

## Comparison of Fresh Pod Yield and Pod Related Characteristics in Pea (*Pisum sativum* L.) Cultivars Sown in Autumn and Spring under Samsun Ecological Conditions

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**Abstract:** : In this study, 15 pea (*Pisum sativum* L.) cultivars sown in autumn and spring were investigated for their fresh pod yield and pod characteristics under Samsun ecological conditions during the 1999-2000 and 2000-2001 growing seasons. The results of the study for fresh pod yield from the combined 2 years showed that there was a statistically significant difference among the cultivars. The highest fresh pod yield was obtained from Vilmoren (17,840 kg ha<sup>-1</sup>), followed by Lancet (14,290 kg ha<sup>-1</sup>), Agromar AG 7306 (13,880 kg ha<sup>-1</sup>), Jumbo (13,830 kg ha<sup>-1</sup>), Sprinter (13,690 kg ha<sup>-1</sup>), Sugar Bon (12,370 kg ha<sup>-1</sup>), Bolero (12,800 kg ha<sup>-1</sup>) and Progress No. 9 (12,300 kg ha<sup>-1</sup>). In addition to high fresh pod yield, there are many other important factors such as low harvest cost, inflated and long pods, large fresh seeds and fresh seed yield after shelling for determining suitable cultivars. When all these factors were considered, Vilmoren, Lancet, Jumbo, Bolero, Agromar AG 7306 and Progress No. 9 cultivars were more suited to Samsun conditions than the others because of their high fresh pod yield, fresh seed yield after shelling long pods and high fresh seed percentage remaining above a 9.5 mm sieve. Fresh pod yield and pod number per plant, pod length, thickness and width for autumn sowing were significantly higher than those for spring sowing. Significantly higher seed numbers per pod and fresh seed weight to fresh pod weights were obtained from spring sowing.

**Key Words:** Pea, *Pisum sativum*, sowing time, fresh pod yield

### Samsun Ekolojik Şartlarında Sonbahar ve İlkbaharda Ekilen Bezelye (*Pisum sativum* L.) Çeşitlerinde Taze Bakla Verimi ve Bakla Özelliklerinin Karşılaştırılması

**Özet:** Bu çalışmada, 1999-2000 ve 2000-2001 yetiştirme döneminde Samsun ekolojik koşullarında sonbahar ve ilkbaharda ekilen 15 bezelye çeşidinin taze bakla verimi ve bakla özellikleri araştırılmıştır. İki yıllık birleştirilmiş deneme sonuçları, taze bakla verimi bakımından bezelye çeşitleri arasında çok önemli farklılıklar olduğunu göstermiştir. En yüksek taze bakla verimi Vilmoren (17,840 kg ha<sup>-1</sup>) çeşidinden elde edilmiştir. Bu çeşidi Lancet (14,290 kg ha<sup>-1</sup>), Agromar AG 7306 (13,880 kg ha<sup>-1</sup>), Jumbo (13,830 kg ha<sup>-1</sup>), Sprinter (13,690 kg ha<sup>-1</sup>), Sugar Bon (12,370 kg ha<sup>-1</sup>), Bolero (12,800 kg ha<sup>-1</sup>) ve Progress No. 9 (12,300 kg ha<sup>-1</sup>) çeşitleri izlemiştir. Taze bezelye üretimine uygun çeşitlerde taze bakla veriminin yüksek olması yanında, hasat maliyetinin düşük olması, çeşidin dolgun ve uzun baklalara, iri taze tohumlara ve meyve kabukları ayrıldıktan sonra yüksek taze iç verimine sahip olması gibi özellikler de istenmektedir. Tüm bu faktörler dikkate alındığında, Vilmoren, Lancet, Jumbo, Bolero, Agromar AG 7306 ve Progress No. 9 çeşitleri yüksek taze bakla verimi, taze iç verimi ve 9.5 mm elek üstü taze iç oranına sahip olmalarından dolayı Samsun koşulları için en uygun çeşitler olarak belirlenmiştir. Sonbahar ekimleri için belirlenen taze bakla verimi, bitki başına bakla sayısı, bakla uzunluğu, kalınlığı ve genişliği değerleri ilkbahar ekimlerinde belirlenenlerden çok önemli derecede yüksek bulunmuştur. Baklada tohum sayısı ve taze tohum ağırlığı/taze bakla ağırlığı oranı ise ilkbahar ekimlerinde çok önemli derecede daha yüksek olmuştur.

**Anahtar Sözcükler:** Bezelye, *Pisum sativum*, ekim zamanı, taze bakla verimi

### Introduction

The garden pea has been an important protein component of human diets for centuries, whereas animal protein is very expensive, and can take many forms

depending on the harvesting stage and the part of the plant harvested. The whole plant (immature or not) provides forage for animal feed, immature pods produce sugar peas, immature seeds produce green peas, and dry

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seeds are suitable for all other uses (Santalla et al., 2001). Several thousand varieties exist throughout the world. They can be classified into the following classes based on the main uses or market: green peas or vining peas for canning and freezing, dry peas, partly for human consumption but mostly for animal feed, forage peas, and sugar or market peas used as a fresh vegetable for human consumption (Cousin, 1997). Nowadays, peas are one of the most important canned vegetables for the food processing industry. They are easily stored in the deep-freezer by consumers. Recently, deep-freezing has become a method commonly used to store fresh pea seeds.

The garden pea is a legume crop that is grown on over 1 million ha worldwide. The sowing area of green peas in Turkey is about 9000 ha. World and Turkish production of green peas is 9,058,564 and 55,000 t, respectively (FAO, 2003). The primary pea sowing areas in Turkey are the Marmara and Aegean regions. Pea production in Samsun province (1015 t) is very limited when compared with bean production (79,882 t) (State Institute of Statistics, 2001).

Yields of grain legumes are smaller and generally more variable than those of many other crop species. In developed countries, grain yields of legumes have not increased as rapidly as those of cereal crops (Jeuffroy and Ney, 1997). Pea yields are very sensitive to high temperature and drought, especially during the flowering period (Davies et al., 1985; Thorup-Kristensen, 1998). They are planted in autumn or early spring to avoid high temperatures and drought stresses at the flowering stage, and reduced pod and seed set. Peas can be grown on a wide range of soil types, from light sandy to heavy clay. However, they prefer a light, humus-rich, non-acid loam that drains well yet retains moisture. The Black Sea region has very suitable climatic and soil conditions for successful pea production.

In contrast to beans, one of the most widely grown vegetables in Samsun, peas can be grown in the winter, from the end of autumn to the middle of spring, without irrigation. Usually, the fields are fallow at that time if summer crops are to be planted. The crop cycle for peas is completed before the spring and summer crops are planted. Although local pea varieties, most of which are field peas with colored flowers, have traditionally been grown by Black Sea region subsistence farmers in small gardens, a limited number of commercial garden pea

cultivars are cultivated for their fresh pods or seeds in Samsun province. The agronomic problems associated with pulse crops differ between geographical areas (Jeuffroy and Ney, 1997). The objective of this study was to evaluate and compare 15 pea cultivars sown in autumn and spring under Samsun ecological conditions for fresh pod yield and pod related characteristics. The other aim of the study was to be able to recommend new registered pea cultivars for growers.

## Materials and Methods

This study was carried out in the experimental area of the Karadeniz Agricultural Research Station in Samsun, Turkey, during the 1999-2000 and 2000-2001 growing seasons. The soil texture of the experimental area, which was rich in phosphorus and potassium, medium in organic matter and without lime and salt in both years, was clay. Soil pH was 7.65 and 7.40 for the 1999-2000 and 2000-2001 seasons, respectively.

Monthly total rainfall (mm) and average temperature (°C) for both years and the long term period (from 1974 to 2001) are shown in Figures 1 and 2. Monthly total rainfall for each year was significantly different from that for the long term period (Figure 1). However, the average temperature (°C) was similar to those of the 2 years (Figure 2).

The study was planned in a split plot design in randomized complete blocks with 3 replications. Sowing times (spring and autumn) were allocated to main plots and pea cultivars to subplots. Autumn sowings were performed on November 12, 1999, and November 11, 2000. Spring sowings were on March 28, 1999, and March 12, 2000. Plots were 1.6 m x 4 m with 4 rows spaced 40 cm apart and with 5 cm between plants. All plots were fertilized at the time of sowing with 60 kg of  $P_2O_5$  ha<sup>-1</sup> in triple superphosphate form and 40 kg of N ha<sup>-1</sup> in ammonium sulfate form. Fifteen cultivars and their entry numbers, names and some of their characteristics are given in Table 1. Sprinter, widely grown in Samsun, was used as the control. Eight replicated 100-seed lots were weighed separately using a 0.01 decimal digital balance. Then, the average of these weighings was expressed as 100-seed weight and recorded in grams (ISTA, 1985a, 1985b). Days to flowering were recorded when 50% of plants flowered in the plots. This was expressed as days from sowing to flowering (IBPGR,

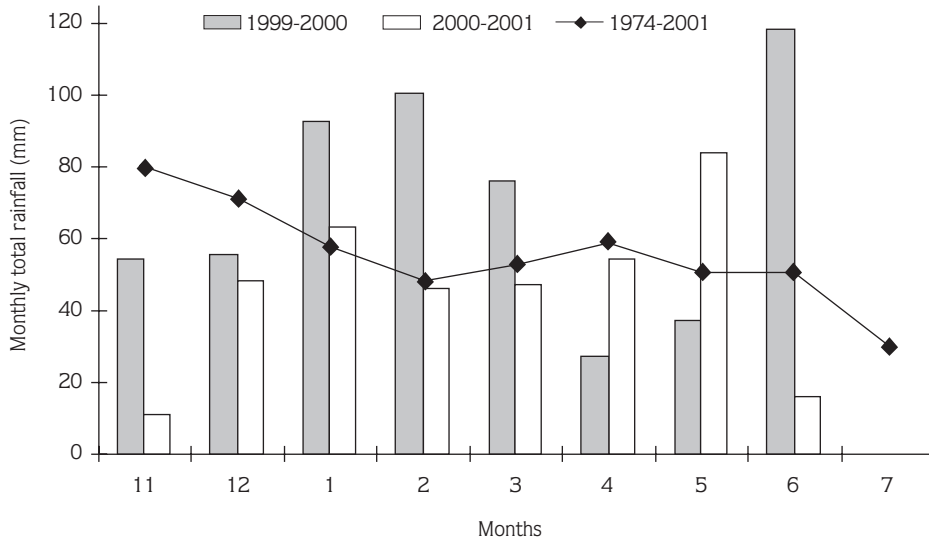


Figure 1. Monthly total rainfall (mm) in both years and over the long term.

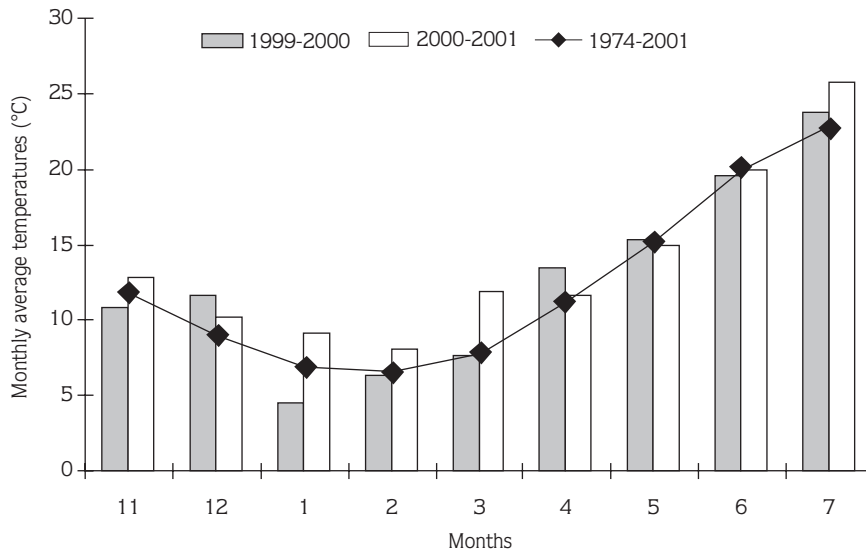


Figure 2. Monthly average temperature (°C) in both years and over the long term.

1985). The mean of 10 plants and 10 pods per plant (total 100 pods) was calculated for the metric traits. Pods per plant, pod length, pod thickness and pod width, and seeds per pod were recorded numerically. Fresh seed proportions remaining above a 9.5 mm sieve and below a 7.5 mm sieve and fresh seed weight to fresh pod weight proportions were recorded in percent (%). Fresh pod yield was recorded in kilograms per hectare.

Data from the 2 years combined were subjected to analysis of variance using the MSTATC program and means showing significance were compared using Duncan's multiple range test.

### Results and Discussion

There was a statistically significant difference ( $P < 0.01$ ) among cultivars in terms of days to flowering.

Table 1. The entry numbers, names, and some characteristics of pea cultivars used in the study.

| Entry no. | Name of cultivar     | Testa color | Seed shape | 100-seed weight (g) |
|-----------|----------------------|-------------|------------|---------------------|
| 1         | Agromar AG 7306      | Light green | Wrinkled   | 27.50               |
| 2         | Bolero               | Light green | Wrinkled   | 20.12               |
| 3         | Erbse Norli          | Cream       | Round      | 15.72               |
| 4         | Feltham First        | Light green | Round      | 40.70               |
| 5         | Green Pearly         | Dark green  | Wrinkled   | 17.52               |
| 6         | Karina               | Light green | Wrinkled   | 21.26               |
| 7         | Kelvedon Wonder      | Dark green  | Wrinkled   | 24.32               |
| 8         | Kleine Rheinlanderin | Dark green  | Round      | 24.88               |
| 9         | Lancet               | Dark green  | Wrinkled   | 22.90               |
| 10        | Jof                  | Dark green  | Wrinkled   | 16.34               |
| 11        | Jumbo                | Light green | Wrinkled   | 31.98               |
| 12        | Progress No. 9       | Light green | Wrinkled   | 34.12               |
| 13        | Sprinter             | Light green | Wrinkled   | 19.50               |
| 14        | Sugar Bon            | Light green | Wrinkled   | 24.70               |
| 15        | Vilmoren             | Light green | Wrinkled   | 33.22               |

The shortest and longest days to flowering for cultivars were determined in Karina (75.25 days) and Vilmoren (86.67 days), respectively. A highly significant interaction was found between cultivar and sowing time. Days to flowering in autumn sowing ranged from 102.67 days (Karina) to 112.83 days (Agromar AG 7306). This period in spring sowing varied between 47.17 days (Kleine Rheinlanderin) and 62.17 days (Jumbo). The difference

between autumn and spring sowings in terms of days to flowering was significant ( $P < 0.01$ ). Days to flowering in autumn sowing (108.73 days) was longer than that in the spring sowing (54.01 days) (Figure 3). Flowering usually begins 40 to 50 days after planting (McKay et al., 2003). Thorup-Kristensen (1998) reported that days to the onset of flowering ranged from 44 to 58 days among pea genotypes.

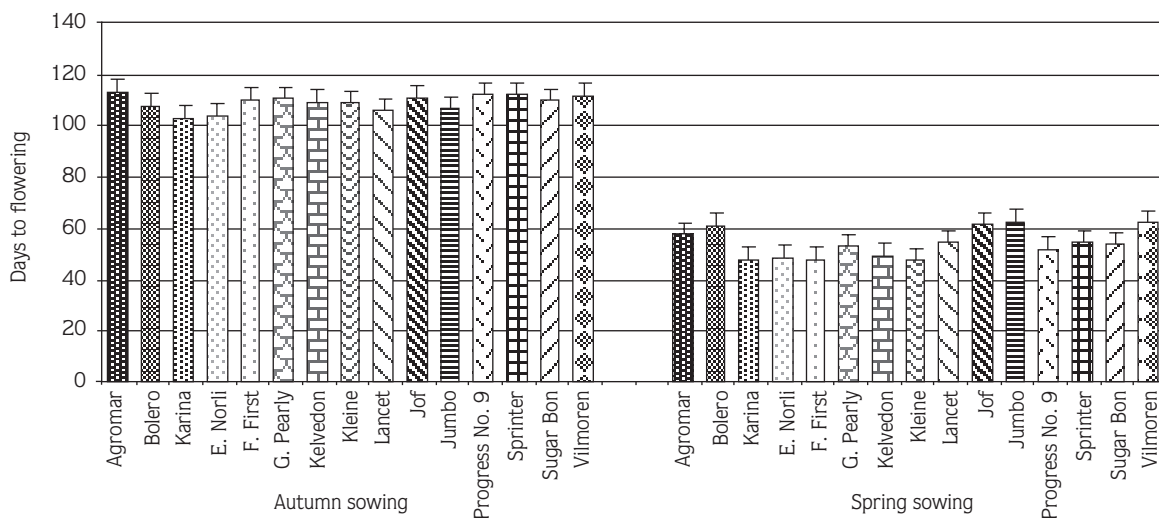


Figure 3. Days to flowering of pea cultivars sown in autumn and spring. Vertical bars indicate standard errors of the mean.

Pods per plant has an important effect on fresh pod yield in green pea production, and showed a significant difference between the sowing times ( $P < 0.05$ ). Pods per plant obtained from autumn sowing (12.16 pods per plant) was higher than that from spring sowing (8.50 pods per plant). Pods per plant ranged from 7.52 (Green Pearly) to 15.13 pods per plant (Sugar Bon). The most productive pea cultivars in terms of pods per plant were Sugar Bon, Bolero, Lancet, Sprinter and Vilmoren (15.13, 13.85, 12.90, 12.63 and 12.47 pods per plant, respectively). However, there was a large difference in Sugar Bon for pods per plant in terms of sowing times. Sugar Bon also had undesirable pod characteristics such as small seeds and constricted pods. There was a significant interaction ( $P < 0.01$ ) between sowing time and cultivar for pods per plant (Table 2).

It was determined that there were longer pods (8.72 cm) in autumn sowing than in spring sowing (7.96 cm) ( $P < 0.01$ ). Differences among the pea cultivars in terms of pod length were significant ( $P < 0.01$ ) and pod length ranged from 6.83 cm to 10.08 cm. Vilmoren (10.08 cm), Jumbo (9.86 cm) and Agromar AG 7306 (9.79 cm) pods were the longest, followed by Progress No. 9 (9.13

cm) (Table 2). The results obtained by Paksoy et al. (1995) for pod length were in agreement with ours.

The study demonstrated that pod thickness was significantly influenced ( $P < 0.01$ ) by sowing time. Thicker pods were obtained from autumn sowing (12.10 mm) compared with spring sowing (11.09 mm). Differences among cultivars in terms of pod thickness were significant ( $P < 0.01$ ). Pod thickness ranged from 9.82 mm to 14.01 mm. The thickest pods were in the Jumbo (14.01 mm) and Agromar AG 7306 (13.44 mm) cultivars. These were followed by Progress No. 9 (12.84 mm), Vilmoren (12.29 mm) and Green Pearly (12.27 mm) (Table 2).

The effect of sowing season on pod width was significant ( $P < 0.01$ ). Pod width in spring sowing (13.27 mm) was greater than that in autumn (14.41 mm). Pod width varied between 16.91 mm (Jumbo) and 11.69 mm (Erbse Norli) (Table 2). The cultivars with the widest pods were Jumbo, Agromar AG 7306, Vilmoren, Progress No. 9 and Green Pearly (16.91, 16.37, 16.18, 16.02 and 15.97 mm, respectively).

It has been reported that the number of seeds per pod ranges from 1 to 12 in cultivated peas (Şehirali, 1988;

Table 2. Pods per plant, pod length, pod thickness and pod width of pea cultivars sown in autumn and spring.

| Entry no. | Pods per plant |          |          | Pod length (cm) |        |          | Pod thickness (mm) |          |           | Pod width (mm) |        |          |
|-----------|----------------|----------|----------|-----------------|--------|----------|--------------------|----------|-----------|----------------|--------|----------|
|           | Autumn         | Spring   | Mean     | Autumn          | Spring | Mean     | Autumn             | Spring   | Mean      | Autumn         | Spring | Mean     |
| 1         | 9.34d-g**      | 7.21efg  | 8.28ef** | 10.26           | 9.32   | 9.79ab** | 14.67ab**          | 12.21c-g | 13.44ab** | 16.72          | 16.01  | 16.37a** |
| 2         | 15.44b         | 12.27b-e | 13.85ab  | 8.48            | 7.54   | 8.01def  | 11.41e-i           | 10.38hi  | 10.89ef   | 13.60          | 12.52  | 13.06bc  |
| 3         | 9.17d-g        | 10.39c-g | 9.78c-f  | 7.90            | 6.90   | 7.40fgh  | 9.88i              | 9.76i    | 9.82f     | 12.76          | 10.62  | 11.69c   |
| 4         | 13.86bcd       | 8.88d-g  | 11.37b-e | 8.63            | 7.52   | 8.08def  | 10.92f-i           | 10.79f-i | 10.85ef   | 12.75          | 12.41  | 12.58bc  |
| 5         | 9.64d-g        | 5.40g    | 7.52f    | 8.47            | 7.78   | 8.12def  | 13.09cde           | 11.46d-i | 12.27cd   | 17.27          | 14.67  | 15.97a   |
| 6         | 8.47efg        | 8.54efg  | 8.50ef   | 7.25            | 6.40   | 6.83h    | 12.43c-f           | 10.54ghi | 11.49de   | 13.66          | 12.59  | 13.12bc  |
| 7         | 9.70d-g        | 6.81fg   | 8.26ef   | 8.87            | 8.10   | 8.48cd   | 12.40c-f           | 10.60ghi | 11.50de   | 14.82          | 12.61  | 13.71b   |
| 8         | 10.00d-g       | 7.02efg  | 8.51ef   | 7.83            | 7.42   | 7.63efg  | 11.10f-i           | 9.88i    | 10.49ef   | 13.46          | 12.76  | 13.11bc  |
| 9         | 15.86b         | 9.95d-g  | 12.90abc | 8.58            | 7.42   | 8.00def  | 11.94c-h           | 11.09f-i | 11.51de   | 12.59          | 11.49  | 12.04c   |
| 10        | 11.71b-f       | 7.06efg  | 9.38def  | 8.55            | 8.01   | 8.28de   | 10.59ghi           | 10.42hi  | 10.51ef   | 13.63          | 12.16  | 12.89bc  |
| 11        | 8.87d-g        | 6.72fg   | 7.79ef   | 10.25           | 9.46   | 9.86ab   | 14.94a             | 13.09b-e | 14.01a    | 17.51          | 16.30  | 16.91a   |
| 12        | 8.26efg        | 8.94d-g  | 8.60ef   | 8.74            | 9.53   | 9.13bc   | 13.15bcd           | 12.52c-f | 12.84bc   | 16.46          | 15.59  | 16.02a   |
| 13        | 15.06bc        | 10.20c-g | 12.63a-d | 9.06            | 7.69   | 8.37cde  | 11.29f-i           | 11.24f-i | 11.27de   | 12.05          | 11.93  | 11.99c   |
| 14        | 21.64a         | 8.63d-g  | 15.13a   | 7.28            | 6.84   | 7.06gh   | 10.45ghi           | 11.03f-i | 10.74ef   | 12.02          | 11.79  | 11.91c   |
| 15        | 15.41b         | 9.54d-g  | 12.47a-d | 10.68           | 9.49   | 10.08a   | 13.21bc            | 11.37f-i | 12.29cd   | 16.81          | 15.55  | 16.18a   |
| Mean      | 12.16a*        | 8.50b    |          | 8.72a**         | 7.96b  |          | 12.10a**           | 11.09b   |           | 14.41a**       | 13.27b |          |

\* and \*\*  $P < 0.05$  and  $P < 0.01$ , respectively

Vural et al., 2000). Seed number per pod has an important effect on pea yield (Apan, 1974). Pea cultivars with high seed numbers per pod are demanded by commercial growers. The number of seeds per pod was lower ( $P < 0.05$ ) in autumn sowing (6.00 seeds per pod) than in spring sowing (6.43 seeds per pod). Seeds per pod ranged from 5.13 to 7.43. Cultivars had a significant effect ( $P < 0.01$ ) on seeds per pod. The best pea cultivars for seeds per pod were Jof (7.43 seeds per pod) and Bolero (7.26 seeds per pod) (Table 3).

There was no significant difference between sowing times for the fresh seed portion remaining above a 9.5 mm sieve. In contrast, it was determined that there was a significant difference ( $P < 0.01$ ) among pea cultivars. Progress No. 9 (97.41%), Jumbo (95.37%), Kelvedon Wonder (95.27%), Agromar AG 7306 (91.34%) and Green Pearly (87.43%) were determined as the largest seeded cultivars. They had the largest seeds in both autumn and spring sowings. Fresh seed percentages varied between 48.40% (Erbse Norli) and 97.41% (Progress No. 9). There was a highly significant ( $P < 0.01$ ) interaction between cultivar and sowing time (Table 3). It was determined that some cultivars had a high fresh seed percentage above a 9.5 mm sieve in autumn sowing while

others had a high percentage in spring sowing. The highest percentage was obtained from Progress No. 9 (98.85%) in spring sowing. Highly significant differences ( $P < 0.01$ ) in terms of fresh seed percentage over a 7.5 mm sieve were found among the cultivars. The highest values were found in Sugar Bon (10.90%) and Erbse Norli (8.36%), whereas Progress No. 9 (0.58%), Jumbo (0.82%) and Kelvedon Wonder (0.82%) had the lowest percentages. Sowing times had no significant effect on this variable (Table 3). Pekşen et al. (2002) reported that the fresh seed percentage remaining above a 9.5 mm sieve was significantly higher in spring sowing (72.86%) than in autumn sowing (57.59%). Fresh seed percentage under 7.5 mm was determined as 3.33% in spring sowing and 19.81% in autumn sowing. The percentage of fresh seed weight to total pod weight in autumn sowing (50.69%) was greater than that in spring sowing (43.69%).

A high fresh seed weight to fresh pod weight ratio is a desirable property. In general, the pod shell is thinner in cultivars with a high fresh seed weight to fresh pod weight ratio than in those with a low fresh seed weight to fresh pod weight ratio. Sowing times had a highly

Table 3. Seeds per pod, fresh seed above 9.5 mm and below 7.5 mm percentage of pea cultivars sown in autumn and spring.

| Entry no. | Seeds per pod |        |           | Fresh seed above 9.5 mm (%) |          |           | Fresh seed below 7.5 mm (%) |         |           |
|-----------|---------------|--------|-----------|-----------------------------|----------|-----------|-----------------------------|---------|-----------|
|           | Autumn        | Spring | Mean      | Autumn                      | Spring   | Mean      | Autumn                      | Spring  | Mean      |
| 1         | 5.90          | 6.86   | 6.38b-e** | 92.06a-d**                  | 90.62a-e | 91.34ab** | 2.61d-g**                   | 0.42fg  | 1.40def** |
| 2         | 7.27          | 7.26   | 7.26ab    | 77.41c-g                    | 64.29ghi | 70.85bcd  | 3.04c-g                     | 4.66b-e | 3.84cd    |
| 3         | 5.21          | 5.26   | 5.23g     | 56.83hi                     | 39.96j   | 48.40g    | 5.65bcd                     | 11.53ab | 8.36ab    |
| 4         | 6.49          | 6.82   | 6.66a-d   | 71.51fgh                    | 87.74b-f | 79.62cde  | 2.80c-g                     | 0.93efg | 1.79c-f   |
| 5         | 4.76          | 5.49   | 5.13g     | 83.12a-e                    | 91.73a-e | 87.43abc  | 3.16c-g                     | 2.20d-g | 2.65c-f   |
| 6         | 5.69          | 5.99   | 5.84d-g   | 82.92c-g                    | 77.69c-g | 80.30ef   | 4.19c-g                     | 2.38d-g | 3.24cde   |
| 7         | 5.69          | 5.72   | 5.71efg   | 96.46ab                     | 94.08ab  | 95.27a    | 0.93efg                     | 0.71efg | 0.82ef    |
| 8         | 5.74          | 6.19   | 5.97c-g   | 63.64ghi                    | 71.69fgh | 67.67f    | 6.50a-d                     | 3.75c-g | 5.05bc    |
| 9         | 6.60          | 6.69   | 6.65a-d   | 76.92d-g                    | 77.29d-g | 77.10def  | 4.15c-g                     | 3.75c-g | 3.97cd    |
| 10        | 7.01          | 7.85   | 7.43a     | 70.88fgh                    | 65.95ghi | 68.42f    | 3.93c-g                     | 2.68d-g | 3.28cde   |
| 11        | 5.73          | 6.70   | 6.21c-f   | 95.11ab                     | 95.63ab  | 95.37a    | 1.46d-g                     | 0.25g   | 0.82ef    |
| 12        | 4.90          | 6.48   | 5.69efg   | 95.97ab                     | 98.85a   | 97.41a    | 0.90efg                     | 0.27g   | 0.58f     |
| 13        | 6.81          | 6.86   | 6.83abc   | 70.47fgh                    | 76.21efg | 73.34ef   | 4.52c-f                     | 3.62c-g | 4.06bcd   |
| 14        | 7.08          | 6.56   | 6.82abc   | 50.09ij                     | 57.89hi  | 56.99g    | 13.21a                      | 8.79abc | 10.90a    |
| 15        | 5.10          | 5.74   | 5.42fg    | 94.80ab                     | 73.08fg  | 83.94bcd  | 0.51fg                      | 3.24c-g | 1.72c-f   |
| Mean      | 6.00b*        | 6.43a  |           | 78.94                       | 77.51    |           | 3.45                        | 2.80    |           |

\* and \*\*  $P < 0.05$  and  $P < 0.01$ , respectively



significant ( $P < 0.01$ ) effect on fresh seed weight to fresh pod weight ratios. The means for fresh seed weight to fresh pod weight ratios (60.07%) in spring sowing were higher than those in autumn sowing (48.38%). The highest fresh seed weight to fresh pod weight ratio was obtained from Kleine Rheinlanderin (60.64%), but this cultivar was not stable in terms of this value. This was followed by Bolero (60.07%). A significant interaction was found between pea cultivars and sowing times. Kleine Rheinlanderin had the highest fresh seed weight to fresh pod weight ratio when it was sown in spring (72.71%). The cultivar with the highest fresh seed weight to fresh pod weight ratio in autumn sowing was Bolero (58.25%) (Table 4).

Sowing time had a highly significant effect on fresh pod yield ( $P < 0.01$ ). Fresh pod yield (13,353 kg ha<sup>-1</sup>) in autumn sowing was higher than that in spring sowing (9273 kg ha<sup>-1</sup>) (Table 4). The number of pods per plant was higher in autumn sowing than that in spring sowing. Autumn sowing also produced pods which were longer,

thicker and wider than those in spring sowing. Results reported by Gülümser et al. (1994) were in agreement with our findings. They reported that the fresh pod yield in winter sowing was significantly higher than that in spring sowing.

Fresh pod yield was influenced by cultivar ( $P < 0.01$ ). The highest fresh pod yield was obtained from Vilmoren (17,840 kg ha<sup>-1</sup>), which also had the longest and widest pods, followed by Lancet, Agromar AG 7306, Jumbo and Sprinter (14,290, 13,880, 13,830 and 13,690 kg ha<sup>-1</sup>, in that order). Erbse Norli (6704 kg ha<sup>-1</sup>), Green Pearly (7000 kg ha<sup>-1</sup>) and Karina (7437 kg ha<sup>-1</sup>) had the lowest fresh pod yields. A highly significant interaction was found between cultivars and sowing times. When we compared all combinations for cultivar x sowing time, and interaction means, the highest fresh pod yield was obtained from Vilmoren (22,080 kg ha<sup>-1</sup>) and Lancet (18,570 kg ha<sup>-1</sup>) when sown in autumn. Except for Erbse Norli and Progress No. 9, fresh pod yield in autumn sowing was higher than that in spring sowing (Table 4).

Table 4. Fresh seed weight to fresh pod weight ratio and fresh pod yield of pea cultivars sown in autumn and spring.

| Entry no. | Fresh seed weight to fresh pod weight ratio (%) |          |          | Fresh pod yield (kg ha <sup>-1</sup> ) |            |            |
|-----------|---|----------|----------|--|------------|------------|
|           | Autumn  | Spring   | Mean     | Autumn                                 | Spring     | Mean       |
| 1         | 43.41jk**                                       | 50.52f-k | 46.97d** | 15,960 bcd**                           | 11,800 d-h | 13,880 b** |
| 2         | 58.25c-g  | 61.89b-e | 60.07ab  | 14,910 b-e                             | 10,700 e-j | 12,800 bc  |
| 3         | 48.78c-k  | 57.48c-h | 53.13a-d | 6472 i-j                               | 6935 h-j   | 6704 e     |
| 4         | 53.76d-j  | 64.65a-d | 59.21ab  | 13,110 c-g                             | 9158 f-j   | 11,140 bcd |
| 5         | 43.70jkl  | 57.87c-h | 50.73cd  | 8063 g-j                               | 5937 j     | 7000 e     |
| 6         | 46.66h-k  | 70.86ab  | 58.76ab  | 8846 f-j                               | 6028 j     | 7437 e     |
| 7         | 47.07g-k  | 67.02abc | 57.04abc | 9290 f-j                               | 7304 h-j   | 8297 de    |
| 8         | 48.56g-k  | 72.71a   | 60.64a   | 10,100 e-j                             | 6760 h-j   | 8430 de    |
| 9         | 49.37g-k  | 60.76b-f | 55.07abc | 18,570 ab                              | 10,020 e-j | 14,290 b   |
| 10        | 54.68d-l  | 62.14b-e | 58.41ab  | 11,570 d-i                             | 7795 h-j   | 9683 cde   |
| 11        | 40.66k  | 51.44e-k | 46.05d   | 15,940 bcd                             | 11,710 d-h | 13,830 b   |
| 12        | 44.96jkl  | 60.73b-f | 52.84bcd | 11,420 d-i                             | 13,190 c-g | 12,300 bc  |
| 13        | 50.04f-k  | 56.60c-h | 53.32a-d | 16,830 bc                              | 10,540 e-j | 13,690 b   |
| 14        | 53.27e-j  | 57.01c-h | 55.14abc | 17,120 bc                              | 7634 h-j   | 12,370 bc  |
| 15        | 42.72jkl  | 49.43g-k | 46.08d   | 22,080a                                | 13,600 c-f | 17,840 a   |
| Mean      | 48.38b**  | 60.07a   |          | 13,353 a**                             | 9273 b     |            |

\* and \*\*  $P < 0.05$  and  $P < 0.01$ , respectively

Vural et al. (2000) reported that fresh pod yield and fresh seed yield ranged from 15,000 to 20,000 kg ha<sup>-1</sup> and 5000 to 8000 kg ha<sup>-1</sup>, respectively. Apan (1974) reported that fresh pod yield for used cultivars was between 2755 kg ha<sup>-1</sup> and 5388 kg ha<sup>-1</sup>. Eşiyok and Duman (1992) found that highest and lowest yields were 4330 kg ha<sup>-1</sup> and 1257 kg ha<sup>-1</sup>, respectively, when cultivars were harvested by hand, and 6970 kg ha<sup>-1</sup> and 15,390 kg ha<sup>-1</sup> for machine harvesting. In a study carried out under Çukurova conditions, it was determined that fresh yields of 15 pea cultivars ranged from 3080 kg ha<sup>-1</sup> to 12,790 kg ha<sup>-1</sup> (Paksoy et al., 1995). Fresh pod yields in the present study were higher than those in these studies.

In temperate areas, peas, which are a cool season crop, can be cultivated in winter and early spring when fields are not planted. If peas are planted in autumn, fields that are fallow until the middle or end of spring can be use more productively. This study determined that some commercial pea cultivars were suitable for Samsun ecological conditions. In autumn sowing in particular,

Vilmoren, Lancet, Sugar Bon, Sprinter, Agromar AG 7306, Jumbo and Bolero had higher fresh pod yields than did the other cultivars. However, high fresh pod yield was not the only determining factor in identifying suitable cultivars for the region. The labor cost in harvesting by hand is the largest outlay in pea production for fresh seeds and pods in Samsun, because no machine harvesting is carried out. A laborer can collect more fresh pods from larger podded pea cultivars than from smaller ones in a day. In addition to high fresh pod yields, regional farmers also prefer pea cultivars with long pods, large fresh seeds and more seeds per pod to reduce high harvest costs. Large seeded and inflated podded pea cultivars are also preferred in local markets by consumers.

In conclusion, Vilmoren, Lancet, Jumbo, Bolero, Agromar AG 7306 and Progress No. 9 cultivars are recommended for fresh pod production under Samsun ecological conditions because of their high fresh pod yields, long pods and high fresh seed percentage that remained above a 9.5 mm sieve.

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