Evaluation of the Relationships among the Quantitative Traits of New Soybean Varieties and Lines

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Abstract

In order to evaluate the quantitative traits of soybean (*Glycine max* L. Merill), 24 genotypes were studied at Baiekola Agricultural Research Station in 2008. The traits studied included phonological and morphological traits, yield components, seed yield, and seed oil and protein content. Results of analysis of variance showed that mean squares of the treatments were significant, indicating significant genetic variation among the genotypes regarding the above–mentioned traits. There was a significant positive correlation between the number of days to flowering and the number of days to maturity, indicating that selection based on a high number of days to flowering leads to indirect selection of late maturing varieties. Among the main yield components, there was a significant positive correlation between the 1000-seed weight and seed yield; therefore, any change in the 1000-seed weight will have significant effects on seed yield. Since the yield components and the qualitative traits do not have any significant correlation with seed yield, cluster analysis cannot be used to put these traits in one group together with high seed yield. The general conclusion is that the genotypes Ronak 2, L2002, and LB4 with seed yields of 2610, 2606, and 2597 kg/h, respectively, are the superior genotypes, and that they can be considered as one statistical group.

Keywords: Correlation, Mean square, Phonological traits, Soybean

1. Introduction

Canola, soybean, sunflower, and cotton are the main crops producing the edible oil consumed in our country. At present, the yearly per capita oil consumption in the country is 17 kilograms, while the recommended yearly per capita is 12.5 kilograms. Every year we import around 1.1 million tons of vegetable edible oil for human consumption and 1.7 million tons of oil meal to be used as animal feed. Less than 7 percent of the yearly edible oil and oil meal needed is produced in the country (Sepeher, 2004).

Soybean (*Glycine max* L.) is an oil crop belonging to the Leguminosae family. Its seed oil content is 20 to 22 percent and its oil meal contains 38 percent proteins (Ahmadi, 2000). Introduction of high yielding varieties adapted to the areas where this crop is planted can have a remarkable role in increasing oil production and be effective in achieving economical independence. In most breeding projects, selection is based on a considerable number of traits which may show a positive or a negative correlation with each other (Arab, 2002; Ali et al., 2003). Therefore, breeding experiments with the aim of finding the best lines is necessary in order to increase production (Yazdi Samadi and Abd–e Mishani, 1992). In these breeding experiments, taking the genetic diversity of the available lines, with respect to the phonological and the morphological traits and the components of yield and the qualitative traits, into consideration is an effective step in improving the traits of the varieties used. Due to the intensification of the biotic and the abiotic stresses, improving the new varieties, together with the existing high yielding varieties such as Telar, Sari, 032 and 033, will provide a dependable strategy in the sustainable cultivation of soybean in the region. Therefore, this research was carried out to compare the soybean lines and varieties existing in the province of Mazandaran, and to study the quantitative and qualitative traits of each of these lines and varieties.

2. Material and Methods

In order to evaluate the relationships of the quantitative traits, an experiment was carried out using 24 new varieties and lines of soybean (Table 1) in the form of randomized complete block design with four replications in the Agriculture Research Station of Baiekola in 2010. In this experiment, each plot included four lines, each of which four meters long, with a distance of 50 centimeters between neighboring lines. During the growing season, sampling was conducted in each plot omitting a boundary of about 0.5 meter from each end of every plot. The factors measured included the time flowering started, the time flowering ended, the length of the flowering period, the height of plants, the time the plants matured, the number of pods in each plant, the number of seeds in each pod, and the seed yield in each plant. To determine the final yield at full maturity, samples were taken from the two central lines in each plot. The statistical calculations of this study included the analysis of variance of the traits studied based on the standards of randomized complete block design. Then, the means were compared using Duncans Multiple Range Test (DMRT). To analyze the relationships of the traits studied, simple correlation and cluster analysis were employed. The statistical software used included Excel, SAS, and SPSS.

3. Results

Number of days to the start of flowering: Results of the comparison of the means of the varieties showed that the varieties Dorksay 3a, B 121, and Hardi 50 had the highest number of days from seeding to flowering, with a mean of 101.3 days, and the variety Ogeden had the lowest number, which was 48.75 days (Table 2).

Number of days to the end of flowering: Results obtained showed that the highest number of days to the end of flowering belonged to the varieties Dorksay 3a and B 121, with an average of 120.5 days, and the lowest number belonged to the varieties Sahar, Sari, and Telar, with an average of 90.25 days (Table 2).

Length of the flowering period: Comparison of the means of the varieties suggested that the variety Dorksay 3a (with 47 days) had the longest and the variety Hardi 50 (with 17 days) the shortest flowering period (Table 2). There was a positive and significant correlation between the length of the flowering period and the number of days to maturity (r=0.314**), which indicates that with an increase in the length of the flowering period, the number of days to maturity also increases. These results are consistent with those obtained by Nazeri et al. (2008)

Number of days to pod formation: Results of the comparison of the means of data showed that the highest number of days to pod formation belonged to the variety Dorksay 3a (114 days) and the lowest to the variety Ogeden (64 days) (Table 2). This may be due to the genetic diversity which exists in the different varieties (Hezarjaribee et al., 2004)

Number of days to maturity: The comparison of the means showed that the longest period from seeding to maturity (177 days) belonged to the variety Dorksay 3a and the shortest to the variety Dare (117 days) (Table 2). These results are consistent with those of Bord (1992). The comparison of the means also showed that the variety Dorksay 3a was at a higher statistical level than the other varieties with respect to the number of days to the start of the flowering period, the number of days to the start of pod formation, and the number of days to maturity; and hence, Dorksay 3a had a greater 1000 seed weight, a fact which was shown by the high correlation between the number of days to maturity and the 1000 seed weight (r=0.497**).

Height of the plants: The maximum height of the plants (149 cm) was observed in the variety B 121 and the minimum final height (77 cm) to the variety Telar (Table 2). Although height of plants is genetically determined, it can be influenced by environmental and management factors such as the weather, the date of seeding, the planting pattern, and the photoperiod (Bucket et al., 1982; Wells, 1991).

Number of pods per plant: The comparison of the means of the varieties and the lines showed that the variety Sari had the highest number (69) of pods per plant and the variety Benus the lowest (38) (Table 3).

1000 seed weight: It was also found that the variety Dorksay 3a had the highest (342.5 g) and the variety Sahar the lowest (163.4 g) 1000 seed weight (Table 3).

Seed yield: Results of the comparison of means showed that the highest seed yield belonged to the variety Ronak 2 with 2610 kilograms per hectare and the lowest to the variety Benus with 1286 Kg.h (Table 3). Moreover, the mean of this trait revealed that the varieties and lines Ronak 2, L.2002, L.B4, Forest, Scott with 2610, 2606, 2597, 2579 Kg.h, respectively, ranked next regarding seed yield, though they were all in one statistical group (Table 3). Increase in crop yield is mainly related to increase in the number of days to the start of flowering, the number of days to the end of flowering, the number of days to pod formation, the number of days to maturity, and the 1000 seed weight. The number of days to pod formation has the greatest effect on yield increase (r=0.464**). In our study, we observed a high correlation between yield and the days to pod formation**,** which is compatible with the findings of Ward et al., 1992.

Percentage of seed oil and protein content: Comparison of the means of the data showed that L.2001 with 21.13% had the highest and B 121 with 15.92% had the lowest oil content (Table 3). Furthermore, comparison of means using Duncans method showed that Ogeden with 42% had the highest and L.B4 with 32.4% the lowest protein content (Table 3).

Cluster analysis

Cluster analysis is one of the most common and efficient methods of multivariate statistical analysis for grouping genotypes. In our research, cluster analysis in Wards method of minimum variance was used to determine the degree of similarity among genotypes. Wards method is the second most common method in cluster analysis, while UPGMA is the most common (Caramos et al., 1988).

Cluster analysis based on mean phonological traits

Figure 1 shows the dendrogram of genotype grouping based on mean phonological traits and using Wards method. Cutting the dendrogram at points 10 units apart resulted in the formation of three clusters. The first cluster included 19 lines and varieties. This cluster was at the level of the grand mean regarding the traits of the number of days to flowering, the number of days to the end of flowering, the length of the flowering period, the number of days to pod formation, and the number of days to maturity. The lines Ogeden and Dare and some of the varieties were in the second cluster. The lines and varieties in this cluster have a longer flowering period than the grand mean flowering period, but their number of days to flowering, number of days to the end of flowering, number of days to pod formation, and number of days to maturity are smaller than the corresponding grand means. This is considered to be an important advantage, and it can be taken advantage of when new varieties are introduced through including these lines in the crosses. The lines and varieties in clusters one and two stand side by side under a sub-branch separate from the other varieties. Hardi 50, Dorksay 3a, and B121 are the varieties and lines included in the third cluster; they are phonologically very different from the other genotypes. These genotypes had a shorter flowering period than the grand mean of the genotypes, but their number of days to flowering, number of days to the end of flowering, number of days to pod formation, and number of days to maturity (all of which are traits not phenologically ideal) were higher, compared to the corresponding grand means.

Cluster analysis on the basis of mean yield and yield components

In this part, the means of 1000 seed weight, the number of pods per plant, and seed yield in kilograms per hectare were used in cluster analysis. Results of the cluster analysis showed that all the genotypes were placed in three groups (Figure 2). The first cluster included the varieties and lines of Dorksay 2a, B121, Sahar, Dare, Sari, 032, Forest, LB4, Cooker Stewart, L.B1, L.2001, Ogeden, Hill, and Benus. The number of pods per plant and the seed yield in this cluster were 9.77 and 1.73 percent higher than the mean, respectively, and the 1000 seed weight was 5.67 percent lower than the grand mean. As a whole, the yield in this cluster was at the level of the mean yield (Table 3). Cluster number two, which included the varieties Ogeden, Hill, Benus, and Telar, ranked lower than the mean regarding all yield traits. The third cluster included the varieties Lee, Dorksay 3a, L.2002, Ronak 2, 033, L.B2, and Hardi 50, in which the number of pods per plant was lower than the grand mean, but, as a whole, since the 1000 seed weight was more than that of the grand mean, the seed yield was higher than that of the grand mean, and also higher than the seed yield of varieties in clusters one and two.

Cluster analysis on the basis of mean yield, yield components, and oil and protein content

The dendrogram of the cluster analysis was mapped based on mean yield, yield components, and oil and protein content; and it was cut at points five units apart from each other (Figure 3). Results obtained showed that the lines and the varieties Lee, Dorksay 3a, Hardi 50, Scott, L.B2, Frost, L.B4, Ronak 2, L.2002 were in one group, the lines and varieties 033, L.B3, L.2001, Cooker Stewart, L.B2, Dare, 032, Dorksay 2a, B.121, Sahar, and Sari formed group 2, and the rest of the lines and the varieties constituted group 3.

The lines and varieties in cluster one had 1000 seed weight, seed yield, and oil and protein content higher than the grand means, and the means of these traits were 12.57, 16.35, 15.69, and 14.54% higher than the corresponding grand means. Therefore, these lines and varieties can be considered valuable with respect to yield and traits related to yield, and it is recommended that they be used in direct seeding or in crosses with a suitable parent to produce populations with genetic segregation and genetic mapping. The lines and varieties in cluster one had 5.3 percent fewer pods per plant than the grand mean.

The lines and varieties in cluster two had 1000 seed weight, seed yield, and oil and protein content higher than the grand means, but the mean in this group of lines and varieties was close to the grand mean.

There were four lines and varieties in group three, and these had mean yield, yield components, and oil and protein content much lower than the grand means. The number of pods per plant, the 1000 seed weight, the seed yield and oil and protein content were 5, 19.5, 25.94, 23.22, and 22.3% lower than the grand means, respectively.

4. Conclusions

The main conclusions drawn from the experiment were that:

1. The highest yield can be obtained from the lines and varieties Scott, Forest, Ronak 2, L.2002, and L.B4.

2. These lines and varieties can be used in breeding, due to the genetic distance and the diversity of the material studied.

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Table 1. Studied cultivars (24 genotypes)

No.	Cultivar	No.	Cultivar
1	BENUS	13	HILL
2	SCOTT	14	SAHAR
3	HARDI 50	15	SARI
4	COOKER STEWART	16	TELAR
5	OGEDEN	17	L.032
6	DARE	18	L.033
7	DORKSOY 2A	19	L.2001
8	FOREST	20	L.2002
9	LEE	21	L. B1
10	RONAK 2	22	L. B2
11	DORKSOY 3A	23	L. B3
12	B 121	24	L. B4

Table 2. Results of Comparison of the traits of the number of days to flowering, the number of days to the end of flowering, the length of the flowering period, the number of days to the start of pod formation, the number of days to maturity, and the height of plants in varieties studied

Cultivars	Plant Height (cm)	Days to maturity	Days to the start of pod formation	Flowering period (Day)	Days to the end of flowering	Days to flowering initiation
BENUS	122.8 b-d	172 de	70.7 p	41 d	102.5 f	61.5 fj
SCOTT	122.1 b-d	172 de	87 h	32 h	96 h	64 g
HARDI50	119.3 b-d	177.8 a	109.3 d	17 m	117.3 c	100.3 b
COOKER STEWART	112.8 c-f	171.5 ef	88.2 g	45.7 b	111.5 e	65.75 f
OGEDEN	119.9 b-d	117.8 i	64.5 r	47 a	95.7 h	48.75 l
DARE	135.7 ab	117 i	68.7 q	41.5 d	95.7 h	54.25 k
DORKSOY 2A	92.8 g-j	172.3 cd	88.7 g	29 y	95.5h	66.5 k
FOREST	103. d-h	172.3 cd	77.2 m	31.7 h	94 i	62.2 h
LEE	131.2 bc	177 b	111.5 b	44.5 c	119.5 b	75 d
RONAK 2	131.3 bc	177 b	106.5 f	35.2 e	115.3 d	80 c
DORKSOY 3A	131.6 bc	177.8 a	114.3 a	19.2 l	120.8 a	101.5 a
B 121	149.5 a	171.3 f	110.8 c	19 l	120.3 a	101.3 a
HILL	98.5 e-h	147 g	76 n	28.2 y	92.2 y	64 g
SAHAR	88.3 g-j	146.3 h	74.7 o	29 y	90 k	61 j
SARI	87.8 j	172 de	75.2 o	26.5 k	90.2 k	63.75 g
TELAR	77.5 e-h	172 de	75 o	35.5 e	90.2 k	54.7 k
L.032	98.4 d-g	172 de	79 l	32.5 h	94.5 i	62 hi
L.033	105.3 f-i	172 de	82.7 i	32.2 h	94.2 i	62 hi
L.2001	97.9 f-i	172 de	107.3 e	33.5 g	94.5 i	61 y
L.2002	95.7 f-j	172 de	109.5 d	33.5 g	94.5 i	61 y
L.B1	84.6 h-j	172 de	80.2 k	30.2 i	92 y	61.7 hi
L.B2	117.3 b-e	172 de	80.5 k	34 fg	96 y	62 hi
L.B3	118.1 b-d	172.8 c	82 y	30.2 i	94.2 i	64 g
L.B4	93.8 f-j	172.5 cd	77 m	34.7 ef	62 g	62 hi

The difference between the figures in every column that have one letter in common is not statistically significant at the level of 5% (Duncans multiple range test).

Table 3. Results of comparison of the traits of the number of pods per plant, the 1000 seed weight, the seed yield, the percentage oil and protein content in different varieties

Cultivar	Protein content of seed (%)	Oil content of seed (%)	Seed Yield Kg.h	1000 seed weight (g)	Number of pods per plant
BENUS	36.8 b-d	19.2 f	1286 k	243.9 d-h	38.2 h
SCOTT	36.3 b-d	17.8 l	2546 a	257.4 de	47.6 e-g
HARDI50	38.6 bc	16.7 p	2207 b-e	306.7 b	43.5 gh
COOKER STEWART	35 c-e	17.2 o	2013 e-h	289.9 bc	63 ab
OGEDEN	42 a	17.4 n	1607 j	197.1 jk	58 b-d
DARE	37.1 b-d	16.3 q	2079 c-h	199.7 jk	63.3 ab
DORKSOY 2A	35.7 c-e	17.5 m	2146 c-g	246.3 d-h	57.4 b-d
FOREST	34.3 de	18 k	2579 a	220.9 f-k	56.2 b-d
LEE	34.3 de	17.4 n	2429 ab	295.4 bc	56.9 b-d
RONAK 2	37.3 b-d	18 k	2610 a	320 ab	59.2 bc
DORKSOY 3A	37.3 b-d	17.8 l	2286 bc	342.5 a	54.2 cd
B 121	39.4 ab	15.9 r	2154 c-f	214.6 h-k	57.5 b-d
HILL	37.2 b-d	19.2 f	1614 j	219 f-k	59.1 bc
SAHAR	36.9 b-d	18.6 j	2018 e-h	163.4 l	63.2 ab
SARI	34.8 de	18.7 i	2268 b-d	238.4 d-l	69 a
TELAR	37.2 b-d	20.9 b	1759 fj	226.3 e-j	53.3 c-e
L.032	36.9 b-d	19.9 c	1889 hi	218 d-j	62.3 b
L.033	37 b-d	19.8 d	1903 g-i	272.0 g-k	44.7 f-h
L.2001	37.2 b-d	21.1 a	2029 d-h	187.4 cd	54.3 cd
L.2002	37.2 b-d	21.1 a	2609 a	235.7 kl	51.1 d-f
L.B1	36.7 b-d	19.6 e	1903 g-i	205.4 i-k	59.9 bc
L.B2	36.6 b-d	19.9 c	2289 bc	254.4 d-g	42.6 gh
L.B3	35.9 b-d	18.8 h	1950 f-i	239.9 d-i	46.4 fg
L.B4	32.4 e	18.9 g	2597 a	255.3 d-f	56.7 b-d

The difference between the figures in every column that have one letter in common is not statistically significant at the level of 5% (Duncans multiple range test).

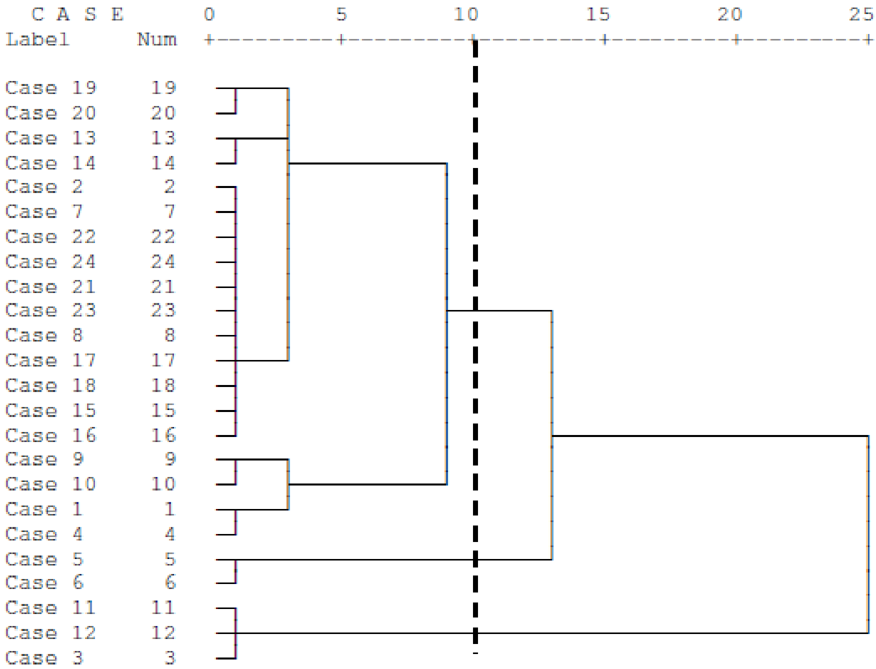

Figure 1. Dendrogram of the genotypes of soybean studied based on mean phenological traits using Wards method and the Euclidean distance

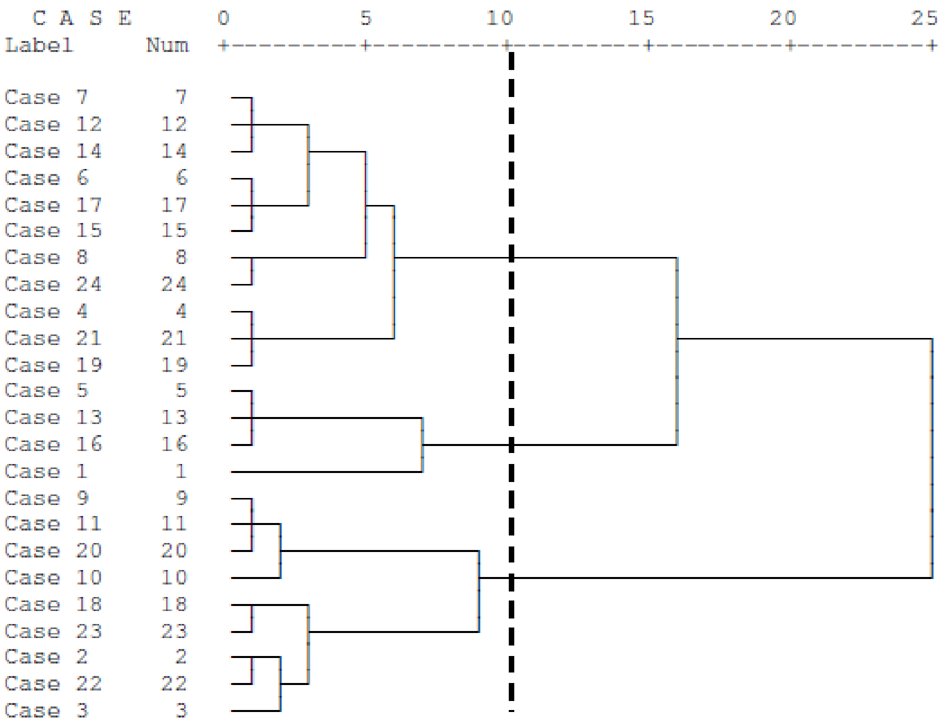

Figure 2. Dendrogram of the genotypes of soybean studied based on mean yield and yield components using Wards method and the Euclidean distance

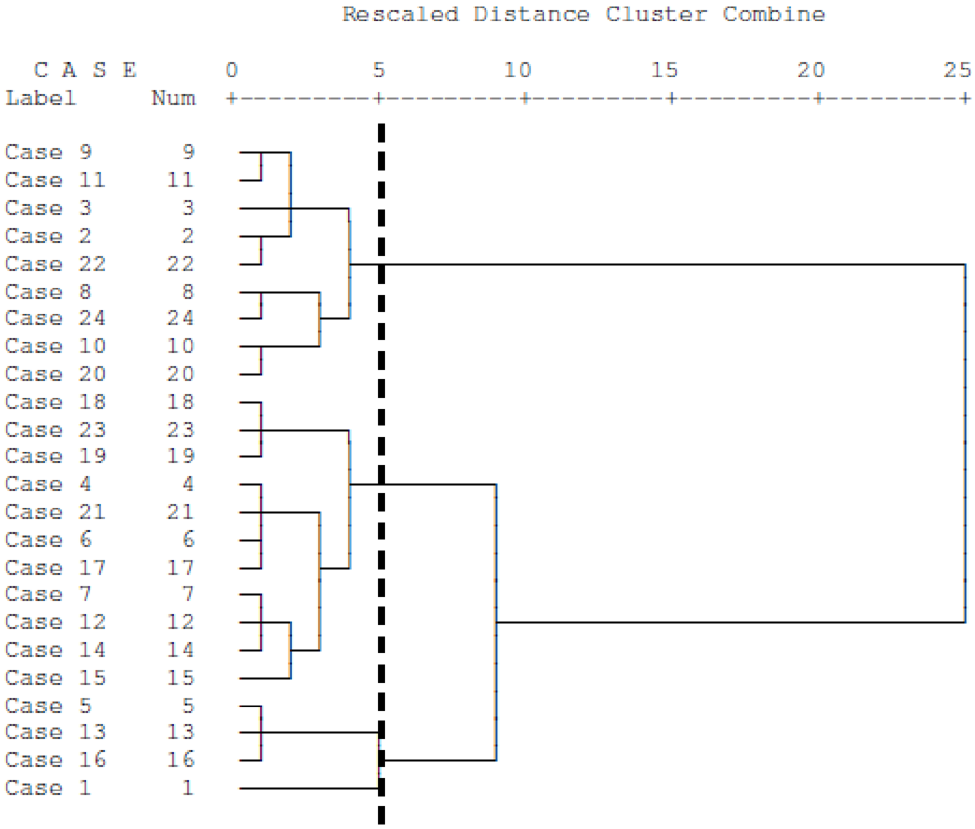

Figure 3. Dendrogram of the genotypes of soybean studied based on mean yield and yield components and oil and protein production using Wards method and the Euclidean distance

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