pure stands as well as the component lines for these three traits. Because the performance of these cultivars either under competition or as pure stands remained constant for these three traits across locations, possibly these traits are not as affected by competition as are the others. Therefore, the environment probably played a minor role in their expression.

General and relative competitive ability were criteria used to evaluate the performance of a cultivar under competition. Generally there was not a direct relationship between the performance of a cultivar in a pure stand and its performance in a composite. At Corvallis and Madras, Hyslop and Luke, respectively did well as pure stands, but were not the best competitors in the composites. Instead Yamhill and Paha, respectively were superior in competition. These results are similar to those reported by Hadwiger (1959) and Schlehuber (1961) and contrary to the results of Harlan and Martini (1938). The success of a line in a pure stand cannot be a direct measure of yielding ability in a composite. The reverse, i.e., a variety that has high general competitive ability in a composite is not a criterion of predicting yielding ability of a cultivar when grown in a pure stand, did not hold true except at Moro where Yamhill's performance was the same under both conditions.

Since the component lines comprise a composite, the mean yield per plot of the five component lines was the basis for comparing the performance of each of the treatments. At Corvallis, there were 10 composites and two pure stands which exceeded the mean yield of the five pure stands. However, only one treatment, Hyslop, had a significantly higher mean yield than the mean of the five pure stands. Hyslop had a superior mean value for only yield per plot with the other traits being neither exceptionally high or low. This could have resulted in the higher overall yield of Hyslop since it was not deficient for any of the other factors which contributed to yield.

There were 17 composites and two pure stands whose mean yield exceeded the mean yield of the five pure stands at Madras. Four treatments, Luke, H+L, H+L+S, and H+Y+P, were significantly higher than the average of the five pure stands, but there was no significant difference among them. Luke performed best for number of plants per plot, number of tillers per plot and number of heads per plant when compared with the other pure stands. For the latter traits, it was significantly higher than 26 other treatments. For all traits except number of kernels per head and 1000 kernel weight, Luke exceeded the mean of five pure stands. Luke is a late maturing variety and because of the supplemental irrigation, the growing season was extended. Luke was therefore able to utilize this moisture for increased yields.

In the composite H+L, Hyslop dominated the composite for all traits except plant height. Hyslop yielded more and Luke less when compared with its respective pure stand. In the composite H+L+S, the relative and specific competitive ability of Hyslop and Sprague was, in general, superior to that of Luke. This, in turn, was reflected in the yield contribution of these lines when compared with their pure stands. The yield reduction realized by Luke was observed in all composites containing Luke. The poor performance of Luke under competition was probably due to the inability of Luke to compete with the other cultivars for number of plants and tillers per plot.

The H+Y+P composite also responded favorably at Madras. The specific competitive ability of Paha and Yamhill was significantly higher than that of Hyslop. This is in contrast to H+L and H+S+L composites where Hyslop was identified as having good specific competitive ability. The percent increase in yield of Paha and Yamhill was higher with respect to their pure stands whereas Hyslop responded similarly to its pure stand. The positive yield response by Yamhill and Paha may be due to the specific competitive ability of these lines rather than the specific contribution of the other agronomic characters.

Out of 31 treatments at Moro, 19 composites and three pure stands exceeded the mean yield of the five pure stands. Of those 22 treatments, only three, H+L, H+Y, and Yamhill, had a significantly higher mean yield than the five pure stands.

Yamhill performed exceptionally well as a pure stand and as a composite component. The yield components 1000 kernel weight, number of kernels per head and yield per plant accounted mainly for the outstanding performance of Yamhill.

In the composite H+Y, both of the component lines performed equally well for all the traits studied. Also there was very little difference in yield contribution of each component line when compared with its pure stand; therefore the similar specific competitive ability of these cultivars accounted for the superior performance of this composite.

The performance of the composite H+L at Moro was similar to its performance at Madras. Hyslop was the major contributor for all traits except plant height and therefore was superior for specific competitive ability in this composite.

Across locations treatments did not show significant differences for yield in the combined analysis. The analysis of variance indicated that treatments responded the same for all traits across all locations.

In summary, pure stands responded more favorably under growing conditions at Corvallis than did the composites. Pure stand Hyslop was superior at this location because no stress was observed during the growing season. However, there was a lack of moisture at Moro and Madras. Composites performed better than the pure stands at both stressed locations. Composites may perform well over several years, but in time a specific cultivar may dominate the mixture and the composite may lose some of its genetic diversity through natural selection. Therefore, it may be necessary to reconstitute the composite each year or after several years. Because of the changing disease patterns, and the development of new high yielding and resistant varieties, the components of a composite might also be changed. In this way genetic diversity is maintained in the composite population. However, substitution should occur only after testing and evaluating the performance of the cultivar under competition.

SUMMARY AND CONCLUSIONS

Five genetically and morphologically different winter wheat cultivars, Hyslop (H), Yamhill (Y), Paha (P), Luke (L), and Sprague (S), were blended in all possible combinations. The resulting 26 composite combinations, five pure stands and five filler strains, were planted in a triple lattice design at Hyslop Agronomy Farm, Corvallis, Central Oregon Experiment Station, Madras, and Sherman Experiment Station, Moro, Oregon.

Yield per plot, number of plants per plot, number of tillers per plot, number of heads per plant, yield per plant, number of kernels per head, 1000 kernel weight, and plant height were evaluated. General, specific and relative competitive abilities of component lines and yield rank of pure stands were determined for each location.

The following results were obtained and conclusions drawn:

1. The success of a line in a pure stand cannot be a direct measure of yield ability in a composite. In other words, a component line that has high general competitive ability in composite populations is not a criterion of predicting yielding ability of a cultivar when grown in a pure stand. The exception to this conclusion was at Moro where Yamhill was superior for general competitive ability and was also outstanding when grown in a pure stand.

2. General competitive ability of cultivars ranked as Y > H > P > L > S at Corvallis and Moro, Oregon. However, the rank was P > Y > H > S > L at Madras.

3. The rank of component lines for relative competitive ability was Y > P > H > L > S, P > Y > H > S > L and H > Y > P > S > L at Corvallis, Madras and Moro, respectively.

4. Pure stands ranked differently at all locations. The rank of pure stands for yield was H > Y > L > S > P, L > H > Y > P > S, and Y > H > L > P > S at Corvallis, Madras, and Moro, respectively.

5. Based on one year's data, a pure stand was significantly better than all composite treatments at Corvallis. However, composites showed significantly better performance at Madras and Moro. Environmental conditions were relatively good at Corvallis, but not at the other two locations. Possibly composites have the potential to yield better than pure stands under stress or medium stress conditions. However, this premise should be tested over several years.

6. Hyslop at Corvallis, Luke, H+L+S, H+L, H+Y+P and Madras and Yamhill, H+L and H+Y combinations yielded significantly higher than the mean yield of the five pure stands.

7. Across or between locations, treatments did not show significant differences for yield in the combined analysis. Analysis

of variance indicated that treatments responded the same for all traits across all locations.

8. Because of natural selection, the percentage of component lines in a composite may be expected to change over time. The optimum time period for reconstruction of each composite must be determined and it will be composite specific.

9. Paha was very susceptible to leaf rust (*P. recondita*) at Corvallis. Except for Hyslop, the other cultivars were moderately susceptible. The mean susceptibility of the pure stands was not equal to the mean susceptibility of the composite combinations containing Paha. The composites reduced the amount of leaf rust thus providing a partial disease escape mechanism.

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APPENDIX

APPENDIX TABLE 1. Pedigrees and description of cultivars:

1. Hyslop: This cultivar is a soft white common winter wheat. It is semidwarf with bearded, oblong, mid-dense spikes. It is a high yielding cultivar and resistant to stripe rust (causal agent, *Puccinia striiformis*) and common smut (causal agents, *Tilletia caries* and *T. foetida*). It is moderately resistant to mildew (cusal agent, *Erysiphe graminis*), leaf rust (causal agent, *P. recondita*) and susceptible to *Septoria tritici*. Hyslop is an early cultivar with a moderate number of kernels and good kernel weight. Hyslop was released by Oregon State University from a cross between Nord Despre and Pullman Selection 101 back-crossed to Pullman Selection 101.

2. Yamhill: It is a soft white common winter wheat. This cultivar is midtall with awnless, white, oblong, mid-dense to dense heads. It is a high yielding cultivar, resistant to stripe rust and mildew, but susceptible to common smut. Yamhill is mid-early with a moderate number but heavy kernels. Yamhill was released by Oregon State University from a cross between Heines VII and Redmond (Alba). It was recommended to areas which have about 450 mm rainfall and particularly where acid soils are present like Western Oregon.

3. Paha: This cultivar is a soft white winter club wheat of standard height. It is resistant to smut, susceptible to leaf rust and some races of stripe rust, flag smut (causal agent, *Vroceptis tritici*) and mildew and slightly tolerant to Cercosporella foot rot (causal agent, *Cercosporella herpotrichoides*) and snow mold (causal agent, *Typhula idohoensis*). Paha is a late variety with a high number of small kernels. Paha was released by Washington State University from the cross Suwon 92/4 Omar. It was recommended to areas which have about 250 mm rainfall.

4. Sprague: This is a soft, white common winter wheat with weak straw and small bearded spikes. Sprague is resistant to snow mold, stripe rust and common bunt, but it is susceptible to dwarf but (causal agent, *Tilletia controversa*) and Cercosporella foot rot. Reaction to flag smut is unknown. Sprague is an early variety with a high number of tillers. It was developed by Washington State University. The pedigree of Sprague is P. I. 181268/Gaines, Selection 399-6. Sprague was recommended in areas where snow mold is a severe problem and rainfall is about 250 mm.

5. Luke: This cultivar is a soft white common winter wheat. Luke

is semidwarf with awned, white medium sized spikes. It is resistant to the races of common smut and some of the races of dwarf bunt observed in the Pacific Northwest. It is moderately resistant to Cercosporella foot rot, snow mold and is resistant to stripe rust. It is a late variety with a moderate number of tillers and medium sized kernels. It was released by Washington State University from a cross between PI 1/8383 and Burt. The progeny of this cross was then crossed with Pullman Selection 101. It is recommended for areas where dwarf bunt is a problem and where the amount of rainfall is 450 mm.

APPENDIX TABLE 2. Summary of analysis of variance for all treatments and eight traits at Corvallis, Oregon in 1974.

Treatment	Rank for yield	Yield/ plot (gm)	Plants/ plot	Tillers/ plot	Heads/ plant	Yield/ plant (gm)	Kernels/ head	1000 kernel weight (gm)	Plant height (cm)
1 Y+L+P	25	1196a	310b	702a	2.3a	3.9a	45a	38a	113a
2 L+S+P	17	1247a	372b	788b	2.1a	3.4a	44a	36a	110a
3 H+P	26	1181a	239a	631a	2.7a	5.1b	50a	38a	108a
4 H+Y+L+S+P	23	1199a	307b	692a	2.2a	3.9a	43a	41a	111a
5 H+L+S	21	1200a	320b	815b	2.6a	3.8a	38a	39a	103a
6 H+S	5	1429b	340b	889b	2.7a	4.3a	41a	40a	105a
7 H+Y+L+P	6	1412b	348b	750a	2.1a	4.1a	46a	42b	113a
8 H+Y+S	4	1435b	337b	742a	2.2a	4.3a	44a	44b	111a
9 Sprague	28	1174a	282b	897b	3.2a	4.3a	38a	35a	113a
10 Y+L+S	13	1306a	320b	758a	2.4a	4.1a	42a	41a	111a
11 S+P	20	1215a	275b	731a	2.8a	4.6a	45a	37a	111a
12 Filler	—	—	—	—	—	—	—	—	—
13 Yamhill	3	1442b	321b	647a	2.0a	4.5a	50a	44b	118a
14 Filler	—	—	—	—	—	—	—	—	—
15 L+S	11	1351b	389c	1040c	2.7a	3.5a	36a	36a	108a
16 H+L+P	8	1406b	316b	817b	2.6a	4.5a	43a	40a	111a
17 Luke	19	1226a	222a	816b	3.7b	5.5b	42a	36a	102a
18 H+L	2	1446b	335b	866b	2.6a	4.4a	35a	40a	101a
19 Y+L+S+P	24	1197a	303b	668a	2.3a	4.0a	46a	39a	107a
20 H+Y+L+S	30	1162a	322b	710a	2.3a	3.7a	39a	41a	108a
21 Y+S	18	1229a	334b	682a	2.1a	3.8a	43a	42b	114a
22 H+L+S+P	14	1290a	356b	805b	2.3a	3.7a	43a	38a	109a
23 L+P	31	1079a	325b	680a	2.2a	3.5a	43a	37a	111a
24 Filler	—	—	—	—	—	—	—	—	—
25 H+Y	10	1353b	315b	730a	2.4a	4.4a	43a	43b	118a
26 Filler	—	—	—	—	—	—	—	—	—
27 Hyslop	1	1523b	288b	794b	2.8a	5.3b	46a	41a	101a
28 Filler	—	—	—	—	—	—	—	—	—
29 Y+P	21	1205a	342b	637a	1.9a	3.5a	48a	39a	119a
30 H+Y+S+P	9	1380b	346b	777a	2.3a	4.0a	43a	41a	113a
31 Paha	29	1168a	260a	548a	2.1a	4.5a	57b	38a	127b
32 Y+S+P	27	1181a	249a	676a	2.8a	4.8b	43a	41a	115a
33 H+S+P	16	1257a	273b	762a	2.8a	4.6a	42a	40a	110a
34 Y+L	15	1290a	319b	770a	2.4a	4.0a	40a	42b	111a
35 H+Y+P	12	1332a	331b	758a	2.3a	4.0a	44a	40a	113a
36 H+Y+L	7	1408b	299b	784a	2.6a	4.7b	42a	43b	111a
ANOV		**	**	**	**	**	**	**	**
CV %		8.78	13.50	9.94	14.42	15.22	11.30	3.45	3.60
Effeciency		115.29	100.37	104.43	101.95	100.39	120.93	116.29	127.45
LSD at 0.05		174.88	56.84	104.05	0.499	0.882	6.11	2.15	6.64
mean of five pure stands		1307	275	740	2.76	4.82	46.6	38.8	112.2
location mean $\bar{\bar{x}}$		1284.2	309.3	769.0	2.54	4.26	42.35	40.00	112.18

* Significant at the 5% level
** Significant at the 1% level
The highest mean value of any pure stand accepted as a check for each trait in order to use the LSD test.

APPENDIX TABLE 3. Summary of analysis of variance for all treatments and eight traits at Madras, Oregon in 1974.

Treatment	Rank for yield	Yield/ plot (gm)	Plants/ plot	Tillers/ plot	Heads/ plant	Yield/ plant (gm)	Kernels/ head	1000 kernel weight (gm)	Plant height (cm)
1 Y+L+P	25	1028a	205b	958a	4.7a	5.1a	28a	37a	97b
2 L+S+P	26	1024a	226b	993a	4.4a	4.7a	35b	31a	96b
3 H+P	7	1189b	224b	844a	3.8a	5.4b	41b	35a	99b
4 H+Y+L+S+P	16	1093a	276b	936a	3.5a	4.1a	31b	38a	95b
5 H+L+S	1	1406b	265b	1416b	5.4b	5.4b	28a	36a	97b
6 H+S	10	1156b	233b	1158b	5.0a	5.0a	29a	35a	94b
7 H+Y+L+P	12	1128b	244b	947a	3.9a	4.7a	33b	37a	101b
8 H+Y+S	23	1032a	253b	1104a	4.4a	4.2a	26a	37a	94b
9 Sprague	31	870a	225b	1262b	5.5b	3.8a	24a	29a	95b
10 Y+L+S	13	1120b	268b	1095a	4.3a	4.3a	27a	38a	94b
11 S+P	24	1030a	267b	1009a	3.8a	3.9a	33b	32a	97b
12 Filler	—	—	—	—	—	—	—	—	—
13 Yamhill	22	1035a	175b	823a	4.8a	6.0b	28a	45b	98b
14 Filler	—	—	—	—	—	—	—	—	—
15 L+S	30	928a	204b	1020a	5.0a	4.5a	29a	32a	96b
16 H+L+P	18	1063a	198b	759a	3.8a	5.4b	40b	36a	105b
17 Luke	2	1300b	226b	1339b	6.0b	5.9b	29a	34a	97b
18 H+L	4	1272b	218b	962a	4.5a	6.0b	35b	38a	92b
19 Y+L+S+P	27	989a	238b	939a	4.0a	4.1a	28a	38a	95b
20 H+Y+L+S	8	1193b	246b	1185b	4.8a	4.8a	26a	39a	95b
21 Y+S	9	1176b	228b	1114b	4.9a	5.2a	29a	37a	98b
22 H+L+S+P	28	974a	212b	891a	4.3a	4.7a	31b	36a	88a
23 L+P	17	1070a	207b	916a	4.5a	5.3b	33b	34a	97b
24 Filler	—	—	—	—	—	—	—	—	—
25 H+Y	6	1207b	230b	911a	4.0a	5.3b	33b	41a	98b
26 Filler	—	—	—	—	—	—	—	—	—
27 Hyslop	14	1111a	182b	1015a	5.7b	6.1b	31b	36a	90b
28 Filler	—	—	—	—	—	—	—	—	—
29 Y+P	15	1101a	228b	819a	3.6a	4.8a	37b	37a	98b
30 H+Y+S+P	19	1039a	233b	832a	3.6a	4.5a	36b	35a	93b
31 Paha	29	946a	153a	885a	5.7b	6.5b	37b	32a	95b
32 Y+S+P	20	1037a	266b	980a	3.7a	3.9a	30a	36a	94b
33 H+S+P	11	1137b	255b	1009a	4.0a	4.5a	34b	33a	98b
34 Y+L	5	1229b	196b	860a	4.4a	6.3b	36b	39a	98b
35 H+Y+P	3	1297b	214b	861a	4.0a	6.1b	40b	38a	102b
36 H+Y+L	21	1035a	181b	803a	4.5a	5.8b	31b	42b	95b
ANOV		**	*	**	**	**	**	**	N.S.
CV %		12.47	12.42	13.52	12.13	13.41	9.69	6.84	5.69
Effeciency		101.14	156.13	118.32	131.84	163.22	190.56	106.80	120.34
LSD at 0.05		186.46	51.57	217.98	0.94	1.26	6.06	3.66	8.75
mean of five pure stands		1052.4	192.2	1064.8	5.54	5.66	29.8	35.2	95
location mean $\bar{\bar{x}}$		1098.7	225.6	1024.3	4.61	5.00	30.61	36.39	96.60

* Significant at the 5% level
** Significant at the 1% level
The highest mean value of any pure stand accepted as a check for each trait in order to use the LSD test.

APPENDIX TABLE 4. Summary of analysis of variance for all treatments and eight traits at Moro, Oregon in 1974.

Treatment	Rank for yield	Yield/ plot (gm)	Plants/ plot	Tillers/ plot	Heads/ plant	Yield/ plant (gm)	Kernels/ head	1000 kernel weight (gm)	Plant height (cm)
1 Y+L+P	14	581b	172b	628a	3.7a	3.6b	31b	30b	84b
2 L+S+P	29	440a	170b	709a	4.2b	2.6a	26a	24a	78a
3 H+P	11	586b	175b	676a	3.9a	3.4b	31b	28a	83b
4 H+Y+L+S+P	27	454a	182b	652a	3.6a	2.5a	25a	28a	80b
5 H+L+S	13	584b	168b	790b	4.7b	3.5b	27b	27a	82b
6 H+S	10	587b	198b	691a	3.7a	3.0a	30b	29a	81b
7 H+Y+L+P	8	591b	199b	723a	3.7a	3.0a	28b	29a	82b
8 H+Y+S	5	606b	181b	709a	3.9a	3.4b	29b	30b	84b
9 Sprague	30	420a	196b	895b	4.6b	2.1a	21a	23a	82b
10 Y+L+S	19	556b	190b	678a	3.6a	2.9a	28b	29a	79b
11 S+P	31	361a	187b	588a	3.2a	1.9a	30b	21a	81b
12 Filler	—	—	—	—	—	—	—	—	—
13 Yamhill	3	648b	178b	625a	3.6a	3.7b	33b	33b	83b
14 Filler	—	—	—	—	—	—	—	—	—
15 L+S	18	558b	174b	803b	4.6b	3.2b	27b	26a	79b
16 H+L+P	21	555b	201b	759a	3.8a	2.8a	27b	27a	79b
17 Luke	12	585b	181b	844b	4.9b	3.2b	26a	27a	78a
18 H+L	1	700b	172b	734a	4.3b	4.0b	30b	31b	81b
19 Y+L+S+P	22	542a	188b	711a	3.9a	2.9a	28b	28a	82b
20 H+Y+L+S	4	623b	162a	654a	4.0a	3.9b	31b	31b	80b
21 Y+S	17	570b	185b	653a	3.6a	3.1b	29b	30b	86b
22 H+L+S+P	23	534a	193b	753a	3.9a	2.8a	26a	27a	78a
23 L+P	28	447a	161a	712a	4.4b	2.8a	27b	24a	81b
24 Filler	—	—	—	—	—	—	—	—	—
25 H+Y	2	665b	180b	562a	3.2a	3.7b	36b	29a	83b
26 Filler	—	—	—	—	—	—	—	—	—
27 Hyslop	7	597b	169b	680a	4.0a	3.5b	31b	29a	81b
28 Filler	—	—	—	—	—	—	—	—	—
29 Y+P	24	521a	161a	583a	3.6a	3.2b	30b	29a	87b
30 H+Y+S+P	15	576b	204b	653a	3.2a	2.8a	31b	29a	83b
31 Paha	26	457a	154a	646a	4.2b	3.1b	32b	23a	84b
32 Y+S+P	20	545a	180b	591a	3.4a	3.1a	31b	30b	85b
33 H+S+P	25	513a	184b	604a	3.3a	2.8a	31b	28a	78a
34 Y+L	9	590b	164b	619a	3.8a	3.7b	31b	31b	82b
35 H+Y+P	16	573b	193b	656a	3.5a	3.0a	29b	30b	88b
36 H+Y+L	6	605b	199b	717a	3.6a	3.0a	28b	31b	82b
ANOV		**	N.S.	**	**	**	**	**	**
CV %		8.38	9.59	12.61	14.07	10.82	9.99	7.17	4.81
Effeciency		188.70	145.18	100.00	103.98	188.07	117.54	116.67	101.19
LSD at 0.05		93.04	30.55	118.74	0.74	0.67	4.42	3.18	5.43
mean of five pure stands $\bar{\bar{x}}$		541.4	175.6	738	4.26	3.12	28.6	27	81.6
location mean $\bar{x}$		546.3	180.0	691.8	3.88	3.67	28.22	28.43	82.88

* Significant at the 5% level.
** Significant at the 1% level.
The highest mean value of any pure stand accepted as a check for each trait in order to use the LSD test.

APPENDIX TABLE 5. Summary of analysis of variance for all treatments and eight traits at three locations in Oregon in 1974.

Treatment	Rank for yield	Yield/ plot (gm)	Plants/ plot	Tillers/ plot	Heads/ plant	Yield/ plant (gm)	Kernels/ head	1000 kernel weight (gm)	Plant height (cm)
1 Y+L+P	22	935	229	763a	3.6a	4.2b	35a	35a	98
2 L+S+P	25	903	256	830a	3.6a	3.6a	35a	30a	95
3 H+P	18	986	213	717a	3.5a	4.6b	41b	33a	97
4 H+Y+L+S+P	26	916	255	760a	3.1a	3.5a	33a	35a	96
5 H+L+S	5	1063	251	1007b	4.2b	4.2b	31a	34a	94
6 H+S	6	1058	157a	913a	3.8a	4.1b	33a	34a	93
7 H+Y+L+P	7	1044	264	807a	3.3a	3.9a	36b	36a	99
8 H+Y+S	11	1025	257	852a	3.5a	4.0a	33a	37b	96
9 Sprague	31	821	235b	1018b	4.4b	3.4a	28a	29a	97
10 Y+L+S	15	994	259	843a	3.4a	3.8a	32a	36a	94
11 S+P	28	869	244	776a	3.2a	3.5a	36b	30a	96
12 Filler	—	—	—	—	—	—	—	—	—
13 Yamhill	8	1041	225	698a	3.5a	4.7b	37b	41b	100
14 Filler	—	—	—	—	—	—	—	—	—
15 L+S	20	946	256	954b	4.1a	3.8a	31a	31a	94
16 H+L+P	13	1008	239	778a	3.4a	4.2b	37b	34a	99
17 Luke	9	1037	210	1000b	4.9b	4.8b	32a	32a	92
18 H+L	1	1139	242	854a	3.8a	4.8b	33a	36a	91
19 Y+L+S+P	27	909	243	773a	3.4a	3.7a	34a	35a	95
20 H+Y+L+S	16	992	243	850a	3.7a	4.1b	32a	37b	94
21 Y+S	17	992	249	816a	3.5a	4.0a	34a	36a	99
22 H+L+S+P	23	932	253	816a	3.5a	3.7a	33a	34a	92
23 L+P	29	865	231	769a	3.7a	3.9a	34a	32a	97
24 Filler	—	—	—	—	—	—	—	—	—
25 H+Y	3	1075	242	734a	3.2a	4.4b	37b	38b	96
26 Filler	—	—	—	—	—	—	—	—	—
27 Hyslop	2	1077	213	830a	4.1a	5.0b	36b	36a	91
28 Filler	—	—	—	—	—	—	—	—	—
29 Y+P	21	942	244	680a	3.0a	3.9a	38b	35a	101
30 H+Y+S+P	14	998	261	754a	3.0a	3.8a	36b	35a	96
31 Paha	30	857	189a	693a	4.0a	4.7b	42b	31a	102
32 Y+S+P	24	921	231	749a	3.3a	4.0a	35a	36a	98
33 H+S+P	19	969	237	791a	3.4a	4.0a	36b	34a	96
34 Y+L	10	1036	227	750a	3.6a	4.7b	36b	37b	97
35 H+Y+P	4	1067	246	758a	3.3a	4.4b	38b	36a	101
36 H+Y+L	12	1016	227	768a	3.6a	4.5b	34a	38b	96
ANOV		N.S.	N.S.	**	**	N.S.	**	**	N.S.
CV %		39.40	18.78	23.00	23.53	28.56	24.63	17.54	15.38
L x T Interaction		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
LSD at 0.05		298.33	34.70	147.77	0.67	0.91	6.44	4.76	11.60
mean of five pure stands		966.6	214.4	847.8	4.18	4.54	35.0	33.8	96.4
location mean $\bar{x}$		976.4	238.3	826.4	3.69	4.11	33.73	34.98	97.22

* Significant at the 5% level.
** Significant at the 1% level.
The highest mean value of any pure stand accepted as a check for each trait in order to use LSD test.

APPENDIX TABLE 6. Summary of analysis of variance for within composite treatments for eight traits at Corvallis, Oregon in 1974.

Treatment	Varieties	Yield/ plot %	Plants/ plot %	Tillers/ plot %	Heads/ plant	Yield/ plant (gm)	Kernels/ head	1000 kernel weight (gm)	Plant height (cm)
1	Yamhill	49b	38	41	2.44	4.87b	53a	39	113
	Luke	23a	33	34	2.40	2.78a	31b	37	107
	Paha	28ab	29	25	1.95	3.75ab	51a	38	119
ANOV		*	N.S.	N.S.	*	*	N.S.	N.S.	N.S.
CV %		25.99	12.49	17.28	4.66	12.64	13.03	9.15	5.36
2	Luke	30a	32a	37b	2.47b	3.29b	37a	36b	107
	Sprague	23a	32a	29a	1.95a	2.40a	36a	34a	109
	Paha	47b	36b	34ab	2.03a	4.53c	59b	37c	114
ANOV		**	*	*	**	**	**	**	N.S.
CV %		11.46	3.80	7.09	4.55	11.11	13.68	1.5	3.4
3	Hyslop	54	47	58	3.28b	5.70	44a	39b	98a
	Paha	46	53	42	2.08a	4.44	61b	35a	116b
ANOV		N.S.	N.S.	N.S.	*	N.S.	*	*	*
CV %		29.6	19.53	25.88	12.05	12.38	7.07	2.16	3.14
4	Hyslop	23b	21	22	2.47b	4.36cd	42b	43c	103ab
	Yamhill	33c	25	27	2.44b	5.23d	50c	43c	115bc
	Luke	13a	16	18	2.49b	2.95ab	32a	38b	103a
	Sprague	9a	17	16	2.09ab	2.13a	29a	35a	109ab
	Paha	22b	21	17	1.75a	3.87bc	53c	39b	121c
ANOV		**	N.S.	N.S.	**	**	**	**	**
CV %		9.52	21.58	24.67	8.21	14.76	8.77	3.49	4.18
5	Hyslop	54b	37	44b	2.95b	5.41c	44b	41c	101
	Luke	27a	31	30ab	2.51ab	3.42b	36a	38b	103
	Sprague	19a	32	26a	2.14a	2.31a	31a	34a	105
ANOV		**	N.S.	*	*	**	**	**	N.S.
CV %		19.04	10.19	17.56	7.92	6.83	6.46	2.40	4.51
6	Hyslop	75b	53	64b	3.20b	5.95b	44b	42b	102a
	Sprague	25a	47	36a	2.04a	2.32a	32a	35a	109b
ANOV		*	N.S.	*	**	*	*	*	*
CV %		24.02	16.40	14.98	4.15	12.35	5.53	3.65	1.8
7	Hyslop	23b	25	25	2.23	3.80ab	40b	43b	102a
	Yamhill	37c	28	30	2.28	5.33b	54c	44b	118b
	Luke	15a	22	23	2.23	2.70a	32a	38a	105a
	Paha	25b	26	22	1.94	4.15ab	55c	39a	127c
ANOV		**	N.S.	N.S.	N.S.	*	**	**	**
CV %		9.65	10.21	12.76	13.38	15.46	6.84	2.37	2.10
8	Hyslop	40b	38b	40b	2.37	4.66b	44b	44b	104a
	Yamhill	50c	41b	42b	2.27	5.21b	51c	45b	118b
	Sprague	10a	21a	18a	1.89	2.02a	30a	35a	110a
ANOV		**	**	**	N.S.	**	**	**	*
CV %		9.02	9.95	13.79	17.31	13.69	6.62	2.5	3.67
9	Sprague	1174 (gm)	282	897	3.19	4.26	37.93	35.14	112.5
10	Yamhill	60b	40	41b	2.45	6.11	58b	44b	117
	Luke	26a	33	38b	2.77	3.43a	30a	40b	105
	Sprague	14a	27	21a	1.90	2.09a	31a	35a	108
ANOV		**	N.S.	**	N.S.	*	*	*	N.S.
CV %		28.45	15.18	6.37	15.03	23.55	20.93	4.68	5.30

APPENDIX TABLE 6. Continued

Treatment	Varieties	Yield/ plot %	Plants/ plot %	Tillers / plot %	Heads/ plant	Yield/ plant (gm)	Kernels/ head	1000 kernel Weight (gm)	Plant height (cm)
11	Sprague	38	51	52	2.76	3.37	35a	34a	104
	Paha	62	49	48	2.66	5.77	57b	38b	119
ANOV		N.S.	N.S.	N.S.	N.S.	N.S.	**	**	N.S.
CV %		42.48	12.75	41.39	30.18	29.35	3.10	0.8	11.12
12	Filler	——	——	——	——	——	——	——	——
13	Yamhill	1442 (gm)	321	647	2.04	4.53	50.22	44.36	117.67
14	Filler	——	——	——	——	——	——	——	——
15	Luke	56	52	52	2.67	3.78	38	37	106
	Sprague	44	48	48	2.81	3.29	34	35	111
ANOV		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
CV %		18.04	13.42	12.43	11.77	10.58	9.40	4.47	2.85
16	Hyslop	44b	38	40b	2.73	5.12b	45b	42	104
	Luke	21a	30	33a	2.81	3.14a	29a	38	110
	Paha	35b	32	27a	2.27	5.02b	57c	39	123
ANOV		**	N.S.	*	N.S.	**	**	N.S.	N.S.
CV %		13.44	10.56	8.61	7.77	8.66	7.58	3.84	5.81
17	Luke	1226 (gm)	222.33	816	3.67	5.53	41.57	36.40	102.08
18	Hyslop	66b	55	58	2.76	5.22	47	41	98
	Luke	34a	45	42	2.46	3.48	37	38	105
ANOV		*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
CV %		12.35	10.68	14.34	3.82	13.00	19.06	4.79	3.52
19	Yamhill	43c	32	36b	2.50	5.35b	51b	42c	110
	Luke	16a	25	26ab	2.35	2.53a	29a	37b	98
	Sprague	11a	21	16a	2.30	2.24a	30a	33a	105
	Paha	30b	22	22ab	2.14	5.29b	68c	38b	113
ANOV		**	N.S.	*	N.S.	**	**	**	N.S.
CV %		25.62	20.62	25.73	16.53	20.00	15.55	1.90	5.98
20	Hyslop	30b	24a	27	2.57	4.67c	42b	43c	104a
	Yamhill	42c	31b	30	2.15	4.96c	53c	44c	112b
	Luke	16a	21a	24	2.55	2.91b	29a	38b	113b
	Sprague	12a	24ab	19	1.80	1.82a	29a	34a	105a
ANOV		**	*	N.S.	N.S.	**	**	**	**
CV %		11.26	12.78	15.26	13.59	15.73	2.50	2.48	1.77
21	Yamhill	79b	55	64b	2.46b	5.54b	51b	44b	117b
	Sprague	21a	45	36a	1.61a	1.72a	30a	35a	110a
ANOV		**	N.S.	**	*	*	*	**	*
CV %		6.40	13.38	6.77	9.74	24.00	8.79	1.73	0.81
22	Hyslop	32bc	27	29b	2.52	4.48b	43b	41b	101a
	Luke	21b	27	28b	2.42	2.89a	33a	36a	104a
	Sprague	11a	19	16a	1.95	2.14a	33a	34a	112a
	Paha	36c	27	27b	2.23	4.81b	58c	37a	120b
ANOV		**	N.S.	*	N.S.	**	**	**	*
CV %		18.56	15.07	16.43	13.34	14.12	8.19	4.00	4.82

APPENDIX TABLE 6. Continued

Treatment	Varieties	Yield/ plot %	Plants/ plot %	Tillers/ plot %	Heads/ plant	Yield/ plant (gm)	Kernels/ head	1000 kernel weight (gm)	Plant height (cm)
23	Luke	45	52	58	2.33	2.90a	33a	37	102a
	Paha	55	48	42	1.90	4.12b	59b	36	118b
ANOV		N.S.	N.S.	N.S.	N.S.	**	*	N.S.	*
CV %		41.79	26.83	39.83	15.21	4.03	13.96	6.63	2.46
24	Filler	——	——	——	——	——	——	——	——
25	Hyslop	43a	45a	48	2.54	4.13	39a	42a	101
	Yamhill	57b	55b	52	2.21	4.54	47b	44b	113
ANOV		*	*	N.S.	N.S.	N.S.	*	**	N.S.
CV %		7.59	2.48	9.97	12.02	6.83	3.3	0.11	4.70
26	Filler	——	——	——	——	——	——	——	——
27	Hyslop	1523 (gm)	288	794.33	2.78	5.33	46.36	41.41	100.92
28	Filler	——	——	——	——	——	——	——	——
29	Yamhill	63b	53	57	2.05	4.21	52	41b	116
	Paha	37a	47	43	1.70	2.79	45	37a	121
ANOV		*	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.
CV %		3.07	4.30	17.62	19.16	11.78	16.46	1.37	4.98
30	Hyslop	32b	26	30c	2.54	4.68b	44b	42bc	99a
	Yamhill	37b	27	31c	2.65	5.57b	48b	44c	117b
	Sprague	7a	21	15a	1.77	1.49a	25a	34a	111b
	Paha	24b	25	24b	2.33	4.00b	46b	38b	124c
ANOV		**	N.S.	**	N.S.	**	**	**	**
CV %		22.23	18.12	9.78	21.77	21.20	12.81	3.72	2.98
31	Paha	1168 (gm)	260	548	2.11	4.49	57.28	37.51	127.25
32	Yamhill	57c	42b	49b	3.24b	6.71c	47b	44c	115
	Sprague	12a	25a	21a	2.45a	2.24a	27a	34a	109
	Paha	31b	33ab	29a	2.36a	4.47b	49b	39b	121
ANOV		**	*	**	*	**	*	**	N.S.
CV %		16.21	14.58	16.66	8.43	16.3	13.17	0.81	6.5
33	Hyslop	46b	37	44	3.32	5.76b	41b	42c	102
	Sprague	18a	28	27	2.62	2.79a	30a	35a	109
	Paha	36b	35	29	2.35	4.77b	53c	39b	87
ANOV		*	N.S.	N.S.	N.S.	*	**	**	N.S.
CV %		23.25	13.56	25.51	15.14	15.50	2.07	3.71	31.43
34	Yamhill	76b	55	59b	2.57	5.56b	50b	44b	118b
	Luke	24a	45	41a	2.26	2.19a	27a	37a	102a
ANOV		*	N.S.	**	N.S.	*	**	**	*
CV %		6.66	11.73	1.56	12.91	11.72	3.94	2.11	3.13
35	Hyslop	32a	33a	36b	2.48	3.80	38a	40b	98a
	Yamhill	44b	41b	40b	2.20	4.26	47b	42c	120b
	Paha	24a	26a	24a	2.29	4.04	47b	37a	120b
ANOV		*	*	*	N.S.	N.S.	**	**	**
CV %		15.47	10.13	12.34	12.12	14.72	1.34	1.95	1.26

APPENDIX TABLE 6. Continued.

Treatment	Varieties	Yield/ plot %	Plants/ plot %	Tillers/ plot %	Heads/ plant	Yield/ plant (gm)	Kernels/ head	1000 kernel weight (gm)	Plant height (cm)
36	Hyslop	36b	34b	36b	2.82	4.99	43b	42b	104a
	Yamhill	49c	41c	39b	2.46	5.59b	51c	44c	117b
	Luke	15a	25a	25a	2.64	2.83a	28a	38a	111a
ANOV		**	**	*	N.S.	**	**	**	*
CV %		16.42	9.67	13.82	14.93	11.12	8.85	1.42	2.84

* Significant at the 5% level. (Student Newman Keuls' Test)
** Significant at the 1% level. (Student Newman Keuls' Test)

APPENDIX TABLE 7. Summary of analysis of variance for within composite treatments for eight traits at Madras, Oregon in 1974.

Treatment	Varieties	Yield/ plot %	Plants/ plot %	Tillers/ plot %	Heads/ plant	Yield/ plant (gm)	Kernels/ head	1000 kernel weight (gm)	Plant height (cm)
1	Yamhill	45b	39b	36	4.31	5.81b	31b	44b	98
	Luke	12a	21a	25	5.21	2.69a	16a	32a	93
	Paha	43b	40b	39	4.59	5.53b	39b	32a	98
ANOV		*	*	N.S.	N.S.	*	**	**	N.S.
CV %		26.91	16.36	29.66	21.74	19.95	15.21	2.38	6.02
2	Luke	23	24	26	4.65	4.50	31	31	92
	Sprague	30	41	40	4.35	3.47	30	30	94
	Paha	47	35	34	4.14	6.02	48	32	101
ANOV		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
CV %		31.38	7.64	34	11.25	24.6	26.79	7.93	4.47
3	Hyslop	49	47	52	4.29	5.60	36	38	95
	Paha	51	53	48	3.48	5.27	47	33	104
ANOV		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S
CV %		13.23	9.77	10.18	22.85	21.69	24.39	17.12	14.85
4	Hyslop	23b	23b	23b	3.51	4.22b	30b	39b	91
	Yamhill	27b	19b	20b	3.63	5.61b	34b	44c	97
	Luke	9a	12a	12a	3.46	3.03a	25a	35a	93
	Sprague	14a	22b	24b	3.80	2.63a	22a	32a	96
	Paha	27b	24b	21b	3.10	4.64ab	46c	33a	100
ANOV		**	*	**	N.S.	*	**	**	N.S.
CV %		22.30	17.21	12.77	11.02	22.60	8.49	5.35	1.31
5	Hyslop	48b	39b	38b	5.14	6.55b	34	38	99
	Luke	22a	24a	22a	4.78	5.06a	30	36	95
	Sprague	30a	37b	40b	5.92	4.26a	22	32	95
ANOV		*	**	*	N.S.	*	N.S.	N.S.	N.S.
CV %		17.63	9.47	18.39	13.49	10.85	19.22	6.08	4.11
6	Hyslop	63	48	57	5.93	6.54b	31	37b	95
	Sprague	37	52	43	4.10	4.53a	28	31a	93
ANOV		N.S.	N.S.	N.S.	N.S.	*	N.S.	*	N.S.
CV %		17.7	6.82	24.64	28.79	6.41	14.35	3.97	6.62
7	Hyslop	24ab	29b	27	3.56	3.95	29b	38b	93
	Yamhill	30ab	27b	25	3.82	5.30	32b	42b	102
	Luke	11a	15a	16	4.26	3.20	22a	34a	95
	Paha	36b	29b	32	4.17	5.16	42c	32a	114
ANOV		*	*	N.S.	N.S.	N.S.	**	**	N.S.
CV %		33.20	15.5	28.95	14.68	21.51	8.7	5.89	9.8
8	Hyslop	34b	30b	35	5.09	4.68b	26	36b	91
	Yamhill	47c	42b	36	3.80	4.73b	31	40c	99
	Sprague	19a	28a	29	4.68	2.88a	21	31a	90
ANOV		**	*	N.S.	N.S.	**	N.S.	**	N.S.
CV %		10.68	9.43	7.15	11.17	8.45	14.01	3.5	3.28
9	Sprague	870 (gm)	225	1262	5.53	3.83	23.99	29.46	94.83
10	Yamhill	49b	34	31	3.79	6.17b	37b	44c	95
	Luke	25a	30	30	4.20	3.70a	25a	35b	96
	Sprague	26a	36	39	4.46	3.05a	24a	30a	93
ANOV		*	N.S.	N.S.	N.S.	*	*	**	N.S.
CV %		26.16	8.06	20.82	13.76	19.58	12.19	5.96	2.24

APPENDIX TABLE 7. Continued

Treatment	Varieties	Yield/ plot %	Plants/ plot %	Tillers/ plot %	Heads/ plant	Yield/ plant (gm)	Kernels/ head	1000 kernel weight (gm)	Plant height (cm)
11	Sprague	43	52	63	4.61	3.28	23	31	96
	Paha	57	48	37	2.95	4.67	49	32	97
ANOV		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
CV %		24.24	5.6	37.32	34.06	23.41	31.38	6.96	3.09
12	Filler	——	——	——	——	——	——	——	——
13	Yamhill	1035 (gm)	175	823	4.78	6.01	28.25	45.04	98
14	Filler	——	——	——	——	——	——	——	——
15	Luke	46	40a	39a	4.87	5.26	34	32	96
	Sprague	54	60b	61b	5.07	4.08	26	31	97
ANOV		N.S.	**	*	N.S.	N.S.	N.S.	N.S.	N.S.
CV %		11.07	2.23	8.06	6.96	14.78	16.04	5.50	1.46
16	Hyslop	35b	35b	33ab	3.57	5.26b	42b	37	92
	Luke	14a	22a	25a	4.39	3.47a	21a	38	94
	Paha	51c	43b	42b	3.73	6.42c	50b	35	95
ANOV		**	**	*	N.S.	**	**	N.S.	N.S.
CV %		12.62	11.97	16.44	12.67	9.16	13.47	3.16	5.4
17	Luke	1300 (gm)	226.33	1339	6.03	5.86	28.98	33.71	97
18	Hyslop	66b	60b	62	4.58	6.55	37	38b	92
	Luke	34a	40a	38	4.14	5.15	33	37a	92
ANOV		*	**	N.S.	N.S.	N.S.	N.S.	*	N.S.
CV %		16.67	2.93	14.67	10.50	13.79	22.56	0.76	4.37
19	Yamhill	31	26	23	3.58a	5.70b	36ab	43b	94
	Luke	21	16	18	4.73b	3.53ab	21a	36a	95
	Sprague	16	25	32	4.92b	2.80a	17a	33a	94
	Paha	32	33	27	3.12a	4.32ab	40b	36a	96
ANOV		N.S.	N.S.	N.S.	**	*	*	**	N.S.
CV %		50.00	24.18	29.19	10.34	22.06	28.18	3.77	5.51
20	Hyslop	32ab	28b	29	4.91	5.50b	29c	38a	92
	Yamhill	34b	25b	22	4.09	6.49b	36d	44b	95
	Luke	14a	16a	17	4.89	4.06a	24b	35a	94
	Sprague	20ab	31b	32	5.15	3.19a	19a	33a	96
ANOV		*	*	N.S.	N.S.	*	**	*	N.S.
CV %		29.88	15.52	23.09	12.96	17.39	6.33	7.61	3.8
21	Yamhill	66	49	43	4.15	6.81b	40b	41b	100
	Sprague	34	51	57	5.70	3.54a	22a	30a	96
ANOV		N.S.	N.S.	N.S.	N.S.	**	**	**	N.S.
CV %		25.37	23.64	11.25	11.57	5.84	6.71	2.86	2.52
22	Hyslop	24b	24b	21a	3.76	4.62b	31b	40c	91
	Luke	13a	17a	18a	4.40	3.65a	22a	38b	86
	Sprague	19ab	26b	30b	4.94	3.41a	21ab	34a	89
	Paha	44c	33c	31b	4.11	6.19c	45c	35a	88
ANOV		**	**	**	N.S.	**	**	**	N.S.
CV %		14.12	13.84	13.69	12.03	3.96	14.75	2.30	4.49

APPENDIX TABLE 7. Continued

Treatment	Varieties	Yield/ plot %	Plants/ plot %	Tillers/ plot %	Heads/ plant	Yield/ plant (gm)	Kernels/ head	1000 kernel weight (gm)	Plant height (cm)
23	Luke	35	43	42	4.36	4.18a	28	35	98
	Paha	65	57	58	4.50	6.20b	41	33	107
ANOV		N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.
CV %		30.00	30.95	46.48	20.27	10.90	15.35	3.85	14.29
24	Filler	——	——	——	——	——	——	——	——
25	Hyslop	42	44	49	4.54	5.02	29.06a	39	94
	Yamhill	58	56	51	3.56	5.44	36.40b	42	102
ANOV		N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.
CV %		13.7	6.77	12.61	14.93	12.24	4.00	5.25	8.43
26	Filler	——	——	——	——	——	——	——	——
27 •	Hyslop	1111 (gm)	182	1015	5.65	6.13	31.17	35.88	90
28	Filler	——	——	——	——	——	——	——	——
29	Yamhill	50	51	49a	3.47	4.71	33a	43b	99
	Paha	50	49	51b	3.80	4.94	42b	32a	96
ANOV		N.S.	N.S.	**	N.S.	N.S.	*	**	N.S.
CV %		2.44	5.90	0.36	4.96	3.29	6.51	1.22	3.19
30	Hyslop	22	24	22	3.39	4.09b	34b	36b	92
	Yamhill	27	25	23	3.42	5.00c	36b	41c	92
	Sprague	19	28	29	3.60	2.90a	25a	31a	93
	Paha	32	23	26	3.92	6.21d	50c	32a	94
ANOV		N.S.	N.S.	N.S.	N.S.	**	**	*	N.S.
CV %		20.87	15.75	16.00	9.22	9.13	9.51	4.26	1.12
31	Paha	946 (gm)	153	885	5.71	6.54	36.78	31.69	95
32	Yamhill	41b	32	33	3.79	5.10b	32b	42c	92
	Sprague	19a	33	32	3.62	2.19a	21a	30a	94
	Paha	40b	35	35	3.77	4.56b	38b	32b	95
ANOV		*	N.S.	N.S.	N.S.	*	**	**	N.S.
CV %		17.86	17.88	8.68	12.51	16.94	9.45	2.77	1.57
33	Hyslop	31	28	27	3.89	4.98	33b	39b	95
	Sprague	29	37	41	4.45	3.54	26a	31a	97
	Paha	40	35	32	3.61	5.19	46c	31a	102
ANOV		N.S.	N.S.	N.S.	N.S.	N.S.	**	**	N.S.
CV %		21.47	19.27	20.11	14.61	15.82	6.01	4.30	3.36
34	Yamhill	62	55	46	3.71	7.03	41	47b	99
	Luke	38	45	54	5.30	5.41	27	38a	97
ANOV		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	**	N.S.
CV %		21.00	10.20	19.96	16.5	9.94	16.89	0.62	3.82
35	Hyslop	27a	29	30	4.21	5.65	36a	38b	98a
	Yamhill	36b	35	34	3.87	6.30	38a	43c	103b
	Paha	37b	36	36	4.05	6.29	49b	32a	105b
ANOV		*	N.S.	N.S.	N.S.	N.S.	**	**	**
CV %		8.91	9.26	13.41	8.25	6.27	6.51	1.97	1.44

APPENDIX TABLE 7. Continued.

Treatment	Varieties	Yield/ plot %	Plants/ plot %	Tillers/ plot %	Heads/ plant	Yield/ plant (gm)	Kernels/ head	1000 kernel weight (gm)	Plant height (cm)
36	Hyslop	38b	38b	41b	4.74	5.55b	31ab	38a	89a
	Yamhill	47b	38b	37b	4.58	7.39c	37b	45b	98b
	Luke	15a	24a	22a	4.29	3.91a	24a	38a	97b
ANOV		**	*	**	N.S.	**	*	**	*
CV %		13.25	12.34	7.65	15.61	10.55	10.86	2.23	2.72

* Significant at the 5% level. (Student Newman Keuls' Test)
** Significant at the 1% level. (Student Newman Keuls' Test)

APPENDIX TABLE 8. Summary of analysis of variance for within composite treatments for eight traits at Moro, Oregon in 1974.

Treatment	Varieties	Yield/ plot %	Plants/ plot %	Tillers/ plot %	Heads/ plant	Yield/ plant (gm)	Kernels/ head	1000 kernel weight (gm)	Plant height (cm)
1	Yamhill	52c	44	43b	3.71	4.41	35b	33c	86b
	Luke	19a	27	28a	3.84	2.42	22a	28b	79a
	Paha	29b	29	29a	3.71	3.53	37b	25a	84b
ANOV		**	N.S.	*	N.S.	N.S.	**	**	*
CV %		13.81	27.26	13.42	15.72	22.22	8.89	1.25	2.4
2	Luke	34ab	30	36	5.07	2.94ab	21a	26b	74
	Sprague	17a	31	27	3.48	1.39a	17a	23a	77
	Paha	49b	39	37	4.17	3.72b	38b	23a	82
ANOV		*	N.S.	N.S.	N.S.	*	*	*	N.S.
CV %		24.38	20.44	6.93	18.1	28.48	21.76	3.10	6.85
3	Hyslop	58b	48	57	4.59b	4.01b	29a	30b	79
	Paha	42a	52	43	3.20a	2.78a	35b	25a	86
ANOV		*	N.S.	N.S.	*	*	*	**	N.S.
CV %		9.05	16.81	8.9	8.74	9.86	3.50	1.65	3.12
4	Hyslop	25b	21	26b	4.49b	2.83c	23a	28b	79ab
	Yamhill	37c	24	27b	3.87ab	3.80d	32b	30c	82ab
	Luke	7a	14	14a	3.68ab	1.30a	14a	27b	77a
	Sprague	9a	18	13a	2.86a	1.21a	18a	24a	79ab
	Paha	22bc	23	20ab	3.08ab	2.36bc	33b	23a	84b
ANOV		**	N.S.	**	*	**	**	**	*
CV %		33.84	21.89	18.23	13.08	20.88	19.73	4.71	2.92
5	Hyslop	58b	39	48b	5.86b	5.22b	31b	28	80
	Luke	27a	31	31a	4.63ab	2.95a	24a	27	84
	Sprague	15a	30	21a	3.30a	1.77a	21a	26	83
ANOV		*	N.S.	*	*	*	*	N.S.	N.S.
CV %		32.67	15.71	20.85	13.39	24.71	9.49	6.95	3.93
6	Hyslop	83b	58b	70b	4.44	4.36b	34b	30	81
	Sprague	17a	42a	30a	2.60	1.25a	19a	25	82
ANOV		*	*	**	N.S.	*	*	N.S.	N.S.
CV %		24.38	8.52	7.38	17.97	23.00	14.09	5.39	5.28
7	Hyslop	37b	28	37b	4.82	3.99b	31	29a	80a
	Yamhill	34b	30	27ab	3.34	3.14ab	30	33b	82ab
	Luke	12a	20	17a	3.13	1.65a	20	28a	80a
	Paha	17a	22	19a	3.23	2.40ab	30	25a	88b
ANOV		**	N.S.	*	N.S.	*	N.S.	*	*
CV %		25.22	16.47	25.97	23.13	23.96	33.26	6.23	3.50
8	Hyslop	45b	35	45b	5.15b	4.45b	29b	29b	84
	Yamhill	46b	40	35b	3.44a	3.85b	35c	32c	86
	Sprague	9a	25	20a	3.01a	1.34a	19a	24a	79
ANOV		**	N.S.	*	*	*	**	**	N.S.
CV %		21.22	15.30	18.74	19.16	30.34	5.24	4.69	30.6
9	Sprague	420 (gm)	196	895	4.57	2.13	20.76	22.52	82.33
10	Yamhill	62c	41	45b	3.89	4.45b	37b	31b	82
	Luke	23b	28	30a	4.15	2.55a	29a	27a	77
	Sprague	15a	33	25a	2.75	1.34a	24a	25a	77
ANOV		**	N.S.	*	N.S.	**	**	*	N.S.
CV %		18.69	14.85	16.97	16.43	22.76	7.54	4.94	6.00

APPENDIX TABLE 8. Continued

Treatment	Varieties	Yield/ plot %	Plants/ plot %	Tillers/ plot %	Heads/ plant	Yield/ plant (gm)	Kernels/ head	1000 kernel weight (gm)	Plant height (cm)
11	Sprague	24a	46	42	2.83	1.01a	16a	22	80
	Paha	76b	54	58	3.48	2.68b	43b	21	82
ANOV		*	N.S.	N.S.	N.S.	**	**	N.S.	N.S.
CV %		15.30	13.33	30.27	33.90	3.46	50.61	1.51	2.16
12	Filler	—	—	—	—	—	—	—	—
13	Yamhill	648 (gm)	178	625	3.56	3.66	32.87	33.05	83.47
14	Filler	—	—	—	—	—	—	—	—
15	Luke	53	41	53	5.92b	4.14	27	26b	75
	Sprague	47	59	47	3.72a	2.55	27	25a	82
ANOV		N.S.	N.S.	N.S.	*	N.S.	N.S.	*	N.S.
CV %		23.10	14.51	15.88	9.70	14.34	12.72	0.66	6.29
16	Hyslop	48	37	45	4.63	3.60	27b	28b	78a
	Luke	21	29	27	3.48	2.00	22a	27b	78a
	Paha	31	34	28	3.17	2.55	33c	25a	83b
ANOV		N.S.	N.S.	N.S.	N.S.	N.S.	**	**	*
CV %		16.96	9.68	17.63	15.90	32.88	6.47	1.80	1.76
17	Luke	585 (gm)	181	844	4.90	3.23	26.12	27.04	77.83
18	Hyslop	74b	65b	68b	4.51	4.67b	33b	32	81
	Luke	26a	35a	32a	3.88	2.94a	25a	30	80
ANOV		**	*	*	N.S.	*	*	N.S.	N.S.
CV %		0.31	13.69	10.69	11.73	9.03	5.61	2.36	4.35
19	Yamhill	48c	32	34b	4.12ab	4.37b	35b	31b	85
	Luke	17ab	21	24a	4.43b	2.33a	20a	27ab	77
	Sprague	10a	21	18a	3.10a	1.34a	18a	24a	79
	Paha	25b	26	24a	3.60ab	2.89ab	34b	23a	87
ANOV		**	N.S.	*	*	**	**	*	N.S.
CV %		21.85	22.63	18.34	12.1	20.65	10.77	7.91	5.79
20	Hyslop	43b	34b	40c	4.92b	5.06b	33b	30b	81
	Yamhill	40b	30b	31b	4.23b	5.15b	38b	33c	82
	Luke	9a	14a	14a	4.17b	2.36a	20a	29b	81
	Sprague	8a	22ab	15a	2.53a	1.29a	19a	26a	78
ANOV		**	*	**	**	**	**	**	N.S.
CV %		21.00	22.38	17.00	9.45	20.54	16.15	3.69	3.42
21	Yamhill	84b	59b	69b	4.18b	4.42b	35b	31b	86
	Sprague	16a	41a	31a	2.78a	1.12a	18a	23a	85
ANOV		**	*	*	*	**	*	**	N.S.
CV %		12.86	10.00	18.00	10.26	12.45	8.29	2.94	3.97
22	Hyslop	48c	36b	40b	4.35	3.69b	28b	29b	80b
	Luke	15a	18a	18a	3.78	2.28ab	22a	28ab	74a
	Sprague	10a	19a	17a	3.47	1.58a	18a	25a	75a
	Paha	27b	27a	25a	3.73	2.98b	32b	24a	82b
ANOV		**	*	**	N.S.	**	**	*	*
CV %		22.41	18.60	20.31	9.65	16.04	11.67	5.73	2.77

APPENDIX TABLE 8. Continued.

Treatment	Varieties	Yield/ plot	Plants/ plot	Tillers/ plot	Heads/ plant	Yield/ plant	Kernels/ head	1000 kernel weight	Plant height
23	Luke	41a	45a	47	4.74	2.63	21	25b	77
	Paha	59b	55b	53	4.16	2.99	32	23a	85
ANOV		*	*	N.S.	N.S.	N.S.	N.S.	*	N.S.
CV %		7.60	2.68	1.67	20.55	12.93	13.97	2.83	6.02
24	Filler	——	——	——	——	——	——	——	——
25	Hyslop	51	50	59b	3.72	3.72	32	49	82
	Yamhill	49	50	41a	2.65	3.65	43	51	84
ANOV		N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.
CV %		4.02	5.95	8.57	14.57	10.53	10.83	4.45	3.00
26	Filler	——	——	——	——	——	——	——	——
27	Hyslop	597 (gm)	169	680	3.99	3.53	30.55	29.23	81.17
28	Filler	——	——	——	——	——	——	——	——
29	Yamhill	69b	58	61b	3.87	3.85b	32	31b	85
	Paha	31a	42	39a	3.31	2.35a	29	24a	90
ANOV		*	N.S.	**	N.S.	**	N.S.	**	N.S.
CV %		12.81	11.67	4.37	7.87	5.33	2.35	2.09	1.78
30	Hyslop	32bc	26	31b	3.88b	3.43c	31b	29b	80
	Yamhill	38c	28	31b	3.58b	3.83c	31b	31c	84
	Sprague	8a	22	18a	2.57a	1.09a	18a	24a	81
	Paha	22b	25	20ab	2.68a	2.55b	39c	25a	87
ANOV		**	N.S.	*	**	**	**	**	N.S.
CV %		22.26	17.05	21.42	8.17	10.08	8.32	2.91	2.24
31	Paha	457 (gm)	154	646	4.24	3.08	31.88	22.63	83.83
32	Yamhill	58c	37	42	3.70	4.39b	36b	33b	85
	Sprague	13a	32	26	2.75	1.19a	17a	26a	85
	Paha	29b	31	32	3.58	3.57b	37b	26a	86
ANOV		**	N.S.	N.S.	N.S.	**	**	**	N.S.
CV %		13.76	13.56	19.16	11.32	19.20	7.63	4.19	3.53
33	Hyslop	55b	37	43	3.83	4.10b	38b	30b	75
	Sprague	14a	34	24	2.34	1.15a	20a	25a	79
	Paha	31ab	29	33	3.76	2.98b	34b	24a	81
ANOV		*	N.S.	N.S.	N.S.	*	*	**	N.S.
CV %		40.7	15.75	36.61	34.18	27.76	17.48	4.35	4.86
34	Yamhill	73b	59b	60b	3.84	4.58b	37b	32	84
	Luke	27a	41a	40a	3.75	2.40a	21a	29	79
ANOV		*	*	*	N.S.	*	*	N.S.	N.S.
CV %		21.2	6.50	6.50	12.20	10.30	12.80	3.20	3.10
35	Hyslop	38b	37b	42c	3.86	3.00ab	26a	30b	82a
	Yamhill	42b	37b	35b	3.27	3.46b	34c	31b	92b
	Paha	20a	26a	23a	3.22	2.28a	29b	25a	92b
ANOV		**	**	**	N.S.	*	**	**	*
CV %		5.30	4.50	8.20	9.4	11.00	4.60	4.30	3.10

APPENDIX TABLE 8. Continued

Treatment	Varieties	Yield/ plot %	Plants/ plot %	Tillers/ plot %	Heads/ plant	Yield/ plant (gm)	Kernels/ head	1000 kernel weight (gm)	Plant height (cm)
36	Hyslop	45b	41b	47b	4.23b	3.37b	28b	30ab	80
	Yamhill	44b	40b	37b	3.33a	3.34b	33b	32b	86
	Luke	11a	19a	16a	3.02a	1.61a	20a	28a	81
ANOV		**	**	**	*	**	**	*	N.S.
CV %		18.00	7.89	15.80	8.6	7.70	8.60	4.60	4.00

* Significant at the 5% level. (Student Newman Keuls' Test)
** Significant at the 1% level. (Student Newman Keuls' Test)

APPENDIX TABLE 9. Summary of analysis of variance for within composite treatments for eight traits at three locations in Oregon in 1974.

Treatment	Varieties	Yield/ plot (gm)	Plants/ plot	Tillers/ plot	Heads/ plant	Yield/ plant (gm)	Kernels/ head	1000 kernel weight (gm)	Plant height (cm)
1	Yamhill	451c	92b	302b	3.49a	5.03b	40b	38b	99b
	Luke	168a	64a	218a	3.81a	2.63a	23a	32a	93a
	Paha	316b	73a	243ab	3.41a	4.27b	42b	31.5a	101b
ANOV		**	**	*	N.S.	**	**	**	**
CV %		26.17	17.52	24.23	19.83	18.86	12.92	6.05	5.1
Loc. x cult. interact.		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	**	N.S.
2	Luke	254a	75a	268a	4.06b	3.57b	30a	31a	91a
	Sprague	221a	89a	274a	3.26a	2.42a	28a	29a	93a
	Paha	429b	92a	288a	3.45b	4.76c	48b	31a	99b
ANOV		**	N.S.	N.S.	*	**	**	N.S.	**
CV %		23.46	18.30	26.14	14.74	23.03	20.20	4.98	4.76
L x C Interaction		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
3	Hyslop	518a	101a	398b	4.05b	5.10b	36a	36b	91a
	Paha	468a	112a	319a	2.92a	4.16a	47b	31a	102b
ANOV		N.S.	N.S.	*	**	*	*	*	*
CV %		22.68	16.11	15.63	16.65	17.18	15.00	10.57	9.20
L x C Interaction		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
4	Hyslop	216b	55b	179c	3.49c	3.81b	32b	37d	91a
	Yamhill	285c	58b	182c	3.32bc	4.88c	39c	39e	98b
	Luke	93a	36a	110a	3.21bc	2.42a	24a	33c	91a
	Sprague	103a	48b	142b	2.92ab	1.99a	23a	30a	95b
	Paha	219b	58b	147b	2.64a	3.62b	45d	32b	102c
ANOV		**	**	**	**	**	**	**	**
CV %		29.14	20.55	18.23	11.77	20.12	11.69	4.56	3.95
L x C Interaction		N.S.	N.S.	**	*	N.S.	N.S.	*	N.S.
5	Hyslop	555b	96c	422b	4.65b	5.73b	36c	36c	94a
	Luke	265a	72a	2.67a	3.97a	3.81ab	30b	33b	94a
	Sprague	244a	83b	318a	3.79a	2.78a	25a	31a	94a
ANOV		**	**	**	*	**	**	**	N.S.
CV %		21.00	11.24	19.48	13.43	14.42	12.33	5.18	4.25
L x C Interaction		N.S.	N.S.	**	**	N.S.	N.S.	N.S.	N.S.
6	Hyslop	761b	135a	570b	4.52b	5.62b	36b	36b	92a
	Sprague	297a	122a	343a	2.91a	2.70a	27a	30a	94a
ANOV		*	N.S.	**	**	**	**	**	N.S.
CV %		23.18	13.56	20.18	24.52	12.45	11.09	4.23	4.81
L x C Interaction		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
7	Hyslop	272b	71b	234b	3.54a	3.91b	33b	37b	91a
	Yamhill	353c	75b	2.21b	3.15a	4.59b	39bc	40c	101b
	Luke	132a	52a	149a	3.20a	2.52a	25a	33a	93a
	Paha	287b	67b	202b	3.12a	4.05b	42c	32a	110c
ANOV		**	**	*	N.S.	**	**	**	**
CV %		23.54	13.43	24.76	18.86	20.37	16.80	4.83	6.19
L x C Interaction		**	*	*	N.S.	*	N.S.	N.S.	N.S.
8	Hyslop	400b	89b	332b	4.20b	4.60b	33b	36b	93a
	Yamhill	491c	105c	319b	3.17a	4.60b	39c	39c	101b
	Sprague	134a	63a	201a	3.19a	2.08a	23a	30a	93a
ANOV		**	**	**	**	**	**	**	**
CV %		12.00	11.15	12.56	15.89	14.64	8.70	3.55	3.65
L x C Interaction		*	**	*	*	N.S.	*	N.S.	N.S.
9	Sprague	821	234	1018	4.43	3.41	27.56	29.04	96.55
10	Yamhill	562b	99b	320b	3.38a	5.58c	44b	39c	98b
	Luke	251a	79a	273ab	3.71b	3.20b	26a	34b	93a
	Sprague	182a	81a	251a	3.04a	2.16a	25a	30a	93a
ANOV		**	**	*	*	**	**	**	*
CV %		28.14	13.66	17.78	13.54	20.79	16.74	5.29	4.68
L x C Interaction		*	N.S.	**	*	N.S.	N.S.	*	N.S.

APPENDIX TABLE 9. Continued

Treatment	Varieties	Yield/ plot (gm)	Plants/ plot	Tillers/ plot	Heads/ plant	Yield/ plant (gm)	Kernels/ head	1000 kernel weight (gm)	Plant height (cm)
11	Sprague	330a	122a	420a	3.40a	2.55a	25a	29a	94a
	Paha	539b	121a	356a	3.03a	4.38b	50b	30a	99a
ANOV		*	N.S.	N.S.	N.S.	**	**	N.S.	N.S.
CV %		38.29	10.89	38.32	33.47	27.19	29.19	4.38	7.76
L x C Interaction		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
12	Filler	——	——	——	——	——	——	——	——
13	Yamhill	1041	225	698	3.46	4.73	37.11	40.81	99.71
14	Filler	——	——	——	——	——	——	——	——
15	Luke	494a	119a	453a	4.49b	4.39b	33a	32a	92a
	Sprague	452a	137a	501a	3.87a	3.31a	29a	30a	97b
ANOV		N.S.	N.S.	N.S.	**	**	N.S.	N.S.	*
CV %		17.98	13.19	12.06	8.12	13.81	12.69	4.42	3.66
L x C Interaction		N.S.	N.S.	**	**	N.S.	N.S.	N.S.	N.S.
16	Hyslop	416b	88b	305b	3.64a	4.67a	38b	36b	91a
	Luke	188a	66a	222a	3.56a	2.87a	24a	34b	94b
	Paha	405b	85b	252a	3.06a	4.66a	47c	33a	100b
ANOV		**	**	**	N.S.	N.S.	**	**	**
CV %		17.00	12.18	18.29	18.35	15.28	10.10	3.97	5.08
L x C Interaction		**	*	*	N.S.	N.S.	**	N.S.	N.S.
17	Luke	1037	210	1000	4.87	4.87	32.22	32.38	92.30
18	Hyslop	771b	142b	531b	3.95b	5.48b	39a	37b	90a
	Luke	368a	99a	322a	3.49a	3.86a	32a	35a	93a
ANOV		**	**	**	*	**	N.S.	*	N.S.
CV %		14.05	10.35	13.77	10.54	12.91	18.54	3.28	4.06
L x C Interaction		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
19	Yamhill	372c	73b	235a	3.40ab	5.14c	41b	39c	96a
	Luke	169a	50a	172a	3.84b	2.80a	23a	33b	90a
	Sprague	122a	55a	178a	3.44ab	2.12a	22a	30a	93a
	Paha	279b	65ab	189a	2.95a	4.17b	47c	32a	99a
ANOV		**	**	N.S.	**	**	**	**	*
CV %		38.97	22.58	26.06	12.44	21.35	19.01	4.48	5.81
L x C Interaction		N.S.	N.S.	*	**	N.S.	N.S.	N.S.	N.S.
20	Hyslop	332b	67b	267b	4.13b	5.07c	35b	37c	92a
	Yamhill	382b	70b	224b	3.49a	5.53c	42c	40d	96b
	Luke	139a	43a	154a	3.87ab	3.11b	24a	34b	96b
	Sprague	140a	63b	205b	3.16a	2.10a	22a	31a	93a
ANOV		**	**	**	**	**	**	**	*
CV %		20.48	12.66	21.37	12.4	18.04	9.06	5.20	3.00
L x C Interaction		N.S.	*	**	**	N.S.	N.S.	N.S.	*
21	Yamhill	743b	135a	455b	3.60a	5.59b	42b	39b	101b
	Sprague	284a	114a	362a	3.37a	2.12a	23a	29a	97a
ANOV		**	N.S.	**	N.S.	**	**	**	*
CV %		18.46	16.79	12.59	11.63	14.72	8.27	2.48	2.51
L x C Interaction		*	N.S.	**	**	N.S.	N.S.	*	N.S.
22	Hyslop	300b	72b	241b	3.54a	4.26c	34b	37d	90a
	Luke	159a	56a	174a	3.54a	2.94b	26a	34c	88a
	Sprague	129a	53a	174a	3.45a	2.38a	24a	31a	91a
	Paha	344b	72b	228b	3.36a	4.66c	45c	32b	97b
ANOV		**	**	**	N.S.	**	**	**	**
CV %		25.89	16.14	16.70	11.74	5.29	11.28	3.94	4.36
L x C Interaction		**	**	**	*	**	*	N.S.	**

APPENDIX TABLE 9. Continued.

Treatment	Varieties	Yield/ plot (gm)	Plants/ plot	Tillers/ plot	Heads/ plant	Yield/ plant (gm)	Kernels/ head	1000 kernel weight (gm)	Plant height (cm)
23	Luke	347a	111a	372a	3.81a	3.24a	27a	32a	92a
	Paha	518a	120a	398a	3.52a	4.44b	44b	31a	103b
ANOV		N.S.	N.S.	N.S.	N.S.	**	**	N.S.	*
CV %		37.00	27.05	38.91	20.81	10.34	14.73	5.20	9.25
L x C Interaction		N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.
24	Filler	——	——	——	——	——	——	——	——
25	Hyslop	474a	111a	380a	3.60b	4.29a	34a	38a	92a
	Yamhill	601b	130b	356a	2.81a	4.54a	42b	40b	100b
ANOV		**	**	N.S.	**	N.S.	**	*	*
CV %		10.55	4.89	11.35	14.64	10.51	6.95	3.83	6.10
L x C Interaction		*	**	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
26	Filler	——	——	——	——	——	——	——	——
27	Hyslop	1077	213	830	4.14	5.00	36.03	35.51	91
28	Filler	——	——	——	——	——	——	——	——
29	Yamhill	555b	130b	373b	3.13a	4.26b	39a	38b	100a
	Paha	387a	114a	306a	2.94a	3.36a	39a	31a	102a
ANOV		**	**	**	N.S.	**	N.S.	**	N.S.
CV %		8.40	6.50	9.77	9.39	7.09	12.42	1.51	3.91
L x C Interaction		**	N.S.	*	N.S.	**	N.S.	**	N.S.
30	Hyslop	280b	67a	207b	3.27b	4.07b	36b	36c	90a
	Yamhill	336b	68a	212b	3.22b	4.80c	39b	39d	98c
	Sprague	115a	61a	157a	2.65a	1.83a	23a	30a	95b
	Paha	267b	64a	177ab	2.97ab	4.25b	45c	32b	102d
ANOV		**	N.S.	**	**	**	**	**	**
CV %		13.11	17.81	15.89	9.86	15.03	10.95	3.81	2.39
L x C Interaction		**	N.S.	**	**	**	*	*	**
31	Paha	857	189	693	4.02	4.70	41.98	30.61	102.03
32	Yamhill	463c	85b	298c	3.58b	5.40b	39b	40c	97b
	Sprague	134a	69a	207a	2.94a	1.87a	22a	30a	96a
	Paha	323b	77ab	244b	3.24ab	4.20b	41b	32b	101b
ANOV		**	*	**	*	**	**	**	*
CV %		17.35	16.11	13.95	11.43	15.92	11.12	2.65	3.61
L x C Interaction		**	N.S.	**	N.S.	N.S.	N.S.	**	N.S.
33	Hyslop	404b	80a	288a	3.68a	4.95b	37b	37b	91a
	Sprague	209a	78a	257a	3.14a	2.49a	25a	30a	95a
	Paha	357b	79a	247a	3.24a	4.32b	44c	31a	90a
ANOV		**	N.S.	N.S.	N.S.	**	**	**	N.S.
CV %		25.87	16.53	26.07	14.45	18.48	9.42	4.10	19.86
L x C Interaction		*	N.S.	*	N.S.	N.S.	**	*	N.S.
34	Yamhill	725b	127b	407b	3.37a	5.72b	43b	41b	101b
	Luke	311a	99a	343a	3.77b	3.33a	25a	35a	93a
ANOV		**	**	*	*	**	**	**	**
CV %		13.00	11.16	13.61	15.05	10.81	11.97	2.00	3.4
L x C Interaction		**	N.S.	*	**	N.S.	N.S.	**	*
35	Hyslop	328a	81b	267b	3.52b	4.15a	33a	36b	93a
	Yamhill	433b	95c	272b	3.11a	4.67a	40b	39c	105b
	Paha	307a	70a	219a	3.18b	4.20a	42c	32a	105b
ANOV		**	**	**	*	N.S.	**	**	**
CV %		13.01	9.36	12.03	9.62	0.10	4.62	2.68	1.94
L x C Interaction		**	**	**	N.S.	N.S.	**	**	**

APPENDIX TABLE 9. Continued

Treatment	Varieties	Yield/ plot (gm)	Plants/ plot	Tillers/ plot	Heads/ plant	Yield/ plant (gm)	Kernels/ head	1000 kernel weight (gm)	Plant height (cm)
	Hyslop	387b	84b	316b	3.93a	4.63b	34b	37b	91a
36	Yamhill	480c	91c	290b	3.46a	5.44c	40c	41c	101c
	Luke	143a	52a	161a	3.32a	2.78a	24a	35a	97b
ANOV		**	**	**	N.S.	**	**	**	**
CV %		14.46	10.12	10.79	14.00	9.79	9.56	2.7	3.16
L x C Interaction		*	*	N.S.	N.S.	*	N.S.	**	N.S.

* Significant at the 5% level. (Student Newman Keuls' Test)
** Significant at the 1% level. (Student Newman Keuls' Test)

APPENDIX TABLE 10. Climatic data for Corvallis, Madras and Moro, Oregon during the 1973-74 growing season.

Location	Months	Temperature (F)			Precipitation
		max.	min.	mean	(mm)
Corvallis	October	62.0	42.1	52.5	68.6
	November	49.3	38.3	43.8	464.4
	December	48.9	46.5	47.7	315.0
	January	43.5	29.9	36.7	294.4
	February	47.3	35.0	41.2	191.0
	March	54.0	36.1	45.0	225.3
	April	57.5	40.7	49.5	60.7
	May	63.6	42.4	53.0	37.1
	June	74.6	48.4	61.5	15.5
	July	77.5	49.5	63.5	46.0
	August	----	----	----	----
	TOTAL				1718.0
Madras	October	63.7	33.8	48.8	24.9
	November	47.1	31.7	39.4	82.1
	December	47.7	31.6	39.7	51.3
	January	37.1	20.0	28.6	20.4
	February	51.5	29.0	40.3	15.3
	March	54.9	30.3	42.6	41.7
	April	60.3	32.2	46.3	27.7
	May	66.9	36.1	51.5	1.8
	June	84.5	46.2	64.9	0.8
	July	83.7	48.3	66.0	10.5
	August	85.0	49.2	67.1	0.0
	TOTAL				276.0
Moro	October	59.6	38.3	49.0	21.6
	November	42.9	31.5	37.2	94.0
	December	42.8	31.5	37.2	101.3
	January	33.1	18.3	25.7	32.8
	February	46.6	30.2	38.4	24.6
	March	50.4	31.7	41.1	33.0
	April	54.6	36.2	45.4	30.0
	May	60.9	39.0	50.0	9.7
	June	78.4	49.5	64.0	0.5
	July	79.6	51.6	65.6	10.4
	August	----	----	----	----
	TOTAL				357.9