



Research Article

Morphological Characterization of the Diversity of Selected High-Yielding Pea Varieties in Khyber Pakhtunkhwa, Pakistan

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Abstract | The morphological characterization of high-yielding pea varieties is essential for enhancing agricultural productivity and food security. Its production needs to be increased further in line with the global population. The current investigation evaluates morphology, seed yield, and yield components to maximize pea cultivars' performance. The present research was done to assess the yield production of eleven different pea varieties as PL8, PL3, pL4, PL7, Meteor, PL6, PL11, PL2 (4), PL2, PL19, and Climax were grown in an experimental Field at the University of Malakand. Many quantitative characteristics such as the number of leaves, leaf size, leaf color, venation, leaf arrangement on stem, leaf Margins, fresh leaf weight, plant height, number of branches, nods, types of flowers, inflorescence, flower color, pods number, length of pod, seed number per pod, weight of each pod, weight 10 pods, 100 seeds weight and total yield per plant has been investigated. Compared to other alternatives, variety PL8 had the greatest number of leaves. On the other hand, the yield an important factor was also recorded for all of the selected varieties. The variety PL8 can produce higher green pod yields, pod number per plant, pod length, seed number per pod, and hundred seed weight compared to other alternatives. The result showed that among the eleven different high-yielding pea varieties, the PL-8 variety recognized a significantly higher yield than the rest.

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Keywords | Pea varieties, Yield, Morphology, Climax, Diversity



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Introduction

An essential annual cool-season vegetable, peas are a healthy leguminous seed crop that is frost-hardy and extensively grown for their green pods across the world. It is mostly planted in temperate

countries because it is a cool-season crop (Singh *et al.*, 2023). Pea is a fast-growing, annual herbaceous plant that requires the trellis to support growth. *Pisum sativum* is a cool-season vegetable belonging to the family Fabaceae (formerly Leguminosae). It is grown in temperate zones, at higher elevations, or during

cool seasons in warm zones worldwide (Elzebroek and Wind, 2008). The most significant cool-season seed crop is the field pea (*Pisum sativum* L.), a single self-pollinated diploid ($2n=14$) annual that is prized as a high-protein snack (Mckay, 2003). Most of the world's colder temperate zones and the highlands of tropical regions are home to its cultivation. The crop can be grown in a variety of soil types, from heavy clays to light sandy loams, although it cannot withstand salinity or wet soil (Food and Agriculture Organization, 2012). The pH of soil ranges from 5.5 to 6.5. Aside from comprising little in the way of iron, it was abundant in protein (25%) amino acids, sugars (12%), carbohydrates, vitamins A and C, calcium, and phosphorus. Due to the substantial amount of protein, they contain, peas are a beneficial vegetable. The pods of peas contain a great amount of carbohydrates and protein. Pea is considered one of the most important sources of human food nutrition throughout the world. Tryptophan and lysine, two amino acid levels that are comparatively low in cereal grains, are high in peas. A pea's nutritional benefits make it a major winter vegetable crop in Pakistan. Similar to pulses, peas are an excellent source of protein because they include important amino acids like tryptophan and lysine, which are lacking in grains (Roy *et al.*, 2010; Singh, 2017). In addition to that, it also contains dietary fibers and antioxidants used as animal feed (Iqbal *et al.*, 2006; Jahreis *et al.*, 2016; Bessada *et al.*, 2019). In Pakistan, 144422 tons of peas were produced from an area of 22436 hectares during 2015-16 with an average green pod yield of 6.44 t/ha (Chisti *et al.*, 2018). In Punjab, its production is 112267 tones from an area of 17644 during 2015-16. Punjab province has a lion's share in pea area 78.6% and production 77.7 % (Fruits, Vegetables and Condiments Statistics of Pakistan, 2015-16). A decrease in per acre average yield (6.44 T/ha) in Pakistan is associated with a lack of disease-resistant and high-yielding varieties along with the use of appropriate production technology. Keeping in view the scenario the high-yielding variety PL8 was originally developed through morphological characterization of yield production at a Research field, in the University of Malakand, Khyber Pakhtunkhwa, Pakistan. This variety is suitable for high-yielding, normal planting with the potential to tolerate against diseases in comparison with existing pea varieties. The main objectives of this study are to examine the diversity among the various pea varieties demonstrate superior characteristics contributing to increase the crops productivity.

Materials and Methods

Experimental site

The research experiment was carried out to examine the high yielding pea varieties on the development and production attributes of field pea cultivars during Rabi year 2019 at the experimental fields of the University of Malakand. The latitude, longitude, and altitude of the experimental sites are 34.6692 degrees N, 72.0621 degrees E, and 844m/2769 feet, respectively.

Seed collection

First of all, we collected seeds of eleven varieties of peas, from the seed bank of the National Agriculture Research Center (NARC). There were eleven lines of different pea varieties and consisted of only one plot. Different varieties of pea such as PL8, PL3, pL4, PL7, Meteor, PL6, PL11, PL2 (4), PL2, PL19 and Climax were grown in experimental field.

Field preparation

The selected experimental land was well plowed, the clods were crushed, and the weeds were removed by leveling the land to make the soil surface leveled for uniform irrigation and fertilizer distribution. Relying on the crops demands, irrigations were applied every seven to fifteen days. The crop was planted in October 2019 on well-prepared beds. During the entire growing period of the crop, no pesticide was sprayed in the experimental field. The field was also avoided from being poorly drained just to reduce the incidence of seed and seedling diseases.

Experimental design

The experiment design was laid in a field plot to grow eleven different varieties of pea plants. Eleven different varieties such as PL8, PL3, pL4, PL7, Meteor, PL6, PL11, PL2 (4), PL2, PL19 and Climax were grown in experimental plots. The experimental plot was 8m in length and 3m in width. The experimental plot consisted of eleven lines. In every line, every variety was sowed. There was a 3 m row length and a 30 cm gap between each row. Throughout the growing period, standard agronomic procedures were followed.

Seed sowing

First of all, we took eleven different varieties of pea seeds which were sown in the experimental field. The seeds were sown in conditions of organic farming without the use of any fertilizers and pesticides.

Weeds were controlled mechanically during the growth period. Each seed was depth in soil up to 1.5-2.5 inches. Seeds were sown in October, and after 15 days seedlings emerged in the field.

Soil preparation

Soil was selected from the research field of the Department of Botany, University of Malakand. Under normal climatic and soil conditions eleven different pea varieties were grown. The soil was mixed, aerated, fertile, well-drained, high in organic matter, and loamy which is the best soil for pea plant growth. Soil pH was 6. The optimum temperature for pea plant growth ranges from 4-5 degrees centigrade was maintained.

Germination

Under our field observation, a young and juvenile seedling appeared within 9 days after sowing. The seedling was too thin and delicate to be observed. They were being provided with all the necessities and needs that any plant requires for their growth. The climate was suitable for the germination of pea seeds, light was suitable and full for germination and growth, an ideal pH for pea plant germination is 5.5 to 6.5, optimum temperature range of 4-5 degrees centigrade was also suitable for germination of pea plant. After all the suitable conditions pea will sprout (put forth shoots) in 21 to 30 days.

Plant material and growth conditions

For healthy germination, plants need various macro and micronutrients. The soil provided these nutrients because the soil was loamy soil and rich in nutrients. Generally, an optimum pH is necessary for healthy germination so soil pH is also checked by dissolving one gram of soil in distilled water and then checking by pH meter. From germination to maturity, the plot was regularly watered according to the needs of plants. After providing all the required conditions it was observed that the young plantlet was very normal having proper leaves, stem size, and height which confirms the normality of roots. In terms of the duration of available light, it was a neutral daylight at the time of germination i.e. length of the day was almost equal to the length of the night. The optimum temperature for the growth of the pea seed was maintained at the experimental plot.

Results and Discussion

During our experimental work, we grew eleven

different varieties of pea plants such as PL8, PL3, PL4, PL7, Meteor, PL6, PL11, PL2 (4), PL2, PL19 and Climax. We have eleven lines of these pea varieties. We examined several Attributes/Traits in these plants such as plant height, number of branches, nodes, number of leaves, leaf size, leaf length, leaf width, leaf color, venation, leaf arrangement on stem, leaf margins, fresh leaf weight, types of flowers, inflorescence, color of flower, number of pods per plant, pod length, number of seeds per pod, weight of each pod, weight 10 pods and 100 seeds weight.

Number of leaves

One significant factor influencing the fresh pod yield of green pea cultivation is the number of leaves per plant. The number of leaves per plant is shown in the following table. Eleven pea leaf variants were contrasted. Table 1 shows that there was a statistically significant variation in the number of leaves per plant among the pea types. PL8 had a higher number of leaves as compared to other varieties.

Table 1: Number of leaves per five plants in each variety.

Variety	Number of leaves per five
PL8	440.8
PL3	422.2
PL4	412.6
PL7	389
Meteor	405.4
PL6	351.2
PL11	426
PL2(4)	328
PL2	332
PL19	130.2
Climax	240.4

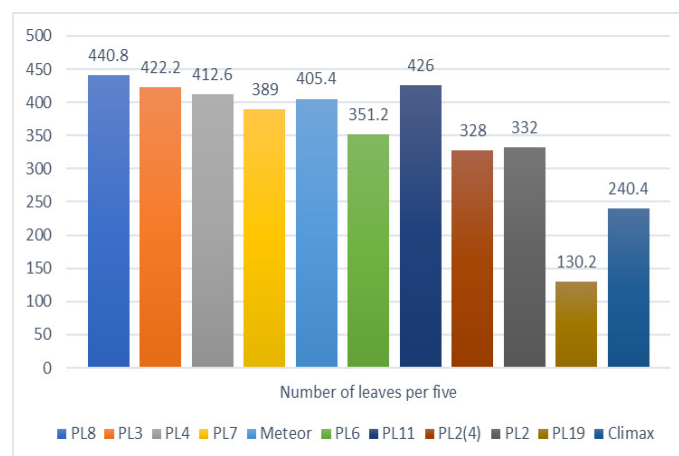


Figure 1: Graphical illustration of number of leaves per five plants in each variety.

Number of pods/plants

Data concerning the number of pods/plants indicated significant differences among the cultivars. The Variety PL8 produced the maximum number of green pods/plants Table 2. It indicated that priority could be given to a certain cultivar over others based on number of pods/plants if other parameters were also at optimum levels. Pods/plant has a significant and positive correlation with biological yield, grain yield, and harvest index.

Table 2: Number of pods per five plants in each variety.

Variety	Number of pods per five plants in each variety
PL8	90.6
PL3	82.4
PL4	67.8
PL7	49.6
Meteor	58.2
PL6	49.8
PL11	47.6
PL2(4)	48
PL2	37.4
PL19	35.4
Climax	32.2

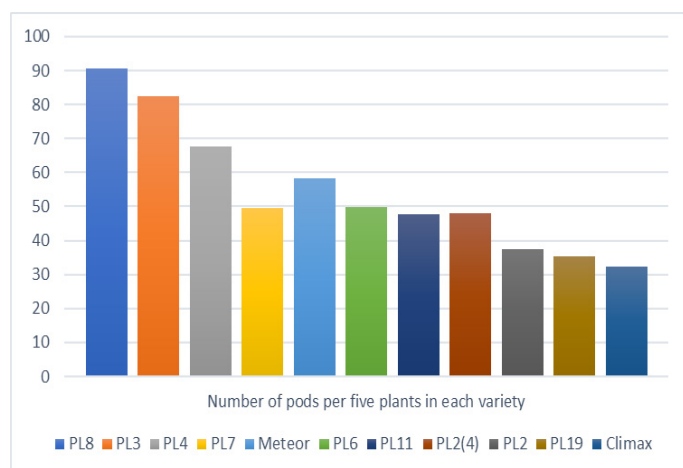


Figure 2: Graphical illustration of number of pods per five plants in each variety.

Pod length

Major distinctions within the cultivars were noticed in the pod length statistics. A comparison of the average for cultivars indicated that PL8 exhibited the maximum pod length.

Number of seeds/pods

Relevant data in the table indicated the number of seeds per pod. Comparing cultivar averages showed

that the highest number of seeds per pod (7) was generated by the cultivar PL8. The least seeds per pod (4.8) were produced by the variety Meteor. According to these findings, the cultivar Meteor is not a good choice for producing a sufficient quantity of seeds per pod.

Table 3: Number of pod length in per five plants in each variety.

Variety	Number of lengths per five plants in each variety
PL8	8.52
PL3	6
PL4	7.46
PL7	7.22
Meteor	7.44
PL6	7.36
PL11	7.6
PL2(4)	7.54
PL2	7.5
PL19	7.54
Climax	7.18

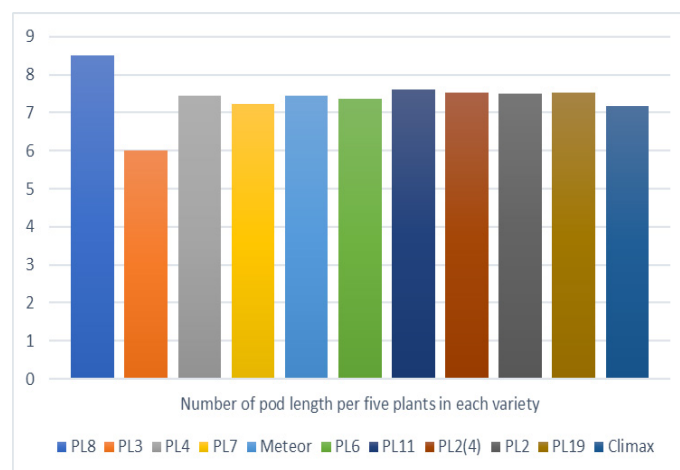


Figure 3: Graphical illustration of a number of pod length in per five plants in each variety.

Weight ten pods

The given table shows the weight of ten pods. We observe differences in the weight of eleven varieties of pea. PL8 show high weight of ten pods compare to other varieties.

100 seeds weight

The variety PL8 gained a maximum hundred seed weight (51.915 g) which was substantially variable from all the other cultivars (Table 5). While the variety climax gained a minimum number of hundred seed weight (19.85g).

Table 4: Number of seeds per five plants in each variety.

Variety	Number of seeds per pod in five plants of each variety
PL8	7
PL3	6
PL4	5.6
PL7	5.6
Meteor	4.8
PL6	6.2
PL11	6
PL2(4)	4.8
PL2	6.8
PL19	4.6
Climax	5.4

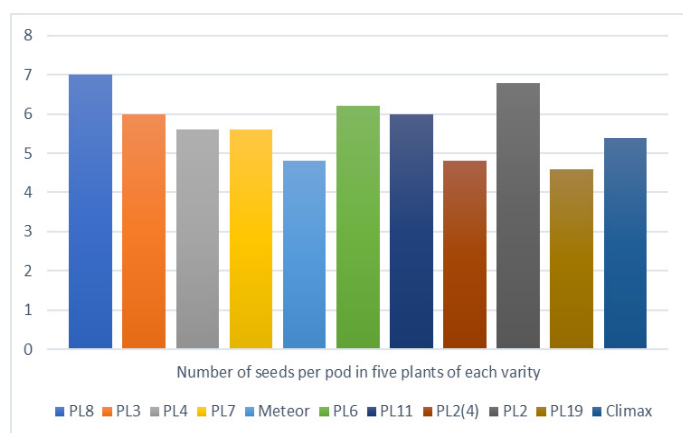


Figure 4: Graphical illustration of number of seeds per five plants in each variety.

Peas are widely grown, nutrient-dense vegetables that are mostly grown as winter crops worldwide. In crop rotation, this crop is quite useful (Tulbek *et al.*, 2024). Next to soybeans, groundnuts, and beans, it is regarded as a significant agricultural legume. Peas occupy the largest sowing area (6,764,000 ha) after beans, cowpeas, and chickpeas, as well as having the second largest production (12,144,000 t) after beans in the world (Abate *et al.*, 2012). Since temperature variations are the primary factors restricting pea cultivation, peas are widely grown in regions with mild to warm climates (Ambrose, 2008). The pea has been considered the most important crop in Pakistan and contributes significantly to the income of the farmers (Ullah *et al.*, 2024). Mainly due to its high nutritional content, it is the most widely grown crop with strong commercial demand. It is grown in the summer in peaks and the winter in plains (Habib and Zamin, 2003). It makes up almost 40% of the entire pulse trade. A total of 15.8 thousand hectares were used to grow the crop in 2011–12, yielding 105 thousand tons

of green peas on average per hectare (Anonymous, 2012). Although it is grown over a wide range of agricultural regions in Pakistan, the average yield per hectare is quite low when compared to the yields that are attained in many other nations and its potential (Zakirullah *et al.*, 2024). The present research work was carried out to determine the high-yielding variety in Khyber Pakhtunkhwa among the selected ones, in the experimental field of the University of Malakand. Eleven varieties of pea such as PL8, PL3, PL4, PL7, Meteor, PL6, PL11, PL2(4), PL2, PL19, and Climax were grown for the study. After Agronomic practices germination occurred and seedlings were selected.

Table 5: Weight ten pods per five plants in each variety.

Variety	weight ten pods per five plants in each variety
PL8	54.876
PL3	35.255
PL4	41.715
PL7	42.245
Meteor	42.899
PL6	39.219
PL11	33.098
PL2(4)	34.96
PL2	39.185
PL19	47.22
Climax	42.533

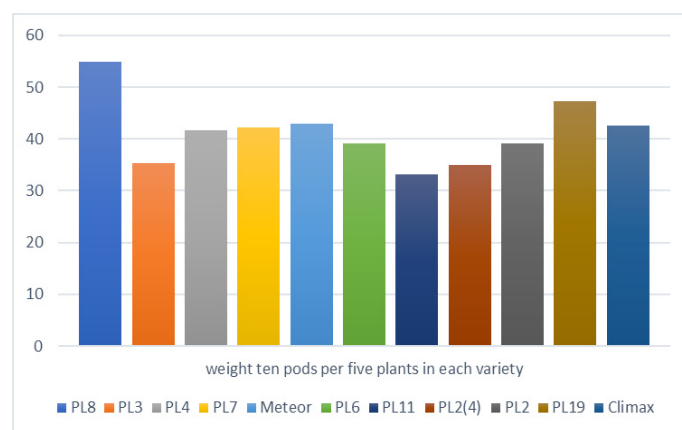


Figure 5: Graphical illustration of the weight ten pods of per five plants in each variety.

The result shows, that the PL8 variety has the highest number of leaves compared to other varieties (Table 1 and Figure 1). PL8 has the greatest number of pods per plant, pod length, number of seeds per pod, weight of ten pods, and 100 seed weight compared to other plants (Tables 2–6 and Figures 2–6). The harvest index, grain yield, and biological yield all

significantly and favorably correlated with the number of pods per plant. In garden pea varieties (Hussain *et al.*, 2005) also observed similar findings. The total yield is influenced by the number of pods on each plant, which is a significant yield component. Genetic traits or unsuitable environmental conditions can reduce the number of pods produced, which can impede pollination, and fertilization, or even result in abortion. These varieties are suitable for growers in the commercial sector who want pea varieties that yield more seeds per pod in the present investigation. This suggests that the PL8 type performs better than other varieties in terms of response to disease resistance. An increase in seed weight eventually results in a large yield, making it a crucial component of yield.

Table 6: 100 seed weights per five plants in each variety.

Variety	100 seeds weight per five plants in each variety
PL8	51.915
PL3	30.33
PL4	31.88
PL7	33.74
Meteor	31.58
PL6	22.625
PL11	29.135
PL2(4)	28.44
PL2	23.97
PL19	26.02
Climax	19.85

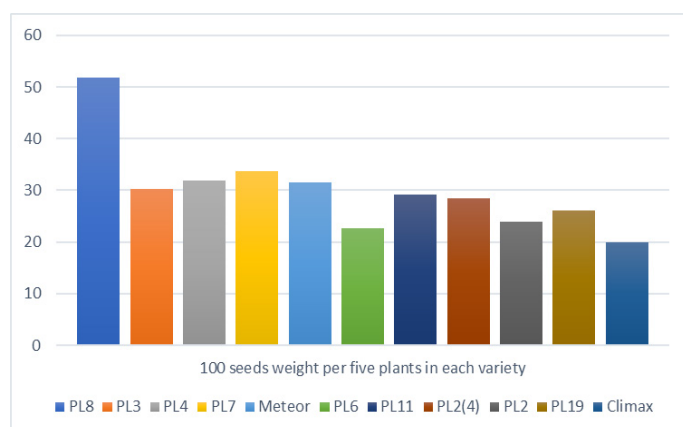


Figure 6: Graphical illustration of 100 seed weight per five plants in each variety.

The study has examined this crucial yield factor in various pea types (Hatam and Amanullah, 2002). In the current study, variety PL8 produced a higher yield than other kinds, and its plants showed the highest hundred seed weight (HSW) in comparison to other types. Furthermore, PL8 plants showed a more

noticeable increase in hundred seed weight (HSW) than Climax plants did. These findings showed that providing the pea plants with natural growing conditions and loamy soil throughout their life cycle produced the greatest results.

Further evidence that this variety is better suited for growth and disease resistance than climax comes from the fact that the PL8 plants exhibited higher hundred seed weight compared to Climax. In this current investigation, the variety PL8 yielded the largest amount. When it comes to green pod production, variety PL8 had the highest documented biological yield and eventually took the top spot. Applying soil and climate control can be linked with improving biological productivity. Positive effects of the PL8 were observed in the biological yield of pea cultivars. A prominent position in the yield and yield components belongs to the final harvest. Various workers in Pakistan have examined the green pods and harvest of peas in varying climatic conditions and varieties (Alam *et al.*, 2010; Ullah *et al.*, 2020; Gudko *et al.*, 2024). Except for seeds per pod, all of them reported notable variations in pea production and yield components. The cultivar PL8 had the maximum green pod production during the current investigation. All the types under study showed an increase in yield components, which in turn led to a rise in green pod yield.

Conclusions and Recommendations

The morphological features of 11 pea varieties cultivated in the experimental field have given significant insight. Among all varieties examined in this study, the PL8 represented superior characteristics such as the maximum number of leaves, pod length, leaf size and color, and seeds per pod. This study revealed that, out of the eleven unique high-yielding pea varieties, the PL-8 type had a noticeably higher yield than the others.

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Novelty Statement

This is the first study reported on the high-yielding

pea varieties collected from Khyber Pakhtunkhwa, Pakistan. The present result could enhance breeding programs and sustainable practices, promoting crop productivity in the region.

Author's Contribution

Hussain Shah, Ali Hazrat: Conception and design.

Ateef Ullah, Hafsa Razzaq: Development of methodology.

Shabir Ahmad, Muhammad Yahya: Acquisition of the data.

Muhammad Abdullah, Sahar Nasim and Waqar

Ahmad: Analysis and interpretation of data.

Muhammad Junaaid and Gul Rahim: Writing, review and revision.

Conflict of interest

The authors have declared no conflict of interest.

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