REPUBLIC OF TURKEY

UNIVERSITY OF DICLE

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BEKHAL OMAR

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FEN BİLİMLERİ ENSTİTÜSÜ MÜDÜRLÜĞÜ

DİYARBAKIR

Bekhal OMAR tarafından yapılan “Impact of Potassium Fertilizer in Growth and Yield of Some Pea (*Pisum sativum L.*) Varieties under Suleymaniyah-Iraq Conditions.” konulu bu çalışma , jürimiz tarafından Tarla Bitkileri Anabilim Dalında YÜKSEK LİSANS tezi olarak kabul edilmiştir

Jüri Üyesinin

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Tez Savunma Sınavı Tarihi: 15/03/2016

Yukarıdaki bilgilerin doğruluğunu onaylarım.

/ /2016

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ENSTİTÜ MÜDÜRÜ

(MÜHÜR)

ACKNOWLEG MENT

This pace of work will never be accomplished without our God Almighty with his blessing his power that works within me.

I would like to express my most scene appreciation and thanks to my supervision Dr. Veysel Saruhan for this supervision. Encouragement. Volume advice and guidance during the writing of this thesis.

Appreciation and highly grateful are also expressed to Dr. Mehmet yilidirm dean of the faculty of agricultural science.

Special thanks and appreciation are due to prof.Dr. Shirawan Esmael Tawfiq the coadvisor for his support. Advice and helps during my work and helps in statistical analysis.

A special gratitude I give to my husband's Dr. Aram omar for his supported and valuable remarks and help during my work.

Thanks and appreciations are also toDR.Dana azad and to my friend Bano Yasin, M. Bestwn O. Rashid. M. Bestwn Ali. Oral Mwsa, Lazyan Qadir. Mr. Sabah. And all staffs of Qlyasan Research Station for the help and for all facilitate that provided me during working in their station.

I would like my father, mother, brother and sister as they are simply perfect. I have no stable word that can fully describe the over lasting love to me for their help, sacrifice and tremendous support.

LIST OF CONTENTS

ABSTRACT

IMPACT OF POTASSIUM FERTILIZER IN GROWTH AND YIELD OF SOME PEA(*Pisum sativum L.*) VARIETIES UNDER SULAYMANIYAH–IRAQ CONDITIİONS

MASTERS THESİS

Bekhal OMAR

DEPARTMENT OF FIELD CROPS
INSTITUTE OF NATURAL AND APPLIED SCIENCES
UNIVERSITY OF DICLE

2016

This study was conducted to determine the effects of four potassium applications on five pea varieties for growth and yield components at Qlyasan Research Station, Faculty of Agriculture, University of Sulaimani during the winter season of 2014-2015 and spring season of 2015. Experiment was arranged using a factorial, split-plot design, within a randomized complete block design with three replicates, over two years. Potassium (0, 40, 60 and 80 kg $K_2O.ha^{-1}$) were assigned to main plots and cultivars Avolla, Joneor, Sancho, Green sage, Mamoth) to sub-plots. The effect of potassium fertilizer was significant for all growth characters except number of branches per plant. Root characters respond to potassium fertilizer significantly except the characters root length and nodules dry weight. Seed yield and all its components respond significantly to potassium applications. The growth characters plant high, number of leaves per plant and leaf width responds significantly to varieties effect. The root of fresh weight, number of nodules per plant and nodules dry weight were significant among cultivars. Regards to the second season, the effect of potassium fertilizer was significant in all studied characters except number of branches per plant, number of seeds per pod, biological weight per plant and harvest index. Potassium level of 80 kg $K_2O.ha^{-1}$ showed superior value for most of studied characters.

Keywords: Pea, *Pisum sativum* L., Potassium, Yield, Yield Components.

ÖZET

SÜLEYMANİYE-IRAQ KOŞULLARINDA POTASYUM GÜBRELEMESİNİN BAZI BEZELYE (*Pisum sativum L.*) ÇEŞİTLERİNDE BÜYÜME VE VERİM ÜZERİNE ETKİSİ.

YÜKSEKLİSANS TEZİ

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DİCLE ÜNİVERSİTESİ
FEN BİLİMLERİ ENSTİTÜSÜ
TARLA BİTKİLERİ ANABİLİM DALI

2016

Bu çalışma; Süleymaniye Üniversitesi Ziraat Fakültesi Olyasan Araştırma İstasyonunda 2014-2105 kış ve ilkbahar 2015 yılında ise ilkbahar yetiştirme mevsiminde, dört farklı potasyum uygulamasının beş bezelye çeşidinde verim ve verim unsurlarına etkilerinin belirlenmesi amacıyla yürütülmüştür.

Deneme tesadüf bloklarında bölünmüş parseller deneme desenine göre 3 tekerrürlü olarak düzenlenmiş, potasyum uygulamaları (0, 40, 60, 80 kg/ha) ana parselleri, bezelye çeşitleri (Avolla, Joneor, Sancho, Green sage, Mamoth) ise alt parselleri oluşturmuştur.

Potasyum gübrelemesinin, büyüme karakterleri üzerine bitkide dal sayısı hariç tüm karakterlerde önemli bulunmuştur. Bitki kök özelliklerinin potasyum uygulamasına tepkisi kök uzunluğu ve nodül kuru ağırlığı hariç önemli bulunmuştur. Yine tohum verimi ve verim unsurlarının potasyum uygulamalarına etkisi önemli bulunmuştur. Çeşitler arasında kök taze ağırlığı, bitki başına nodül sayısı ve ağırlığı yönünden önemli farklılıklar belirlenmiştir. ilkbahar ekimlerinde potasyum uygulamaları bitkide dal sayısı, baklada tohum sayısı, bitkide biyolojik verim ve hasat indeksi dışında tüm karakterlerde önemli bulunmuştur. 80 kg $K_2O.ha^{-1}$ uygulamasının birçok karakterde en yüksek değer verdiği saptanmıştır.

Anahtar Kelimeler: Bezelye, *Pisum sativum* L., Potasyum, Verim, Verim Unsurları.

LIST OF TABLE

1.NTRODUCTION

Pea (*Pisum sativum* L.) is one of the world's oldest domesticated crops cultivated before 10^{th} and 9^{th} millennia BC (Zohary and Hopf 2000). Field pea comprises both the wild species (*P. fulvum* and *P. eratius*) and cultivated species (*P. abyssinicum*) is originated from the Mediterranean region, primarily in the Middle East (Ellis et al., 2011), however the exact center of its diversity is not known yet due to significant change in the areas of origin and loss of passport data of the early accessions,it is a cool season crop grown in many parts of the world, growing best at temperatures of 13 to 18 °C (Petr et al., 2012). To provide enough food for an expanding world population, a massive increase in crop production is required to meet the food demands of future generations, while preserving the ecological and energy related resources of our planet.

Pea is major winter annual crop of temperate regions of the world and was originally cultivated in the Mediterranean basin (Smart, 1990). Its adaptation to relatively cool conditions has enabled its cultivation to spread beyond the area of initial domestication into Europe, Africa, and Asia. In tropical areas, it is cultivated during the cold months (Sardana et al., 2007).

Pea is one of the best known grain legumes in temperate climate because of its universal popularity as a fresh vegetable. The cultivation of pea is very ancient. The origin of the pea is not certain but it would seem that it first entered cultivation in South-West Asia from where it was carried to the rest of the world (Langer and Hill, 1985).

Agricultural production continues to be constrained by a variety of biotic (e.g., pathogens, insects and weeds) and a biotic (e.g., drought, salinity, cold, frost and water logging) factors that can significantly reduce the quantity and quality of crop production (Bray et al., 2000).

Pea is one of the most important grain legumes traditionallycultivated in many regions of the world. The agronomicalimportance of pea is based on its high concentrationof protein, complex carbohydrates, dietary fiber, vitamin sand minerals for the human and animal diet (Nikolopoulou et al., 2007).

The pea is full of nutrition because its grain is rich in protein (27.8%), complex carbohydrates (42.65%), vitamins, minerals, dietary fibers and antioxidant compounds (Urbano et al., 2003).

The crop is grown in many countries and currently ranks fourth among the pulses in the world with cultivated area of 6.33 million hectares (FAOSTAT, 2012).

Peas have a very long history as a garden crop and many varieties have been evolved. There are early, second early and main crop varieties of pea that climb almost two meters high and dwarf pea that need little support. Sowing to harvesting time is 11-12 weeks for early varieties, 12-13 weeks for second early varieties, and 13-14 weeks for main crop varieties. The size of the plants varies in height from 30 cm for the smallest dwarf varieties to 1.8 m for the taller plants. Pods range from 7.5 cm to 15 cm (Wood, 1979).

Pea is one of the annual herbaceous legume crop belongs to family Fabaceae (Leguminosae). Pea is a self- pollinated cool-season legume or pulse crop and diploid crop having 14 chromosomes (Sato et al., 2010).

Application of recommended dose of (60 kg $K_2O.ha^{-1}$) produced highest yield of pea, the beneficial effects of integrated use of organic manure and inorganic fertilizers on the soil physic–chemical properties and crop yield have also been observed (Bhalarao et al., 2001).

The exists a lot of variation in pea cultivars for different plant characteristics like height, maturity, yield, color and quality of fruit. Cultivars also vary in the adaptability to certain agro-climatic conditions. So it is possible to have a cultivar of better attributes through hybridization (Bakht et al., 2009).

Chemical fertilizers play an important role on plant growth and productivity. Nitrogen is essential for synthesis of chlorophyll, enzymes and protein. Phosphorus is essential for root growth, phospho-proteins, phospholipids and ATP, ADP formation. Potassium plays an important role in the promotion of enzyme activity and enhancing the translocation of assimilates and protein synthesis (Helmy, 2013).

The objective of the present study is to evaluate the performance of five pea varieties under different potassium application levels, to facilitate the selection of

varieties appropriate for rainfed region and to determine the optimum level of potassium fertilizer to be applied.

2. LITERATURE REVIEW

2.1. Potassium

Boyer and Stout (1959), reported that potassium is essential for N and carbohydrate metabolism, activation of various enzymes and adjustment of stomatal movement and water relations.

Evan et al (1971), confirmed that the potassium application in poorly fertile soil is essential to obtained high yield, since it plays an important role in many processes in plant cells. It has significant role in the activation of more than (60) enzymes which catalyze various metabolic processes.

Das et al (1975), confirmed that the up take and translocation nitrate from roots to shoots.

Srivastava, Verma 1985, Kanaujia et al (1997) and Vorob, (2000) confirmed that the application of NPK to pea crop usually promotes vegetative growth and nodulation, and Naik 1989; Saini and Thakur, 1996; Kanaujia et al., 1997, 1998; Vorob, 2000) indicated to its role in improving green pod yield, while Cutcliffe and Munro, (1980), reported that the vine length tended to increase as the rate of all the three nutrients increased.

Usherwood (1985), reported that Potassium is often referred as the quality element for crop production due to its positive interaction with other nutrients (especially with nitrogen) and production practices.

Hadavizadeh (1989), revealed that the good management practices are essential if optimum fertilizer responses are to be realized. These practices include use of recommended pea varieties, good seed bed preparation, proper seeding methods, effective plant insect control. Soil test results, field experience and knowledge of specific crop requirements help to determine the nutrients needed and the rate of application

Halliday (1992), indicated that due attention towards nutrient management is not paid in case of low input and high risk rain fed legume crops, frequently grown in low fertility soils.

Martin and Jamieson (1996) reported that water stress during the last half of the growing season (pollination, pod and seed formation periods) was a major factor in reducing seed yields in temperate dry areas. Water stress during seed filling decreased seed yield and quality.

Mullins et al (1996), signified that the nutrients available to plant particularly nitrogen and phosphorus are important constituents of protein and phospholipids. Phosphorus not only enhances the root growth but also promotes early plant maturity.

Mengel and Kirkb (1997), Mentioned that potassium promotes synthesis of photo-synthates and transport to fruits and grains, and enhances their conversion into starch, protein, vitamins, oil etc.

Sharma et al (1997) and Mishra (1999), found that pod yield increased by 60 kg P_2O_5 ha^{-1} in pea and cowpea, respectively, with no further significant increase at the higher P rate. Application of potassium also enhanced vegetative growth and increased pod yield in pea (Kanaujia et al., 1997 & 1998), in cowpea (Jamadagni and Birari, 1994) and in French bean (Kanaujia et al., 1999) with increasing K_2O rate up to 60 kg ha^{-1}.

Kanaujia et al (1997) also found that growth increased significantly with increasing levels of potassium (0, 30, 60 or 90 kg ha^{-1}). Mean values for potassium revealed that maximum number of pods were obtained from the plants received K_2O 150 kg ha^{-1}. Minimum number of pods was recorded in those plants, which received no potassium. They reported that effects of P, K and rhizobium on growth yield and quality of pea and found significant growth and nodulation increase with the increasing of P and K levels and confirmed that the level of 60 kg P and K ha^{-1} was the best. Climax gave better seed yield 2.24 tons as compared to Meteor with 2.33 tons ha^{-1}seed yield. Treatment, irrigation up to seed filling + P 120 kg ha^{-1}+ K 100 kg ha^{-1} (T3) was found at the top with 2.63 tons ha^{-1} seed yield, followed by (T2) with 2.33 tons ha^{-1} while control (T0) was found at the bottom with 2.02 tons ha^{-1}, respectively. As far as seed vigor tests showed that irrigation up to seed filling + P 120 kg ha^{-1}+ K 100 kg ha^{-1} (T3) was better for both cultivars.

Patel et al (1998), stated that peas cv. "Arbel" significantly increased in plant height, number of branches, leaves per plant, number of pods per plant, grains per pod and pod yield when applied 20 kg N ha^{-1} + 80 kg P ha^{-1} + 40 kg K ha^{-1}. They reported that significantly increased plant height, number of branches, leaves per plant, number of pods per plant, grains per pod and pod yield were observed when applied 20 kg N ha^{-1} + 80 kg P ha^{-1} + 40 kg K ha^{-1} was applied.

Kanaujia et al (1999) had reported that when 0, 30, 60 or 90 kg K_2O ha^{-1} was applied to French bean, number of pods per plant increased with increasing K rates up to 60 kg ha^{-1}. Regarding effect of potassium levels, it is interesting that the plants received 100 kg K ha^{-1} induced maximum pod length and stood atpar with the plants received 150 kg K ha^{-1}, and they reported increase in pod length of French bean with increasing K up to 60 kg ha^{-1}.

Klír (2000), reported that nutrients balance is a suitable way to quick diagnosing of nutrients management. The nutrients balance at the side of inputs, except for the biological nitrogen fixation depends on the commercial and organic fertilizers, seeds and atmospheric deposition of nitrogen and potassium. The side of outputs is the output of nutrients by grain and straw yields. Balance of items depends on the used method.

Vorob (2000), recorded positive effect of joint applications of phosphorus and potassium on growth and yield of peas. Phosphorus and potassium balance in condition without mineral fertilization was negative.

Kakar et al (2002), comfirmed that the maximum plant height (46.30 cm), number of branches $plant^{-1}$ (5.60), number of pods $plant^{-1}$ (33.10), pod length (8.49 cm), seed per pod (6.00), pod yield per plant (188.43 g) and total marketable green pod yield per hectare (5.01 t); were recorded in treatment 75-120-120 or 75-120-0, kg NPK ha^{-1}, which displayed maximum green pod yield due to increase in pod $plant^{-1}$ and pod length. It was further noted that an additional K did not increased the yield.

Akhtar et al (2003), confirmed that the combined effect of P_2O_5 and K_2O is concerned, it significantly influenced the pod length and green pod yield. Maximum pod length was attained when 69 or 46 kg P_2O_5 ha^{-1} was applied in combination with 100 or 150 kg K_2O ha^{-1}. Green pod yield was maximum at 69 kg P_2O_5 ha^{-1} × 100 or 150

kg K_2O ha^{-1}. 100 kg K_2O ha^{-1} resulted in maximum grains per pod, closely followed by 150 kg K_2O ha^{-1}.

Amjad et al (2004), stated that the application of K_2O to the crop had significant positive influence on seed yield, 1000 seed weight and percentage of large sized seeds up to the dose of 100 kg ha^{-1}. Time taken to complete 50 % germination and electrical conductivity of seed leachates were also affected significantly being minimum at the dose of 100 kg K_2O ha^{-1}.

Saeed et al (2004), reported that there was a linear increase in yield response for all the three genotypes from 0-0-0 to 35-87.50-00 kg NPK ha^{-1}, it decreased thereafter with the increase in fertilizer dose. The differences among the varietal means were non-significant during first year, while they were significant during the second year of study. Whereas, the application of fertilizer dose of 35-87.50-00 kg NPK ha^{-1} to gram genotype (K-90395) proved to be the best under the present experimental conditions.

Ezzat et al (2005), indicated that owing to its role in many biochemical processes such as protein synthesis and carbohydrate metabolism. However, the highest growth yield, yield components, protein, N and K contents of the plant and seeds of legumes crop were obtained by adding 360 kg/fed natural rock potassium (feldspar) and no significant increase with recommended treatments .

Singh et al (2006), calculated that the number of pod per plant and fresh vegetable pod yield were significantly higher when the crop was additionally treated with S, Fe and Mo as compared to only recommended N, P, K application. This may be due to the effect of sulphur, Fe and Mo in improving the assimilation of photosynthesis per unit leaf area due to higher chlorophyll content and enzyme activity .The total fresh weight per plant was significant only when compared between added nutrition and no nutrition for pea cultivation. The fresh root weight per plant was significantly higher when Fe was foliar sprayed together with Sand N, P, K recommended dose. The effect of different nutrition and its level on nodule weight and nodule number was significant.

Mohammad Janloo et al (2009), calculated that the application of 50 kg N ha^{-1} fertilizer significantly increased the number of secondary branches per plant, number of filled pod per plant, total number of pod, seed number per plant and seed yield.

Maximum seed yield was achieved when 50 kg N ha^{-1} fertilizer applied. Potassium fertilizer had no significant effect on the above mentioned traits.

Danilovic and Soltysova (2010), recorded that the deficit of phosphorus represented 8.53 kg ha^{-1} $year^{-1}$ (15.96 %) and deficit of potassium represented 9.24 kg ha^{-1} $year^{-1}$ (59.08 %), despite the negative balances of phosphorus and potassium (in conditions without mineral fertilization).

Ashraf et al (2011) reported that the irrigation up to seed filling + P 120 kg/ ha + K 100 kg/ha showed better performance for vegetative and reproductive parameters similarly highest seed yield 2.63 t/ha were found in this combination for both cultivars of pea as compared to other combinations. They stated that the different chemical composition tests of leaves, stems and pods were observed it was found that Climax cultivar was better as compared to Meteor. It is concluded that seed vigor of Climax cultivar with irrigation up to seed filling + P 120 kg/ha+ K 100 kg/ha gave better results as compared to other levels of phosphorus, potash and Irrigation.

Shakoor Khanday et al (2012), ratified that the application of the recommended dose of NPK through fertilization gave significantly higher pod yield than all other interactions.

Helmy (2013), calculated that the application of K_2O to the crop up to the dose of 100 kg/ha had significant positive effect on all the parameters studied, beyond this dose further application of K_2O was ineffective. As combined effect of P_2O_5 and K_2O is concerned, it significantly influenced the pod length and green pod yield. Maximum pod length was attained when 69 or 46 kg P_2O_5 ha^{-1} was applied in combination with 100 or 150 kg K_20 ha^{-1}. Green pod yield was maximum at 69 kg P_2O_5 ha^{-1} x 100 or 150 kg K_2O ha^{-1}.

Wang et al (2013), indicated to the emerging role of K in defending against a number of biotic and abiotic stresses including diseases, pests, drought, salinity, cold and frost and water logging. The availability of K and its effects on plant growth, anatomy, morphology and plant metabolism are discussed. The physiological and molecular mechanisms of K function in plant stress resistance are reviewed. This article also evaluates the potential for improving plant stress resistance by modifying K

fertilizer inputs and highlights the future needs for research about the role of K in agriculture.

Negash and Mulualem (2014), revealed that the grain yield of field pea was significantly affected by ploughing frequency and weeding frequency. The highest seed yield was attained by ploughing twice, weeding once and applying 100 kg ha^{-1} of DAP fertilizer. Field pea and other grain legumes, like lentil and chick pea, are commonly cultivated in rotation with cereal grains. The crop is also known to enhance soil fertility by forming a symbiotic relationship with Nitrogen fixing micro organisms in the soil.

Mishra (2014), reported that the pea plant can readily absorb and utilize the nutrients and express the highest value in all characters and finally the pod yield under combined application of organics and in organics.

2.2. Varieties

Zain et al (1983), Cawood (1987), reported that the semi-leafless pea genotypes with reduced plant height had better light interception and canopy aeration than normal leaf types .

Berry (1985), Snoad (1985), Armstrong (1989), showed increased dry matter partitioning to fruits, improved water use efficiency and decreased susceptibility to fungal diseases

Heath and Hebblethwaite (1985b), reported that the improved standing ability of semi-leafless pea was the main reasing to emphasize its popularity .

Cote et al (1992), reported that the ability of semi-leafless cultivars to withstand lodging and disease and the fact that their morphology allows better aeration within the canopy, have all contributed to their commercial importance.

Martin et al (1994), confirmed that the first commercial cultivars of semi-leafless pea were released in the early 1980s.

Wang et al (1998) Grosjean et al (2000); Morrison et al (2007); Nalle et al (2011) reported that field pea trypsin inhibitors could be different among genotypes and field pea genotypes with low trypsin inhibitors would be more suitable for use as animal feed .

Zohary and Hopf, (2000) reported that field pea (*Pisum sativum* L.) is one of the world's oldest domesticated crops cultivated before 10^{th} and 9^{th} millennia BC, there are two main leaf types in field pea. One has normal leaves; the second type is the semi-leafless type that has modified leaflets reduced to tendrils with vine lengths of two to four feet.

Cruz-Suarez et al (2001), Thiessen et al (2003); Allan and Booth (2004); Adamidou et al (2009), reported that field peas has been used in production of concentrated feed for aquaculture, (Brand et al., 2000; Stein et al., 2004; Petersen and Spenser, 2006) pigs, Wiryawan and Dingle, 1999; Nalle et al., 2011) poultry and Bednar et al; 2001, De-Oliveira et al., 2008; Carciofi et al., 2008) pets like dogs and cats.

Vargas et al (2001), reported that the genotype × environment interaction, defined in this case as the different phenotypic response of genotypes to environmental changes .

Kakar et al (2002), reported that the characteristics of a cultivar as well as combination of traits differ according to climatic conditions of the localities.

May et al (2003), indicated that in semi-leafless cultivars, the leaflets are replaced with tendrils, the end result being less leaf area but better resistance to lodging.

Singh et al (2006), calculated that the pod length and number of grain per pod were significantly higher in Azad P-1 and Azad P-3 over Arkel. Average pod weight was higher in Azad P-1 followed by Azad P-3 and Arkel. The grain yield was significantly higher in Azad P-1 (13.48 q ha^{-1}) followed by Azad P-3 (11.87 q ha^{-1}) and Arkel (9.77 q ha^{-1}). The fresh pod yield was significantly higher in Azad P-1 (96.2 q ha^{-1}) at par to Azad P-3 followed by Arkel. The total fresh weight per plant was non-significant, but fresh root weight $plant^{-1}$ was significantly lower in Arkel and at par to Azad P-1, Azad P-3. The genotypic effect on nodule number per plant was not significant but nodule weight per plant was significantly higher in Azad P-1 (6017 mg) over Arkel (394.6 mg) and Azad P-3 (323.2 mg) that essentially indicated the higher N-fixation capacity of Azad P-1 variety over Arkel and Azad P-3.

Bozoglu et al (2007), noticed that all the observed characteristics showed statistical difference among cultivars. Dry seed yields varied between 1328 and 2724 kg K_2O ha^{-1}. Highest dry seed yield was obtained from Bolero. Bolero, Agromar AG 7306, Feltham First, Jumbo, Sprinter, Sugar Bon and Vilmoren which are recommended for sowing in autumn, particularly for their high seed yield which can be greater than 2000 K_2O ha^{-1}. Agromar AG 7306, Vilmoren and Jumbo didn't respond to change of sowing time.

Reza et al (2007), found that the different phenotypic response of genotypes to environmental change cannot be explained by the genotype and the environment main effect, unless it is considered along with G × E interaction effects .

Kibe and Kamithi, (2007); Shirtliffe and Johnston, (2002); Dahmardeh et al (2010), reported that the cultivars had significant effect on full pod number, total pod number, seed number, and seed yield. Plant height, first pod height, total pod number and seed yield were affected by plant densities. The SPRING Cultivar with plant density of 40 plant m-2 may be suggested for winterly pea grown in the Mediterranean-type conditions. Earlier studies show that seeding rate and cultivar are important factors affecting yield and quality of grain legumes.

Bilgili et al (2010), found that the forage yield of the pea genotypes averaged 26605 kg ha^{-1} and the highest yield were obtained from the leafed genotype Urunlu. Its forage yield reached to 35970 kg ha^{-1} yield level at Samsun location.

Ellis et al (2011), reported that field pea comprises both the wild species (*P. fulvum* and *P. eratius*) and cultivated species (*P. abyssinicum*) is originnated from the Mediterranean region, primarily in the Middle East.

Turk et al (2011), reported that Two semi-leafless cultivars (Ulubatli and Kirazli) and two leafed cultivars (Golyazi and Urunlu) were investigated. Plant height, plants number per m^2, seeds number per pod, lodging scores, 1000 seed weight, forage yield, DM yield, seed yield, forage CP yield and seed CP yield were determined. According to two years averages, Golyazi had the highest 1000 seed weight, forage yield, DM yield, seed yield, forage CP yield and seed CP yield. Semi-leafless pea cultivars (Ulubatli and Kirazli) had significantly better standing ability than normal leaf cultivars (Urunlu and Golyazi). Increasing seed rates resulted in an increase in plants per m^2, lodging scores, forage yield, DM yield and forage CP yield; however, increasing seed rates caused decrease in seeds pod-1and seed CP yield in two years averages.

Petr et al (2012), indicated that the exact center of its diversity is not known yet due to significant change in the areas of origin and loss of passport data of the early accessions.

Rodrigues et al (2012), concluded that all 10-field pea genotypes are an excellent feedstuff for ruminants and non-ruminants animal and it could be supplied as plain or included in concentrate feed because it is an excellent protein and energy supplement. It combines in the same grain high levels of crude protein and starch. Due to the low fat content is a very interesting pulse for pets' light diets. They reported that the nutritional

composition of field peas is well documented; however antinutritional factors are depending on field pea genotype. It could be useful for accurate feed formulation because interaction of cultivars, soil, climate and agronomic factors can cause appreciable differences in nutrients profiles between locally grown gradients and those available around the world.

Shahid et al (2012), signified a significant correlation was found between the root/shoot dry weight and leaf K+/Na+ and Ca+2/Na+ ratios. Based on the percent increase or decrease over control for the measured attributes, the tested pea genotypes were categorized into less salt tolerant, intermediate and high salt tolerant groups at seedling stage.

Habtamu and Million (2013), found out that genotypes differed significantly in respect to phonological, yield and some yield related traits were highly influenced by the environment. Large magnitude of variability among the genotypes contributed to pod length and reaction to Ascochyta blight.

Khan et al (2013), calculated that the maximum pod yield was noted in 2001-55 (10.43 t ha^{-1}) followed by FS-21-87 (9.52 t ha^{-1}). Genotype 2001-55 also excelled in number of seeds per pod (8.56) and pod length (9.33 cm). Maximum plant height was observed in Shareen (125.7 cm) against minimum plant height (65.57 cm) in genotype 2001-55. Maximum 100- seed fresh weight (49.50 g) was noted in FS-21-87 followed by 2001-55 (46.00 g) and check Climax (40.0 g) against minimum in genotype DMR-4 (20.20 g). On the basis of overall performances, genotypes 2001-55 and FS-21-87 are recommended for further evaluation.

Poltronieri et al (2013), reported that legumes play an increasing role in mixed cropping systems, crop rotations and as target crops for food, livestock feeding and in human diets. Among grain legumes, the most important protein-rich crops are peas. The availability of early varieties favors the production of grain pea in shorter periods, after the end of rainy seasons and before the long periods of pre summer drought .

3. MATERIALS AND METHODES

3.1. Materials:

Five pea varieties, namely Avolla, Joneor, Sancho, Green sage, Mamoth, were were evaluated at Qlyasan Agricultural Research Station, Faculty of Agricultural Science, University of Sulaymani located (latitude 350 34' 307", N, longitude 450 21' 992" Ealtitude 765 m^2 KM North west of Sulaymaniyah city), during two seasons winter season of (2014-2015) spring season (2015).

3.2. Methods

The experiment conducted Randomized Block design (CRBD) in split plot design and replicated three times. The potassium fertilizer levels (0, 40, 60, 80 kg K_2O ha^{-1}) were implemented in main plots. The pea varieties allotted in sub plots, sowing was conducted during (November 26, 2014) and spring season (January 25, 2015) each sub plots consist of 5 rows. The recommended dose of fertilizer was used 40 kg N/ha and 40 kg P_2O_5 ha^{-1}. All required agricultural practices were used as needed. The experiment were harvested for seed yield at maturity on (May 17, 2015).

3.3. Soil properties:

The representative soil sample were taken from the field before tillage at 0-30 cm depth, were air dried then sieved using 2 mm sieves and packed to analysis. Some physical and chemical properties were analyzed at Soil and Water Sciences Department, Faculty of Agricultural Sciences, University of Sulaimani, as shown in Table 3.1.

a- Particle size distribution (PSD) was determined according to the international pipette method.
b- Soil reaction pH was determined by using a (LCE portable) pH-meter.
c- Cation exchange capacity (CEC) was determined by using an ion exchange process method
d- Electrical conductivity was measured by using EC-meter (model PW9525, Philips Company).

e- Organic matter determined by using Walkley and Black method

f- Available P was determined by Olsen's method

g- Total N was determined by Micro Kjeldeal method

h- Calcium carbonate ($CaCO_3$) was determined by the titrimetric method

i- Ca^{+2}& Mg^{+2} were determined by EDTA titrymetry (Jakson, 1958).

j- K^+ and Na^+ were determined by using (Corning 400 flame photometer).

k- $CO3^{=}$ and $HCO3^{=}$ were determined by titration method using (0.01N HCL)

l- Cl^- was determined by titration with (0.01N $AgNO_3$), $SO4^{=}$ was determined by titrimetric method using (0.01N EDTA).

Table 3.1. Some physical and chemical properties of soil at Qlyasan location.

Soil Properties		Sampling in Qlyasan location before cultivation
P.S.D.		Silty clay
Sand (%)		5.92
Silt(%)		43.28
Clay (%)		50.8
E.C.($ds.m^{-1}$)		0.46
pH		7.17
O.M. (%)		1.8
Total N (mg/g)		0.66
Available phosphate ($mg.kg^{-1}$) soil		5.2
$CaCO_3$ (%)		26.5
Soluble Ca ions & An ions mmole -1	Ca++	2.1
	Mg++	0.9
	K+	0.17
	Na+	0.63
	CO_3^{-2}	0.00
	HCO_3^{-2}	2.77
	Cl	0.13
	SO_4^{-2}	0.79

Table 3.2. Climatic conditions of Qlyasan location for the season 2014-2015.

Date	Qlyasan Location			
	Min Temp (C^o)	Max Temp (C^o)	Monthly Avg. Temp (C^o)	Precipitation (mm)
Oct.	9.1	34.4	20.4	43.2
Nov.	2.9	22.2	12.0	151.6
Dec.	2.2	17.9	9.2	128.6
Jan.	-3.2	16.6	6.8	100
Feb.	0.2	19.8	8.8	65
Mar.	3.2	22.0	12.0	94.8
Apr.	5.0	32.2	16.7	29.4
May.	11.2	36.9	24.6	19.8

3.4 Studied Characters

The following characters were studied in our investigation.

3.4.1 Root Characters

1. **Root length plant^{-1} (cm):** Measured from crown level to the top of the main root.
2. **Root fresh weight plant^{-1} (g):** The mean of root fresh weight plant^{-1} for the five plant samples was recorded in each plot.
3. **Root dry weight plant^{-1} (g):** The mean of root dry weight perplant for the five plant sampleswas recorded for each plot.
4. **No. of nodules plant^{-1}:** The mean of number of nodulesperplantfor the five plant sampleswas recorded for each plot.
5. **Nodules fresh weight plant^{-1} (g):** The mean of nodules fresh weight of the five plant samples was recorded in each plot.
6. **Nodules dry weight plant^{-1} (g):** The mean of nodules dry weight perplant of the five plant samples was recorded in each plot.

3.4.2 Growth Characters

1. **Plant height (cm):** Mesured from the soil surface to the top of the plant.
2. **No. of branches plant^{-1}:** The mean number of branches perplant of the five plants was recorded in each plot.

3. **No. of leaf plant^{-1}:** The mean number of leaf perplant of the five plants was recorded in each plot.
4. **Leaf fresh weight plant^{-1} (g):** The mean of leaf fresh weight perplant of five the plant samples was recorded in each plot.
5. **Leaf dry weight plant^{-1} (g):** The mean of leaf dry weight per plant of the five plant samples was recorded in each plot.
6. **Stem fresh weight plant^{-1} (g):** The mean of stem fresh weight per the plant of five plant samples was recorded in each plot.
7. **Stem dry weight plant^{-1} (g):** The mean of stem dry weight per plant of the five plant samples was recorded in each plot.

3.4.3 Forage Yield Characters

1. **Plant fresh weight (ha^{-1}):** The mean of plant fresh weight of the five plant samples was recorded in each plot (g plant^{-1}) and converted to (t ha^{-1}).
2. **Plant dry weight (ha^{-1}):** The mean of plant dry weight of the five plant samples was recorded in each plot (g plant^{-1}) and converted to (t ha^{-1}).

3.3.4 Yields and its Components

1. **No. of pods plant^{-1}:** The mean of number of pods per plan of the five plant samples was recorded in each plot.
2. **Weight of pods plant^{-1} (g):** The mean of weight of pods per plan of the five plant samples was recorded in each plot.
3. **Pod length plant^{-1} (cm):** The mean of pods length per plan of the five plant samples was recorded in each plot.
4. **No. of seeds pod^{-1}:** The mean of number of seeds per pod of the five plant samples was recorded in each plot.
5. **Weight of seeds pod^{-1} (g):** The mean of weight of seeds per podof the five plant samples was recorded in each plot.
6. **Weight of seeds plant^{-1} (g):** The mean of weight of seeds per plan of the five plant samples was recorded in each plot.
7. **100-seed weight (g):** The mean of 100 seeds weight was recorded in each plot.

8. **Biological weight plant^{-1} (g):** The mean of fresh weight of the five plant samples without the roots was recorded in each plot.
9. **Harvest Index:** Measured by separating the seeds from straw yield and weighed to calculate the H. I. according to the following equation:

$$H.I.\% = \frac{Total\ economical\ organ\ yield}{Total\ vegetativebiomass + Total\ economical\ organ\ yield}\ \chi\ 100$$

10. **Seed yield (kg ha^{-1}):** The mean of seeds weight of the five plant samples was recorded in each plot (g plant^{-1}) and converted to (Kg ha^{-1}).

4. RESULTS and DISCUSSIONS

The results of variance analysis for the effect of potassium fertilizer on pea cultivars for growth characters given Table 4.1.

Table 4.1. Variance analysis of the growth characters.

Autumn season						
S. O. V.	d.f	M.S				
		Plant height (cm)	No. of braches / Plant	No. of leaves / Plant	Leaf length (cm)	Leaf width (cm)
Blocks	2	8.213	0.867	0.317	0.473	0.115
Potassium Fertilizer	3	1384.677	2.639	34.283	15.110	4.237
Error (a)	6	10.913	0.089	4.050	0.224	0.106
Varieties	4	87.149	1.975	17.775	0.508	0.870
Potassium Fertilizer x Varieties	12	87.832	0.931	4.853	0.748	0.123
Error (b)	32	4.897	0.992	2.408	0.516	0.094
Spring season						
S. O. V.	d.f	M.S				
		Plant height (cm)	No. of braches / Plant	No. of leaves / Plant	Leaf length (cm)	Leaf width (cm)
Blocks	2	0.867	0.067	0.350	0.217	0.104
Potassium Fertilizer	3	1268.417	1.622	37.089	12.594	3.327
Error (a)	6	10.200	0.156	2.839	0.528	0.186
Varieties	4	49.608	0.225	17.400	0.192	0.603
Potassium Fertilizer x Varieties	12	75.931	0.303	7.589	0.803	0.074
Error (b)	32	4.200	0.383	1.654	0.450	0.084

4. RESULTS and DISCUSSIONS

The results of variance analysis for the effect of potassium fertilizer on pea cultivars for growth characters given Table 4.2.

Table 4.2. The average value of the effect of potassium fertilization on growth characters in pea.

Autumn season					
K- Fertilizer (K2O / ha)	Plant height (cm)	No. of braches / Plant	No. of leaves / Plant	Leaf length (cm)	Leaf width (cm)
0 Kg K_2O / ha	40.18 d	2.06	15.2 b	8.72 b	1.56 c
40 Kg K_2O / ha	44.13 c	2.40	17.4 a	8.72 b	2.26 b
60 Kg K_2O / ha	55.69 b	3.06	18.8 a	8.60 b	2.50 b
80 Kg K_2O / ha	60.67 a	2.40	17.7 a	10.68 a	2.84 a
LSD ($p \leq 0.05$)	2.95	N.S	1.79 a	0.42	0.29
Spring season					
K- Fertilizer (K2O / ha)	Plant height (cm)	No. of braches / Plant	No. of leaves / Plant	Leaf length (cm)	Leaf width (cm)
0 Kg K_2O / ha	37.1 d	1.8	11.2 c	7.5 c	1.5 c
40 Kg K_2O / ha	41.7 c	2.0	12.9 b	8.0 bc	2.0 b
60 Kg K_2O / ha	52.9 b	2.6	14.8 a	8.3 b	2.3 ab
80 Kg K_2O / ha	56.6 a	2.4	14.1 ab	9.6 a	2.6 a
LSD ($p \leq 0.05$)	2.854	N.S	1.505	0.649	0.385

The effect of potassium fertilizer on plant height is highly significant, the application of 80 kg K_2O ha^{-1} predominated the rest by (48.48, 37.47, and 8.94% in compare to 0, 40 and 60 kg K_2O ha^{-1} respectively. Which recorded maximum value 60.67 cm, and followed by the application of 60 kg K_2O ha^{-1}, which recorded 55.69 cm and exceeded 0 and 40 kg K_2O ha^{-1} by 38.58 and 26.193 % . The application of 40 kg K_2O ha^{-1} recorded 44.13 cm and predominated the treatment of control by 9.81%, the lowest value due to plant height recorded by the control with 40.18 cm.

Number of branches per plant, respond non significantly to potassium fertilizer effect. The values of this character were restricted between 2.067 and 3.067 branches for both levels of 0 and 60 kg K_2O ha^{-1} respectively (table 4.1. at atumn season).

Number of leaves per plant. It was noticed that character no of leaves per plant respond high significantly to potassium applications. Maximum number of leaves recorded by the application of 60 kg K_2O ha^{-1} , which was 18.80 leaves, in which exceeded the treatment of control by 23.68 %, the minimum number of leaves recorded by control which was 15.20 leaves. No significant differences were recorded between the applications of 40, 60 and 80 kg K_2O ha^{-1} for this character.

Highly significant response of the character leaf length to potassium fertilizer applications was noticed. Maximum leaf length value recorded by the level of 80 kg K_2O ha^{-1} with 10.68 cm, and exceeded the levels of 0, 40 and 60 kg K_2O ha^{-1} by 22.55, 22.55 and 24.16% respectively, while there were not significant differences among the levels of 0, 40 and 60 kg K_2O ha^{-1}. The lowest value due to leaf length 8.60 cm was produced by the application of 60 kg K_2O ha^{-1}.

Highly significant differences were noticed among potassium application levels due to the character leaf width. The application of 80 kg K_2O ha^{-1} produced maximum leaf width 2.84 cm , which predominated the applications of 0, 40 and 60 kg K_2O ha^{-1} by 79.19, 25.36 and 13.36 % respectively, while there were no significant differences between 40 and 60 kg K_2O ha^{-1} in leaf width .The lowest value for this character was exhibited by the treatment of control with 1.58 cm.

Regarding to spring season, the effect of potassium fertilizer in growth characters was highly significant for all characters except number of branches/plant, which was not significant. The application of 60 kg K_2O ha^{-1} produced maximum values for the characters number of branches per plant and number of leaves per plant with 2.60 and 14.86 %, respectively .The maximum values due to the characters plant height, leaf length and leaf width were 56.66, 9.66 cm and 2.60 cm exhibited by the application of 80 kg K_2O ha^{-1} respectively. The lowest values for the characters plant height number of branches per plant, number of leaves per plant, leaf length and leaf width were produced by the treatment of control as 37.13, 1.86, 11.26, 7.53 and 1.50 cm respectively.

Previous workers indicated that the application of potassium enhanced vegetative growth and nodulation were increased significantly with increasing levels of potassium, Kanaujia et al 1997 1998 vorob 2000.

The results of The Average of growth characters for pea varaieties given Table 4.3.

The average of the growth characters for pea varieties confirm the presence of highly significant differences amonge varieties for the character plant height. The variety Avolla recorded maximum plant height value with 53.57 cm , and exceeded the varieties of Joneor, Green sage, and Mamoth by 11.05, 11.32 and 10.93%, respectively, while no significant difference were noticed between Avolla and Sancho varieties and also among the varieties of Joneor, Green sage, and Mamoth. The minimum value for this character was exhibited by the variety of Green sage with 48.12 cm. Significant differences were recorded among varieties for plant height previously by Hussain and Badshah (2002), Hussain et al (2005) and Khan et al (2013), the average of growth character for pea varieties. Abdolla (2015) reported no significant differences among varieties due to the character number of branches per plant.

Table 4.3. The Average of growth characters for pea varaieties.

Autumn season					
Varieties	Plant height (cm)	No. of braches / Plant	No. of leaves / Plant	Leaf length (cm)	Leaf width (cm)
Avolla	53.57 a	2.91	19.33 a	9.44	2.37 b
Joneor	48.24 b	1.83	16.08 b	9.05	1.97 c
Sancho	52.62 a	2.58	16.91 b	9.30	2.31 b
Green Sage	48.12 b	2.66	16.91 b	8.91	2.69 a
Mamoth	48.29 b	2.41	17.16 b	9.19	2.14 bc
LSD ($p \leq 0.05$)	2.47	N.S	1.29	N.S	0.25
Spring season					
Varieties	Plant height (cm)	No. of braches / Plant	No. of leaves / Plant	Leaf length (cm)	Leaf width (cm)
Avolla	49.00 a	2.41	15.33 a	8.41	2.13 b
Joneor	46.25 b	2.08	12.25 c	8.25	1.83 c
Sancho	49.58 a	2.16	13.08 c	8.50	2.11 bc
Green Sage	45.58 b	2.16	12.58 c	8.25	2.44 a
Mamoth	45.16 b	2.33	13.25 b	8.50	1.99 bc
LSD ($p \leq 0.05$)	1.70	N.S	1.070	N.S	0.24

No significant differences were observed among varieties respect to the character number of branches per plant. The values were restricted between 1.83 and 2.91 cm for the varieties of Joneor and Avolla, respectively.

Highly significant differences among varieties for the character number of leaves per plant was recorded.

Avolla variety exhibited maximum number of leaves 19.33 and exceeded the varieties of Joneor, Sancho, Green sage and Mamoth by 20.20, 14.28, 14.28 and 12.61%, respectively, while there were no significant differences among them. The lowest number of leaves 16.08 was produced by the varietyof Joneor (Table 4.3).

The effect of varieties in leaf length, was found to be no significant. The leaf length values for all varieties ranged between 8.91 and 9.44 cm for the varieties of Joneor and Avolla, respectively.

Highly significant differences were noticed among varieties due to the character leaf width. The variety of Green sage showed maximum leaf width value with 2.69 cm which predominated the varieties of Avolla, Joneor, Sancho and Mamoth by 13.38, 36.21, 16.17 and 25.84% respectively (Table 4.3). No significant differences were noticed between the Avolla and Sancho varieties and also between Joneor and Mamoth varieties. The minimum leaf width value was showed by the variety of Joneor with 1.97 cm.

At spring season the difference among varieties for growth characters were highly significant due to the characters plant height, number of leaves per plant and leaf width. Avolla produced the highest value for number of leaves per plant with 15.33 Sancho gave maximum values for plant height with 49.58 cm. Green sage exhibited the highest value for leaf width with 2.44 cm (Table 4.3). At spring season the difference among varieties for growth characters were highly significant due to the characters plant height ,number of leaves per plant and leaf width. Avolla produced the highest value for numberof leaves per plant with 15.33 Sancho gave maximum values for plant height with 49.58 cm. Green sage exhibited the highest value for leaf width with 2.44 cm.

Mamoth gave the lowest value for plant heightwith 45.18 cm, while the lowest value for the characters number of leaves/plant and leaf width were produced by Joneor variety 12.25 and 1.83 respectively.

The interaction effect between potassium fertilizer and pea varieties on growth characters at autumn season represent in table 4.4.

The results of the interaction effect between potassium fertilizer levels and varieties on plant high, was found to be highly significant. Maximum plant height value 65.46 cm was found by the association of Avolla variety under the application of 80 kg K_2O ha^{-1} and followed by 64.80 cm produced by the interaction of Green sage under the same potassium application. The lowest plant high value 30.76 cm was exhibited by the association of Green sage under (0) application of potassium.

The interaction effects between potassium levels and varieties on number of branches per plant, indicated to non significant response. The values were restricted between 1.33 and 4.00 branches for the interaction of Joneor associated with 40 kg K_2O ha^{-1} and green sage coupled with 60 kg K_2O ha^{-1}, respectively.

The interaction effect between potassium levels and pea varieties due to number of leaves per plant, was highly significant of this character to this effect was noticed. The maximum number of leaves was 21.66 leaves exhibited by the interaction of Avolla under the application of 60 kg K_2O ha^{-1} , while the lowest number of leaves was 13.00 leaves produced by the association of Joneor variety with 0 kg K_2O ha^{-1} (Table 4.4).

The interaction effect between potassium fertilizer and pea varieties was not significant due to the character leaf length. The values of this character ranged between 8.16 and 11.30 cm for the interaction of Mamoth variety with 40 kg K_2O ha^{-1} and the same variety under 80 kg K_2O ha^{-1}.

Table 4.4. The interaction effect of potassium fertilizer and varieties on growth characters.

	Autumn season					
K- Fertilizer (K2O / ha)	Varieties	Plant height (cm)	No. of braches / Plant	No. of leaves / Plant	Leaf length (cm)	Leaf width (cm)
0 Kg K2O / ha	Avolla	47.33 gh	2.33	16.33 d-g	9.23	1.53
	Joneor	41.90 ij	1.66	13.00 h	8.43	1.27
	Sancho	40.60 j	2.33	15.33 f-h	8.53	1.93
	Green Sage	30.76 l	2.00	14.66 g-h	8.63	2.10
	Mamoth	40.33 j	2.00	16.66 d-g	8.76	1.09
40 Kg K2O / ha	Avolla	48.60 gh	3.33	18.66 b-c	9.36	2.36
	Joneor	45.53 hi	1.33	17.67 c-f	9.26	1.92
	Sancho	50.43 fg	2.66	17.66 c-f	8.50	2.39
	Green Sage	34.93 k	2.00	17.33 c-f	8.30	2.62
	Mamoth	41.16 j	2.66	15.66 e-f	8.16	2.03
60 Kg K2O / ha	Avolla	52.90 ef	2.66	21.66 a	9.10	2.56
	Joneor	50.36 fg	2.33	17.33 c-f	8.33	2.13
	Sancho	58.16 cd	3.66	19.33 a-c	9.00	2.41
	Green Sage	62.00 ab	4.00	17.33 c-f	8.06	2.85
	Mamoth	55.03 de	2.66	18.33 b-d	8.53	2.56
80 Kg K2O / ha	Avolla	65.46 a	3.33	20.66 ab	10.07	3.03
	Joneor	55.16 de	2.00	16.33 d-g	10.20	2.57
	Sancho	61.30 bc	1.66	15.33 f-h	11.20	2.53
	Green Sage	64.80 ab	2.66	18.33 b-d	10.66	3.20
	Mamoth	56.63 d	2.33	18.00 c-e	11.30	2.86
LSD ($p \leq 0.05$)		3.68	N.S	2.58	N.S	N.S
	Spring season					
K- Fertilizer (K2O / ha)	Varieties	Plant height (cm)	No. of braches / Plant	No. of leaves / Plant	Leaf length (cm)	Leaf width (cm)
0 Kg K2O / ha	Avolla	40.33 g	2.00	11.00 fg	7.66	1.56
	Joneor	39.00 g	1.66	9.66 g	7.66	1.30
	Sancho	39.00 g	2.00	12.66 c-e	7.00	1.73
	Green Sage	28.00 i	2.00	11.33 fg	7.33	1.66
	Mamoth	39.33 g	1.66	11.66 e-g	8.00	1.23
40 Kg K2O / ha	Avolla	46.33 f	2.66	14.33 b-d	8.00	2.06
	Joneor	44.66 f	2.00	12.33 d-f	8.33	1.66
	Sancho	46.33 f	1.66	13.66 b-e	8.33	2.13
	Green Sage	34.00 h	1.66	12.00 ef	7.33	2.43
	Mamoth	37.33 gh	2.33	12.33 d-f	8.00	1.73
60 Kg K2O / ha	Avolla	50.66 de	2.33	18.00 a	8.66	2.23
	Joneor	48.00 ef	2.33	15.33 b	7.66	2.03
	Sancho	56.33 bc	3.00	14.33 b-d	9.00	2.23
	Green Sage	58.00 b	2.66	12.33 d-f	8.66	2.66
	Mamoth	51.66 d	2.66	14.33 b-d	7.66	2.33
80 Kg K2O / ha	Avolla	58.66 b	2.66	18.00 a	9.33	2.66
	Joneor	53.33 cd	2.33	11.66 e-g	9.33	2.33
	Sancho	56.66 b	2.00	11.66 e-g	9.66	2.36
	Green Sage	62.33 a	2.33	14.67 bc	9.66	3.00
	Mamoth	52.33 d	2.66	14.66 bc	10.33	2.66
LSD ($p \leq 0.05$)	3.408	N.S	2.13	N.S	N.S	N.S

The interaction between potassium fertilizer and pea varieties in leaf width was not significant. The values were restricted between 1.09 and 3.20 cm for both interactions Mamoth variety with 0 kg K_2O ha^{-1} and Green sage variety coupled with 80 kg K_2O ha^{-1}.

Concerning to spring season the interaction effect between potassium fertilizer and varieties were highly significant for only plant height and number of leaves per plant.

Maximum value to plant height 62.33 cm was produced under the interaction of 80 kg K_2O ha^{-1} (Table 4.4) coupled with green sage variety, while the lowest value 28.00 cm was produced by the interaction of 0 kg K_2O ha^{-1} with green safe variety.

Regarding to the character number of leaves/plant, maximum value 18.00 leaves was produced by the interaction 60 and 80 kg K_2O ha^{-1} with Avolla variety, while the lowest value 9.66 leaves was exhibited by the interaction of 0 kg K_2O ha^{-1} with Joneor variety.

Table 4.5. The variance analysis of the root characters.

Autumn season							
S. O. V.	d.f	M.S					
		Root length (cm)	Root fresh weight (g)	Root dry weight (g)	No. of nodules / plant	Nodules fresh weight (g)	Nodules dry weight (g)
Blocks	2	3.468	0.047	0.028	3.517	0.000	0.005
Potassium Fertilizer	3	14.533	0.518	0.449	130.194	0.045	0.012
Error (a)	6	5.598	0.034	0.004	1.761	0.000	0.005
Varieties	4	1.376	0.081	0.011	33.192	0.000	0.005
Potassium Fertilizer x Varieties	12	7.121	0.044	0.029	11.292	0.001	0.005
Error (b)	32	5.917	0.024	0.010	3.679	0.000	0.005
Spring season							
S. O. V.	d.f	Root length (cm)	Root fresh weight (g)	Root dry weight (g)	No. of nodules / plant	Nodules fresh weight (g)	Nodules dry weight (g)
Blocks	2	0.621	0.073	0.001	2.450	0.000	0.000
Potassium Fertilizer	3	63.538	0.828	0.465	166.994	0.035	0.003
Error (a)	6	1.012	0.034	0.003	2.494	0.001	0.000
Varieties	4	2.197	0.225	0.003	20.642	0.000	0.000
Potassium Fertilizer x Varieties	12	2.477	0.070	0.023	12.008	0.001	0.000
Error (b)	32	1.147	0.028	0.005	3.192	0.000	0.000

Table 4.6. The effect of Potassium fertilization on root characters.

Autumn season						
K- Fertilizer (K2O / ha)	Root length (cm)	Root fresh weight (g)	Root dry weight (g)	No. of nodules / plant	Nodules fresh weight (g)	Nodules dry weight (g)
0 Kg K2O / ha	18.13	1.64 b	0.54 d	21.3 c	0.14 d	0.03
40 Kg K2O / ha	18.99	1.90 a	0.78 c	24.7 b	0.17 c	0.03
60 Kg K2O / ha	19.04	2.01 a	0.87 b	27.4 a	0.20 b	0.09
80 Kg K2O / ha	20.50	2.05 a	0.94 a	27.6 a	0.26 a	0.06
LSD (p ≤ 0.05)	N.S	0.164	0.05	1.18	0.01	N.S
Spring season						
K- Fertilizer (K2O / ha)	Root length (cm)	Root fresh weight (g)	Root dry weight (g)	No. of nodules / plant	Nodules fresh weight (g)	Nodules dry weight (g)
0 Kg K2O / ha	14.33 c	1.38 c	0.47 d	16.73 c	0.12 d	0.02 c
40 Kg K2O / ha	15.66 b	1.70 b	0.72 c	21.06 b	0.15 c	0.03 b
60 Kg K2O / ha	18.08 a	1.83 ab	0.81 b	23.80 a	0.18 b	0.05 a
80 Kg K2O / ha	18.73 a	1.91 a	0.87 a	23.80 a	0.23 a	0.05 a
LSD (p ≤ 0.05)	0.89	0.16	0.04	1.41	0.02	0.01

No significant effect of potassium fertilizer in the character root length was recorded. The root length value restricted between 18.13 and 20.50 cm for the applications of 0 and 80 kg K_2O ha^{-1} respectively (Table 4.6).

Highly significant effect of potassium fertilizer in root fresh weight was observed. Maximum value 2.05 gm was produced by the application of 80 kg K_2O ha^{-1} and followed by 2.01 gm for the application of 60 kg K_2O ha^{-1}. All application levels were predominated the treatment of control significantly by 15.63, 22.62 and 25.12 %, respectively. The lowest root fresh weight1.64 gm was exhibited by the treatment of control.

The highly significant effect of potassium fertilizer was noticed in the character root dry weight, the root dry weight increased as potassium level increased from 0,0 to 80 kg K_2O ha^{-1}. All application levels exceeded the treatment of control by 42.98, 58.65 and 72.85 %, respectively. Maximum value produced by 80 kg K_2O ha^{-1} which was 0.94 gm, and minimum value 0.54 gm was produced by the treatment of control (Table 4.6).

The effect of potassium fertilizer on number of nodules per plant was highly significant. The number of nodules per plant increased as the potassium application level increased. The highest number of nodules 27.60 was produced by the application of 80 kg K_2O ha^{-1}.

All potassium levels predominated the treatment of control significantly by 15.93, 28.75, and 29.37%, respectively (Table 4.6). The lowest value 21.33 was produced by the application of 0.0 kg K_2O ha^{-1}.

The effect of potassium fertilizer in nodules fresh weight was highly significant table. All application levels exceeded the treatment of control significantly by 21.27, 45.39 and 90.78% , respectively .Maximum weight 0.26 gm was showed by 80 kg K_2O ha^{-1}, and the lowest weight of fresh nodules 0.14 gm was produced by the treatment of control (Table 4.6).

From the same table and appendix no significant effect of potassium fertilizer was observed in nodules dry weight. while it was increased with potassium level increased up to 60 kg K_2O ha^{-1}.

At spring season the effect of potassium fertilizer was highly significant in all character. The application of 80 kg K_2O ha^{-1} exhibited maximum values for all characters which were 18.73, 1.91, 0.87, 23.90, 0.23 and 0.05 for root length, root fresh weight, root dry weight, number of nodules per plant, nodules fresh weight and nodules dry weight respectively, while the treatment of control 0 kg K_2O ha^{-1} gave the lowest values for these characters which were 14.33, 1.38, 0.47, 16.73, 0.12 and 0.02 respectively.

Table 4.7. The differences among pea varieties in root characters.

	Autumn season					
Varieties	Root length (cm)	Root fresh weight (g)	Root dry weight (g)	No. of nodules / plant	Nodules fresh weight (g)	Nodules dry weight (g)
Avolla	18.76	2.01 a	0.83	27.41 a	0.20	0.05 ab
Joneor	19.20	1.86 b	0.75	25.33 b	0.19	0.04 b
Sancho	19.50	1.84 b	0.78	22.75 c	0.19	0.09 a
Green Sage	19.49	1.92 a	0.79	25.58 b	0.19	0.04 b
Mamoth	18.89	1.92 a	0.77	25.33 b	0.19	0.04 b
LSD (p ≤ 0.05)	N.S	0.13	N.S	1.59	N.S	0.04
Spring season						
Varieties	Root length (cm)	Root fresh weight (g)	Root dry weight (g)	No. of nodules / plant	Nodules fresh weight (g)	Nodules dry weight (g)
Avolla	17.16	1.84 a	0.74	22.83 a	0.18	0.04
Joneor	16.00	1.50 b	0.72	21.08 b	0.17	0.04
Sancho	16.76	1.62 b	0.71	19.33 c	0.16	0.04
Green Sage	16.83	1.76 a	0.72	22.08 ab	0.17	0.04
Mamoth	16.75	1.79 a	0.70	21.41 ab	0.17	0.04
LSD (p ≤ 0.05)	N.S	0.138	N.S	1.486	N.S	N.S

Data represent in this table (4.7), confirm that the differences between pea varieties were not significant due to the character root length, and the values were restricted between 18.76 and 19.50 cm for the varieties of Avolla and Sancho, respectively.

Significant differences among varieties for the character of root fresh weight was confirmed. Avolla variety produced maximum values 2.01 g, which exceeded the varieties of Joneor and Sancho significantly. There were no significant difference among the varieties of Avolla, Green Sage and Mamoth. The lowest value 1.86 g was recorded by Joneor variety.

No significant differences were noticed among varieties for the character of root dry weight. The values were ranged between 0.75 and 0.83 g for the varieties of Joneor and Avolla, respectively (Table 4.7).

Highly significant differences were observed among varieties for the number of nodules per plant. Maximum number was produce by Avolla variety 27.41 which exceeded the rest by 8.22, 20.51, 7.16 and 8.22 %, respectively. The lowest numbers of nodules were produced by the varieties of Joneor and Mamoth each with 25.33 nodules per plant.

Non-significant differences among varieties for the nodules fresh weight was observed. The values were restricted between 0.19 and 0.20 for Green Sage and Avolla varieties respectively (Table 4.7).

From the same table and Appendix no significant differences were noticed among varieties for the nodules dry weight. The values were ranged between 0.04 g for both varieties of Joneor and Mamoth and 0.09 g for the variety of Green Sage.

Regarding to the spring season the difference among varieties to the root fresh weight, number of nodules per plant was highly significant. The Avolla variety recorded maximum values for both characters with 1.84 and 22.83 respectively , while the lowest value for fresh root weight 1.50 gm was, recorded by Joneor variety and for number of nodules per plant 19.33 was recorded by Sancho variety.

Significant differences were reported among pea varieties for fresh root weight per plant, while no significant differences among varieties for the nodule number per plant and significant differences were reported for nodules weight per plant (Singh et al 2006).

Table 4.8. The interaction effect of potassium fertilizer and varieties on root characters.

Autumn season							
K- Fertilizer (K2O .ha -1)	Varieties	Root length (cm)	Root fresh weight (g)	Root dry weight (g)	No. of nodules / plant	Nodules fresh weight (g)	Nodules dry weight (g)
0 Kg K2O / ha	Avolla	19.17	1.61 hi	0.61 gh	21.33 hi	0.19 cd	0.03 b
	Joneor	19.43	1.93 c-g	0.69 fg	26.66 d-f	0.15 fg	0.03 b
	Sancho	14.73	2.30 a	0.98 a-c	30.00 a-c	0.18 c-e	0.06 b
	Green Sage	21.70	2.21 ab	1.05 a	31.66 a	0.26 a	0.07 b
	Mamoth	17.60	1.52 i	0.52 h	22.66 g-i	0.13 gh	0.02 b
40 Kg K2O / ha	Avolla	18.50	1.79 e-h	0.70 e-g	23.66 f-h	0.16 d-f	0.03 b
	Joneor	20.60	1.97 b-g	0.88 b-f	27.33 c-e	0.22 b	0.05 b
	Sancho	20.10	1.93 c-g	0.93 a-e	27.66 b-e	0.26 a	0.06 b
	Green Sage	17.33	1.58 hi	0.58 gh	20.33 i	0.12 h	0.03 b
	Mamoth	19.43	1.77 f-i	0.70 c-f	23.66 f-h	0.18 c-e	0.04 b
60 Kg K2O / ha	Avolla	20.50	1.87 d-g	0.81 c-f	24.66 e-g	0.20 bc	0.24 a
	Joneor	20.73	2.15 a-c	1.02 ab	22.33 hi	0.27 a	0.05 b
	Sancho	18.56	1.75 g-i	0.58 gh	21.33 hi	0.12 gh	0.03 b
	Green Sage	19.20	1.94 c-g	0.85 c-f	26.66 d-f	0.16 e-g	0.03 b
	Mamoth	20.36	2.04 b-e	0.83 c-f	28.66 a-d	0.20 bc	0.06 b
80 Kg K2O / ha	Avolla	19.83	1.96 c-g	0.91 a-e	25.66 d-g	0.26 a	0.05 b
	Joneor	18.00	1.74 g-i	0.44 i	21.00 hi	0.12 gh	0.03 b
	Sancho	18.40	2.06 a-d	0.97 a-c	23.00 g-i	0.18 c-e	0.03 b
	Green Sage	19.00	1.88 d-g	0.84 c-f	26.66 d-f	0.19 cd	0.05 b
	Mamoth	20.16	2.01 b-f	0.82 c-f	30.66 ab	0.27 a	0.06 b
LSD($p \leq 0.05$)		N.S	0.25	0.16	3.19	0.02	0.12
Spring season							
K- Fertilizer (K2O .ha -1)	Varieties	Root length (cm)	Root fresh weight (g)	Root dry weight (g)	No. of nodules / plant	Nodules fresh weight (g)	Nodules dry weight (g)
0 Kg K2O / ha	Avolla	15.66 e-g	1.26 ef	0.50 i	16.66 f	0.16 c-e	0.03
	Joneor	13.33 h	1.20 f	0.50 i	16.66 f	0.11 g	0.02
	Sancho	13.67 h	1.26 ef	0.52 i	16.66 f	0.11 g	0.02
	Green Sage	14.33 gh	1.63 cd	0.47 ij	17.00 ef	0.11 g	0.03
	Mamoth	14.66 gh	1.53 de	0.38 j	16.66 f	0.11 g	0.02
40 Kg K2O / ha	Avolla	15.00 f-h	1.80 b-d	0.64 h	21.66 cd	0.13 fg	0.03
	Joneor	15.00 f-h	1.53 de	0.66 f-h	20.66 cd	0.15 d-f	0.03
	Sancho	16.66 c-f	1.53 de	0.67 gh	20.33 cd	0.16 c-e	0.03
	Green Sage	15.66 e-g	1.70 c-d	0.77 c-f	23.00 bc	0.14 ef	0.03
	Mamoth	16.00 d-g	1.93 a-c	0.88 a-c	19.66 de	0.17 c-e	0.03
60 Kg K2O / ha	Avolla	17.33 b-e	2.16 a	0.90 a	26.00 a	0.17 c-e	0.04
	Joneor	17.33 b-e	1.63 cd	0.82 a-e	22.00 c	0.19 bc	0.05
	Sancho	18.06 bc	1.66 cd	0.760 e-g	21.33 cd	0.19 bc	0.05
	Green Sage	19.00 ab	1.90 a-c	0.79 b-e	26.66 a	0.19 bc	0.05
	Mamoth	18.66 b	1.80 b-d	0.76 ef	23.00 bc	0.18 b-d	0.05
80 Kg K2O / ha	Avolla	20.66 a	2.13 a	0.90 ab	27.00 a	0.24 a	0.06
	Joneor	18.33bc	1.66 cd	0.91 ab	25.00 ab	0.24 a	0.05
	Sancho	18.66 b	2.03 ab	0.93 a	19.00 d-f	0.20 b	0.05
	Green Sage	18.33 bc	1.83 bc	0.84 a-e	21.66 cd	0.24 a	0.04
	Mamoth	17.66 b-d	1.90 a-c	0.77 c-f	26.33 a	0.25 a	0.05
LSD ($p \leq 0.05$)		1.78	0.27	0.12	2.97	0.03	N.S

Data represent in this Table 4.8 explain the interaction effect between potassium fertilizer and pea varieties on root length which respond non significantly to this interaction.

There were no significant interaction effect between potassium fertilizer and pea varieties in the character root fresh weight.

From the same Table and Appendix highly significant interaction effect between potassium fertilizer and pea varieties was noticed. Maximum root dry weight value 1.05 g was exhibited by the interaction of Avolla variety under 80 kg K_2O ha^{-1}. The lowest value 0.44 g was recorded by the interaction of Mamoth variety coupled with 0 kg K_2O ha^{-1}.

Highly significant interaction between potassium fertilizer and pea varieties were observed due to the character number of nodules per plant. Maximum number of nodules per plant recorded b y the interaction of Avolla variety under 80 kg K_2O ha^{-1}, which was nodules 31.66 (Table 4.8). The minimum number 20.33 was nodules recorded by the interaction of Sancho variety under 0 kg K_2O ha^{-1}.

From the same table, highly significant interaction between potassium fertilizer and pea varieties were recorded. The interaction of mamoth variety with 80 kg K_2O ha^{-1} recorded maximum value for nodule fresh weight which was 0.27 gm. The minimum value 0.12 gm was recorded by the inter action of Sancho varieties with 0 kg K_2O ha^{-1}.

The interaction between potassium fertilizer and pea varieties was not significant for the character nodules dry weight.

Respect to spring season the interaction effect between potassium fertilizer and varieties were highly significant for root dry weight ,number of nodules per plant and nodules fresh weight, while it was significant for root length and root fresh weight and it was not significant for nodules dry weight.

Maximum value due to the character root length, number of nodules per plant and nodules fresh weight 20.6, 27.0 and 0.24 were recorded by the interaction of 80 kg K_2O ha^{-1} with Avolla variety, while for the character root fresh weight and root dry weight 2.16 and 0.94 gm were, recorded by the interaction of 60 kg K_2O ha^{-1} with Avolla variety.

The lowest value for root length and root fresh weight 13.33 and 1.20 gm were recorded by the association of 0 kg $K_2O.ha^{-1}$ with Joneor variety (Table 4.8), while for root dry weight it 0.38 was produced by the same potassium level under Mamoth variety for the number of nodules/plant the lowest value 16.66 was recorded under the interaction of 0kg K_2O ha^{-1} with the varieties of Avolla, Joneor, Sancho and Mamoth.

The interaction of the same level of potassium with both varieties of Sancho and Mamoth recorded the lowest value for nodules fresh weight with 0.11 gm.

Table 4.9. The variance analysis of yield and its components.

Autumn season											
S. O. V.	d.f	M.S									
		No. of Pods / plant	Weight of pods / plant (g)	Pod length (cm)	No. of seeds/pod	Weight of seeds /pod (g)	100-seed weight (g)	Seeds weight / plant (g)	Biological yield / plant (g)	Harvest Index	Seed yield (Kg/ha)
Blocks	2	5.71	4.325	0.496	0.717	0.036	1.812	10.201	69.628	0.026	1541200.6
Potassium Fertilizer	3	40.203	113.203	3.292	3.883	0.125	19.515	7.686	155.295	0.015	756473.9
Error (a)	6	1.11	1.479	0.085	0.250	0.008	0.498	0.338	7.754	0.001	1282088.0
Varieties	4	47.05	18.625	7.848	6.025	0.125	20.585	34.718	14.676	0.007	1121295.7
Potassium Fertilizer x Varieties	12	4.93	1.146	0.397	0.425	0.014	0.932	0.707	12.672	0.006	1208780.4
Error (b)	32	2.14	0.536	0.145	0.388	0.007	0.915	0.638	1.713	0.001	1180293.1
Spring season											
S. O. V.	d.f	No. of Pods / plant	Weight of pods / plant (g)	Pod length (cm)	No. of seeds / pod	Weight of seeds / pod (g)	100-seed weight (g)	Seeds Weight /plant (g)	Biological Yield /plant (g)	Harvest Index	Seed yield (Kg/ha)
Blocks	2	1.513	3.517	0.041	0.429	0.037	1.433	3.826	34.785	0.075	17781.95
Potassium Fertilizer	3	14.644	2.428	2.797	0.904	0.103	20.317	1.208	23.580	0.022	5610.91
Error (a)	6	0.709	0.394	0.196	0.196	0.007	0.741	0.446	2.006	0.008	2071.32
Varieties	4	11.370	7.598	5.954	3.942	0.100	16.626	7.499	11.501	0.041	34861.66
Potassium Fertilizer x Varieties	12	0.832	0.264	0.340	0.286	0.012	1.503	0.290	9.407	0.014	1349.12
Error (b)	32	0.545	0.217	0.256	0.338	0.008	0.583	0.138	6.867	0.016	643.04

Table 4.10. The effect of Potassium fertilization on yield and its components.

	Autumn season									
K-Fertilizer (K_2O kg/ha)	No. of pods / plant	Weight of pods / plant (g)	Pod length (cm)	No. of seeds / pod	Weight of seeds / pod (g)	100-seed weight (g)	Seeds weight / plant (g)	Biological weight / plant (g)	Harvest Index	Seed yield (Kg / ha)
0	7.4 c	14.70 c	6.35 c	3.4 b	1.14 b	18.18 c	13.11 c	28.1 c	0.52 c	1571.0
40	9.2 b	15.25 c	6.55 c	3.1 b	1.29 ab	19.40 b	13.78 b	27.0 c	0.57 b	1039.5
60	9.5 b	18.49 b	6.87 b	3.5 b	1.32 ab	19.97 b	14.4 a	31.4 b	0.59 ab	1260.3
80	11.4 a	20.51 a	7.42 a	4.3 a	1.35 a	20.91 a	14.73 a	34.0 a	0.60 a	1397.8
LSD ($p \leq 0.05$)	0.94	1.08	0.26	0.4	0.07	0.63	0.520	2.488	0.027	n.s
Spring season										
K-Fertilizer (K_2O kg/ha)	No. of pods / plant	Weight of pods / plant (g)	Pod length (cm)	No. of seeds / pod	Weight of seeds / pod (g)	100-seed weight (g)	Seeds weight / plant (g)	Biological weight / plant (g)	Harvest Index	Seed yield (Kg / ha)
0	3.2 b	5.2 a	5.55 c	3.1	1.06 b	15.0 d	5.0 ab	13.9	0.37	342.6 ab
40	3.8 b	5.7 ab	5.90 bc	2.8	1.19 a	15.9 c	4.9 b	13.3	0.41	337.6 b
60	4.7ab	5.9 a	6.01 b	3.0	1.22 a	16.8 b	5.3 ab	15.5	0.34	363.5 ab
80	5.5 a	6.2 a	6.59 a	3.4	1.24 a	17.7 a	5.5 a	15.9	0.32	379.4 a
LSD ($p \leq 0.05$)	0.752	0.561	0.395	N.S	0.074	0.7	0.5	N.S	N.S	40.6

Highly significant effect of potassium fertilizer on number of pods per plant was observed,the applications of 80 kg K_2O ha^{-1} recorded maximum number of pods per plant 11.46 pods which predominated the other applications by 53.56, 23.74 and 20.28 %, respectively. The lowest number of pods was recorded by the application of 0 kg K_2O ha^{-1} which was pods 7.46. There were not significant differences between the applications of 40 and 60 kg K_2O ha^{-1} for this character.

Highly significant effect of potassium fertilizer was observed in weight of pods per plant, maximum weight was recorded by the potassium level of 80 kg K_2O ha^{-1} which was 14.73 gm and followed by 14.40 gm recorded by 60 kg K_2O ha^{-1}. The application of 80 kg K_2O ha^{-1} exceeded 0and 40 kg K_2O ha^{-1} by 12.36, 6.89 %, respectively. The lowest weight was recorded by the treatment of control which was 13.11 gm (Table 4.10).

Highly significant effect of potassium fertilizer was noticed on the character pod length .The longest pod recorded by 80 kg K_2O ha^{-1}, which was 7.42 cm, and exceeds the rest by 16.90, 13.33 and 8.06 %, respectively. The lowest value recorded by the treatment of control which was 6.35cm.

Highly significant differences among potassium levels due the character number of seeds per pod was noticed. Maximum number 4.33 was seeds exhibited by the level of 80 kg K_2O ha^{-1} , which predominated the other levels by 24.97, 38.32 and 22.63 %, respectively. No significant differences were represent between 40 kg K_2O ha^{-1} and 60 kg K_2O ha^{-1} for this character. The lowest value recorded by the application of 40 kg K_2O ha^{-1} which was 3.13 seeds (Table 4.10).

Highly significant effect of potassium fertilizer in the character weight of seeds per pod was confirmed, the highest value 1.35 gm was recorded by 80 kg K_2O ha^{-1}. which exceeded 0, 40 kg K_2O ha^{-1} by 17.77 and 4.24 %, respectively. There were no significant differences between the application of 60 and 80 kg K_2O ha^{-1}, for this character. The treatment of control recorded minimum value with 1.14 gm.

Highly significant differences were recorded among the potassium levels due to the 100-seed weight. The application of 80 kg K_2O ha^{-1} recorded maximum value 20.91 gm, and out yielded the other applications by 15.00, 7.78 and 4.69 % , respectively. No significant differences were present between 40 and 60 kg K_2O ha^{-1} for this character the lowest value 18.18 gm was recorded by 0 kg K_2O ha^{-1}.

Highly significant differences among potassium levels due to the character seed weight per plant was recorded. Maximum weight recorded by 80 kg K_2O ha^{-1}, which was 20.51 g, and predominated the rest by 39.45, 34.48 and 10.90 %, respectively. No significant differences were observed between 0 and 40 kg K_2O ha^{-1} for this character. The lowest seed weight per plant14.70 gm was recorded by 0 kg K_2O ha^{-1}.

The biological weight per plant responds high significantly to potassium applications, maximum value 34.05 gm was recorded by 80 kg K_2O ha^{-1}, which exceeded the rest by 21.14, 26.13 and 8.25 %, respectively (Table 4.10). No significant differences were noticed between 0 and 40 kg K_2O ha^{-1}. The lowest weight 27.00 gm was recorded by 40 kg K_2O ha^{-1}.

The same table and appendix ratify the highly significant differences among potassium levels due to harvest index. 0 kg K_2O ha^{-1} produced maximum harvest index 0.60, which exceeded 0 and 40 kg $K_2O.ha^{-1}$ by13.79 and 5.61 %, respectively. No significant differences were recorded between 40 and 60 kg K_2O ha^{-1} .and also between 60 and 80 kg K_2O ha^{-1}. The lowest value for harvest index 0.52 was recorded by 0 kg K_2O ha^{-1}.

The potassium applications affected non significantly in seed yield at autumn season .

Respect to spring season the effect of potassium fertilizer was highly significant for the character number of nodules per plant, weight of pods per plant, pod length, weight of seeds per pod and 100 seeds weight, while it was significant for seed weight per plant and seed yield but not significant for the characters number of seeds per pod,

biological weight and harvest index. The application of 80 kg K_2O ha^{-1} produced maximum values for all characters except harvest index recording 5.50, 6.32, 6.59, 1.24, 17,78, 5.56 and 379.48 for the character number of pods per plant.

Weight of pods per plant, pod length, weight of seeds per pod, 100 seed weight, seed weight per plant and seed yield respectively. The treatment of control produced the lowest values for these characters except seed yield with 3.28, 5.26, 5.55, 1.06, 15.06 and 5.02 , respectively (Table 4.10). While 40 kg K_2O ha^{-1} gave minimum value for seed yield with 337.68 $kg.ha^{-1}$.

Kakar et al (2002) confirmed that the application of potassium fertilizer increased the character number of pods per plant.

Kakar et al 2002 and Akhtar et al 2003 reported that the application of potassium fertilizer increased pod yield per plant due to increasing pod length and pod number.

Previous workers ratified that the application of recommended dose of NPK showed better performance of seed yield (Ashraf et al 2011) and (Shakoor Khanady et al 2012).

Table 4.11. The differences among pea varieties in yield and its components.

Autumn season										
Varieties	No. of pods / plant	Weight of pods / plant (g)	Pod length (cm)	No. of seeds / pod	Weight of seeds / pod (g)	100-seed weight (g)	Seeds weight / plant (g)	Biological weight / plant (g)	Harvest Index	Seed yield (Kg/ha)
Avolla	12.5 a	19.4 a	7.94 a	4.58 a	1.43 a	21.77 a	16.91 a	31.95 a	0.61 a	1322.9 ab
Joneor	10.0 b	17.1 b	6.30 c	3.08 b	1.23 b	19.76 b	13.65 bc	30.08 bc	0.57 b	1168.6 ab
Sancho	8.9 bc	16.6 bc	6.19 c	3.08 b	1.22 b	18.96 c	13.88 b	30.14 b	0.55 c	1133.3 b
Green Sage	8.0 c	16.3 c	7.37 b	3.16 b	1.23 b	19.21 bc	12.58 c	29.60 bc	0.55 c	1116.8 b
Mamoth	7.6 c	16.6 bc	6.19 c	4.16 a	1.24 b	18.35 c	13.01 c	28.99 c	0.57 b	1844.1 a
LSD ($p \leq 0.05$)	1.2	0.609	0.317	0.518	0.071	0.79	0.66	1.08	0.02	703.4
Spring season										
Varieties	No. of pods / plant	Weight of pods / plant (g)	Pod length (cm)	No. of seeds / pod	Weight of seeds / pod (g)	100-seed weight (g)	Seeds weight / plant (g)	Biological weight / plant (g)	Harvest Index	Seed yield (Kg/ha)
Avolla	5.8 a	7.08 a	6.96 a	3.83 a	1.34 a	18.23 a	6.45 a	15.62	0.42	439.7 a
Joneor	4.7 a	5.50 c	5.42 b	2.70 b	1.14 b	16.98 b	4.93 c	15.46	0.32	336.3 c
Sancho	3.8 c	5.95 b	5.56 b	2.58 b	1.13 b	15.70 c	5.53 b	14.45	0.43	377.2 b
Green Sage	3.7 c	5.08	6.57 a	2.75 b	1.14 b	15.79 c	4.50 d	13.17	0.32	306.7 d
Mamoth	3.4 c	5.29 cd	5.55 b	3.58 a	1.13 b	15.40 c	4.68 cd	14.75	0.32	319.2 cd
LSD ($p \leq 0.05$)	0.6	0.38 d	0.42	0.48	0.07	0.63	0.309	N.S	N.S	21.08

Data in this table (4.11) signify the presence of highly significant differences between varieties due to number of pods per plant. Avolla variety produce maximum number of pods plant^{-1} 12.58 and pre dominated the rest by 25.83, 41.11, 57.28 and 64.11 %, in compare to Joneor, Sancho, Green Sage and Mamoth respectively. There were no significant differences between Joneor and Sancho and also between Sancho and Green Sage. The lowest value due to this character 7.66 was pods recorded by Mamoth variety.

Highly significant differences were present between varieties for the character weight of pots per plant . Avolla predominated the other varieties recording 16.91 g, and exceeded Joneor, Sancho, Green Sage and Mamoth by 23.86, 21.77, 34.33 and 29.96 %, respectively. Green Sage gave the lowest weight of pods, which was 12.58 g (Table 4.11).

The differences between varieties were highly significant due to the pod length. Avolla gave maximum value for this character which was 7.94 cm and followed by the variety Green Sage with 7.37 cm. Avolla exceeded Joneor, Sancho, Green Sage and Mamothby 25.90, 28.26, 7.68 and 28.26 %, respectively. No significant differences were recorded among Joneor, Sancho and Mamoth. The lowest value 6.192 cm was recorded by the varieties of Sancho and Mamoth.

Highly significant differences between varieties due to the number of seeds per pod was noticed. Maximum number recorded by Avolla with 4.58 seeds and exceeded the varieties of Joneor, Sancho and Green Sage by 48.65, 48.65 and 44.71 respectively. No significant differences were recorded between the varieties of Avolla and Mamoth and also between Joneor and Sancho. The minimum value 3.08 seed was recorded by the varieties of Joneor and Sancho.

Highly significant differences were present in the character weight of seed per pod among pea varieties.

Variety Avolla gave maximum value with 1.46 gm, and predominated the varieties of Joneor, Sancho, Green sage, and Mamoth by 18.94, 19.23, 18.46, and 17.22 %, respectively. There were no significant differences between varieties Joneor ,Sancho, Greensage and Mamoth. The Sancho variety gave the lowest weight, which was 1.22 gm.

The varieties were differ in the 100 seed weight, Avolla showed maximum value 21.77 gm and exceeded Joneor, Sancho, Green sage and Mamoth by 10.13, 14.82, 13.32 and 18.63 %, respectively. No significant differences were present between Joneor and Green sage and also between Sancho and Mamoth .The lowest weight of 100 seed 18.35 was produced by Mamoth variety.

The difference between varieties was highly significant due to the character seed weight per plant. Avolla gave maximum value 19.41 gm and out yielded Joneor,

Sancho, Green sage and Mamoth by 13.20, 16.74, 18.48 and 16.74 %, respectively (Table 4.11). There were no significant difference among Joneor, Sancho and Mamoth and also between Sancho Green sage and Mamoth. The variety of Green sage recorded minimum weight 16.38 gm.

Highly significant differences were recorded between varieties due to the character biological weight per plant. Avolla gave the highest value which was 31.95 gm and exceeded the varieties of Joneor, Sancho, Green sage and Mamoth by 6.22, 6.02, 7.93 and 10.20 %, respectively. No significant differences were recorded among Joneor, Sancho and Green sage and also between Green sage and Mamoth. The lowest value 28.99 gm was recorded by Mamoth variety.

The varieties were recorded different value for the character harvest index. Avolla showed maximum values with 0.61 and predominated the varieties of Joneor, Sancho, Green sage and Mamoth by 6.64, 9.90, 10.50 and 6.08 %, respectively (Table 4.11). No significant differences were recorded between the varieties of Joneor and Mamoth and also between Sancho and Green sag. The variety of Green sage recorded minimum value which was 0.55.

Highly significant differences of seed yield for different pea varieties were recorded. Mamoth with 1844.18 kg ha^{-1} gave maximum value and exceeded the other varieties of Avolla, Joneor, Sancho and Green sage by 39.40, 57.798, 62.72 and 65.12 % ,respectively. No significant differences were observed between Avolla, Joneor and Sancho. Green sage produce the lowest seed yield which was 1116.82 $kg.ha^{-1}$ (Table 4.11).

Concerning to spring season the difference between varieties were highly significant for all characters except seed weight per plant which was significant and biological weight per plant and harvest index which were not significant.

Avolla variety recorded maximum value for the characters number of pods per plant, weight of pods per plant, pod length, number of seeds per pod, weight of seeds per pod, 100 seed weight, seed weight per plant and seed yield with 5.86, 7.08, 6.96, 3.83 , 1.34 ,18.23, 6.45 and 439.73, respectively (Table 4.11). The lowest value, due to the number of pod per plant 100 seed weight and seed yield was 3.48, 15.40 and 319.27 recorded by Mamoth variety while for weight of pods per plant and seed weight per plant were 5.08 and 4.50 gm recorded by Green sage variety, and for number of seeds per pod and weight of seed per pod were 2.58 and 1.13 recorded by Sancho variety, while for pod length it 5.42 was recorded by Joneor variety.

Arshad et al 1998 stated that number of seeds was correlated with pod length.Significant differences were reported among varieties for the characters number of seeds per pod and 100-seed weight (Ali et al 2002a; Ali et al 2002 b ; Abdolla 2015).

Table 4.12. The interaction effect of potassium fertilizer and varieties on yield and its components.

Autumn season											
K-Fertilizer Kg/ha)	Varieties	No. of pods / plant	Weight of pods / plant (g)	Pod length (cm)	No. of seeds / pod	Weight of seeds / pod (g)	100-seed weight (g)	Seeds weight / plant (g)	Biological weight / plant (g)	Harvest Index	Seed yield (Kg / ha)
0	Avolla	9.0 c-e	16.7 f	7.30 c	3.66	1.19	21.01	15.50	26.0 j	0.64 a	1138.00 b
	Joneor	7.3 d-f	15.0 h	6.16 e-g	3.33	1.09	18.53	13.70	29.40 gh	0.51 ij	1024.63 b
	Sancho	8.0 d-f	14.50 hi	5.76 f-h	3.00	1.18	17.00	12.87	30.70 e-g	0.47 j	988.43 b
	Green Sage	6.3 f	13.30 i	7.10 cd	3.33	1.11	17.83	11.28	28.33 hi	0.47 j	906.76 b
	Mamoth	6.6 f	14.00 hi	5.43 h	4.00	1.15	16.53	12.21	26.10 j	0.54 hi	3797.60 a
40	Avolla	12.6 ab	18.03 de	7.26 c	4.33	1.46	21.73	16.65	32.60 b-e	0.55 g-i	1229.00 b
	Joneor	11.3 bc	15.30 gh	6.33 ef	2.66	1.24	19.63	13.31	25.76 j	0.59 b-f	1042.80 b
	Sancho	9.3 cd	15.06 h	5.6 gh	2.33	1.18	18.60	13.45	24.90 j	0.61 a-e	1026.46 b
	Green Sage	6.6 ef	13.43 i	7.30 c	2.66	1.31	18.53	12.69	26.86 ij	0.50 j	915.86 b
	Mamoth	6.3 f	14.42 hi	6.20 e-g	3.66	1.28	18.50	12.90	24.87 j	0.58 c-f	983.46 b
60	Avolla	14.0 a	20.60 b	8.13 b	4.66	1.55	22.00	17.45	33.33 bc	0.62 a-d	1404.00 b
	Joneor	8.667 de	18.16 de	6.13 e-g	2.66	1.31	20.16	14.04	31.83 c-f	0.57 e-h	1237.33 b
	Sancho	9.000 c-e	17.17 ef	6.10 e-g	3.33	1.25	20.10	14.57	30.90 e-g	0.55 g-i	1167.00 b
	Green Sage	7.667 d-f	18.73 cd	7.43 c	2.66	1.26	19.56	12.68	29.66 f-h	0.63 ab	1276.66 b
	Mamoth	8.333 d-f	17.85 d-f	6.56 e	4.33	1.25	18.03	13.28	31.56 c-g	0.56 f-h	1216.66 b
80	Avolla	14.667 a	22.31 a	9.06 a	5.66	1.64	22.36	18.12	35.86 a	0.62 a-c	1520.66 b
	Joneor	12.667 ab	20.10 b	6.60 de	3.66	1.27	20.73	13.56	33.33 bc	0.60 b-f	1370.00 b
	Sancho	9.333 cd	19.82 bc	7.23 cd	3.66	1.28	20.16	14.65	34.06 ab	0.58 d-h	1351.33 b
	Green Sage	11.333 bc	20.07 b	7.66 bc	4.00	1.25	20.93	13.70	33.56 bc	0.59 b-f	1368.00 b
	Mamoth	9.333 cd	20.23 b	6.56 e	4.66	1.30	20.36	13.63	33.45 bc	0.60 a-f	1379.00 b
	LSD (p ≤ 0.05)	2.434	1.32	0.63	N.S	N.S	N.S	N.S	2.17	0.040	1806.86

4. RESULTS and DISCUSSIONS

Spring season											
K-Fertilizer Kg/ha)	Varieties	No. of pods / plant	Weight of pods / plant (g)	Pod length (cm)	No. of seeds / pod	Weight of seeds / pod (g)	100-seed weight (g)	Seeds weight / plant (g)	Biological weight / plant (g)	Harvest Index	Seed yield (Kg / ha)
0	Avolla	4.16	6.33	6.13	3.33	1.11	17.50 bc	5.96 bc	13.00	0.47	406.76 ab
	Joneor	5.33	7.33	6.43	3.66	1.31	18.03 ab	6.70 a	16.00	0.42	347.66 c-e
	Sancho	6.66	7.33	7.13	3.66	1.42	18.23 ab	6.56 ab	16.20	0.40	359.03 cd
	Green Sage	7.33	7.33	8.16	4.66	1.52	19.10 a	6.56 ab	17.23	0.38	277.23 i
	Mamoth	3.16	5.33	5.06	3.16	1.03	15.30 c-e	5.10 d-f	14.83	0.34	322.66 d-h
40	Avolla	4.66	5.33	5.80	2.33	1.14	17.10 bc	4.50 f-i	14.26	0.32	456.80 a
	Joneor	4.83	5.66	5.16	2.66	1.23	17.10 bc	5.10 d-f	16.13	0.31	306.76 e-i
	Sancho	6.16	5.66	5.66	2.66	1.17	18.20 ab	5.03 ef	16.63	0.30	331.76 d-h
	Green Sage	3.33	5.16	5.23	2.66	1.10	14.00 h	5.26 de	15.16	0.34	293.13 hi
	Mamoth	3.66	5.66	5.43	2.33	1.11	15.20 d-h	4.86 e-h	10.20	0.66	299.96 g-i
60	Avolla	4.00	6.16	5.43	2.66	1.15	17.20	5.667cd	15.40	0.36	447.66 a
	Joneor	4.50	6.83	6.16	2.66	1.18	16.20 c-e	6.33 ab	17.03	0.37	347.66 c-e
	Sancho	2.66	4.33	6.13	2.66	1.03	14.50 fg	4.06 i	13.96	0.32	386.30 bc
	Green Sage	2.66	5.16	6.33	2.33	1.21	14.30 fg	4.30 hi	13.03	0.33	318.16 e-i
	Mamoth	4.33	5.16	6.66	2.66	1.17	16.50 ce	4.66 e-i	14.46	0.32	318.16 e-i
80	Avolla	5.33	5.66	7.16	3.33	1.15	17.80 b	4.96 e-g	11.23	0.30	447.70 a
	Joneor	3.10	5.16	5.20	3.66	1.03	14.00 h	4.733 e-h	12.60	0.38	343.13 c-e
	Sancho	2.66	5.16	5.53	3.33	1.16	15.16 ef	4.40 g-i	13.26	0.33	431.73 a
	Green Sage	4.00	5.16	5.66	3.66	1.16	15.0 ef	4.66 e-i	15.60	0.29	338.56 d-g
	Mamoth	4.16	5.66	5.80	3.66	1.19	17.40 bc	4.93 e-g	17.53	0.28	336.30 d-g
LSD ($p \leq 0.05$)		N.S	N.S	N.S	N.S	N.S	1.27	0.61	N.S	N.S	42.17

Data in this table (4.12) explain the interaction effect between potassium fertilizer and pea varieties in seed yield and its components.

Significant interaction between potassium fertilizer and pea varieties were presented due to the character number of pods per plant. Maximum number of pods 14.66 was produced by the interaction of Avolla variety with 80 kg K_2O ha^{-1}. The lowest number of pods 6.33 pods was showed by both interaction Green sage with 0 kg K_2O ha^{-1} and Mamoth under 40 kg K_2O ha^{-1}.

The interaction between potassium fertilizer and varieties was not significant for the character weight of podsper plant. The values were restricted between 11.21 and 18.12 for the interactions of Green sage with 0 kg K_2O ha^{-1} and Avolla with 80 kg K_2O ha^{-1} respectively.

Significant interaction was observed between potassium fertilizer and pea varieties for the character pod length. The interaction of Avolla variety with 80 kg K_2O ha^{-1} produced maximum pod length 9.06 cm, while the interaction between Mamoth and 0 kg K_2O ha^{-1} showed the lowest value of pod length which was 5.43cm.

The interaction between potassium fertilizer and pea varieties was not significant due to the character number of seeds per pod. The values were ranged between 2.66 for the interactions of Joneor under 40 and 60 kg K_2O ha^{-1} and Green sage under 40 and 60 kg K_2O ha^{-1} and 5.66 for Avolla under 80 kg K_2O ha^{-1}.

The effect of interaction between potassium fertilizer and pea varieties were not significant for the character weight of seeds per pod. The values of seed weight per pod restricted between 1.09 and 1.64 gm for the interactions of Joneor variety coupled with 0 kg K_2O ha^{-1} and Avolla variety coupled with 80 kg K_2O. ha^{-1} respectively (Table 4.12).

The interaction effect between potassium fertilizer and pea varieties was not significant due to the 100-seed weight. The 100-seed weight values restricted between 16.53 and 22.36 gm for both interactions of Mamoth under 0 kg K_2O ha^{-1} and Avolla variety under 80 kg K_2O ha^{-1} respectively.

The character seed weight per plant respond significantly to the interaction between potassium fertilizer and pea varieties. The maximum weight 22.31 gm was, exhibited by Avolla variety coupled with 80 kg K_2O ha^{-1}, while the lowest weight 13.30 gm was, produced by Green sage variety coupled with 0 kg K_2O ha^{-1}.

Respond high significant to the interaction effect of potassium fertilizer and pea varieties. The interaction between Avolla variety with 80 kg K_2O ha^{-1}produced maximum biological weight which was 35.86 gm, while the interaction of Mamoth variety with 40 kg K_2O ha^{-1} gave the lowest weight which was 24.867gm.

The interaction between potassium fertilizer and pea variety was highly significant due to the character harvest index. Maximum value of harvest index 0.64 was produced by the interaction of Avolla variety coupled with 0 kg K_2O ha^{-1}, while the lowest value 0.47 was produced by the interaction of Sancho variety with 0 kg K_2O ha^{-1}.

Highly significant interaction was produced between potassium fertilizer and pea varieties for the character Seed yield. Maximum value of seed yield 3797.60 K_2O ha^{-1} was produced by Mamoth variety associated with 0 kg K_2O ha^{-1} while the minimum seed yield 906.76 K_2O $ha^{-1}$was produced by Green sage variety under the application of 0 kg K_2O. ha^{-1} (Table 4.12).

Respect to spring season, all studied characters in this table respond to the interaction effect between potassium fertilizer level and varieties non significantly except the 100-seed weight, seed weight per plant and seed yield, which respond

significantly to this effect. Maximum value due to 100-seed weight was 19.167 g recorded by the interaction of 80 kg K_2O ha^{-1} and Avolla variety, while the lowest value 14.00 gm was recorded by the interaction of 0 kg K_2O ha^{-1} with Mamoth variety. The interaction of 40 kg K_2O ha^{-1} with Avolla variety recorded maximum value for seed weight per plant with 6.70 gm and seed yield with 456.80 m kg ha^{-1} while the interaction of 0 kg K_2O ha^{-1} with Green sage variety recorded minimum value for seed weight per plant and seed yield with 4.06 gm and 227.22 kg.ha^{-1} respectively.

Data in this Table (4.13) explain the effect of potassium fertilizer in plant forage weight at autumn season.

Table 4.13. The variance analysis of plant forage wieght.

Autumn season							
S. O. V.	d.f	M.S					
		plant fresh weight(gm)	Leaf fresh weight(gm)	Stem fresh weight(gm)	plant dry weight(gm)	laef dry weight(gm)	stem dry weight(gm)
Blocks	2	5.987	5.987	0.780	0.867	0.606	0.050
Potassium Fertilizer	3	239.216	239.216	44.186	28.839	4.808	10.132
Error (a)	6	8.294	8.294	3.905	0.539	0.554	0.051
Varieties	4	168.788	168.788	43.405	5.979	1.195	2.027
Potassium Fertilizer x Varieties	12	18.185	18.185	5.260	1.134	0.596	0.809
Error (b)	32	8.979	8.979	1.477	0.802	0.611	0.128
Spring season							
S. O. V.	d.f	plant fresh weight(gm)	Leaf fresh weight(gm)	Stem fresh weight(gm)	plant dry weight(gm)	laef dry weight(gm)	stem dry weight(gm)
Blocks	2	12.717	16.850	13.067	0.686	0.176	0.130
Potassium Fertilizer	3	193.083	54.978	69.172	26.471	4.446	9.230
Error (a)	6	16.317	9.428	16.822	0.565	0.108	0.286
Varieties	4	106.225	71.233	38.692	4.415	1.404	1.337
Potassium Fertilizer x Varieties	12	13.958	7.422	12.436	1.349	0.391	0.898
Error (b)	32	9.875	5.263	5.362	0.939	0.430	0.437

The effect of potassium fertilizer was highly significant in all character except leaf dry weight which was significant the application of 80 kg K_2O ha^{-1} produced maximum values for the characters plant fresh weight, leaf fresh weight, plant dry weight, leaf dry weight and stem dry weight with 47.57, 29.13, 10.22, 6.52 and 3.70 gm respectively. The application of 60 kg K_2O ha^{-1} gave maximum stem fresh weight 18.78 gm. The minimum value due to these characters was produced by the treatment of control with 38.65, 15.08, 6.83, 5.13 and 1.692 gm, respectively.

Table 4.14. The effect of Potassium fertilization on Plant forage weight(g).

	Autumn season					
K- Fertilizer (K2O / ha)	plant fresh weight(gm)	Leaf fresh weight(gm)	Stem fresh weight(gm)	plant dry weight(gm)	laef dry weight(gm)	stem dry weight(gm)
0 Kg K2O / ha	38.65 c	23.56 b	15.08 b	6.80 c	5.13 c	1.69 c
40 Kg K2O / ha	44.08 b	27.43 a	16.64 b	8.42 b	5.82b	2.59 b
60 Kg K2O / ha	46.58 a	27.79 a	18.78 a	8.52 b	5.79 bc	2.72 b
80 Kg K2O / ha	47.57 a	29.13 a	18.44 a	10.22 a	6.52 a	3.70 a
LSD (p ≤ 0.05)	2.53	2.15	1.76	0.65	0.66	0.20
Spring season						
K- Fertilizer (K2O / ha)	plant fresh weight(gm)	Leaf fresh weight(gm)	Stem fresh weight(gm)	plant dry weight(gm)	laef dry weight(gm)	stem dry weight(gm)
0 Kg K2O / ha	35.73 b	21.20 b	14.53 b	6.50 c	4.70 c	1.78 b
40 Kg K2O / ha	40.80 a	24.26 a	16.53 ab	8.12 b	5.37 b	2.80 b
60 Kg K2O / ha	42.00 a	23.93 ab	19.40 a	8.18 b	5.40 b	2.78 b
80 Kg K2O / ha	44.20 a	25.80 a	18.40 a	9.75 a	6.05 a	3.70 a
LSD (p ≤ 0.05)	3.60	2.74	3.66	0.67	0.29	0.48

Regards to spring season all these character respond high significantly to potassium application levels.The application of 80 kg K_2O ha^{-1} gave maximum values for characters plant fresh weight, leaf fresh weight, plant dry weight, leaf dry weight and stem dry weight with 44.20, 25.80, 9.75, 6.05 and 3.70 gm, respectively (Table 4.14). While the application of 60 kg K_2O ha^{-1} give maximum value for stem fresh weight with 19.400 gm the application of 0 kg K_2O ha^{-1} produced the lowest value for all characters with 35.73, 21.20, 14.53, 6.50, 4.72 and 1.78 gm, respectively.

The significant value of potassium fertilizer were noticed previously in total fresh weight of pea (Singhet et al 2006).

Data in this Table (4.15) explain the average of plant forge weight at both seasons Regarding to autumn season there were highly significant difference between varieties for all characters except the character leaf dry weight which was not significant, the Avolla variety gave maximum values for all characters with 50.02, 30.64, 19.38, 9.63, 6.28 and 3.35 gm respectively.

The lowest value for the characters plant fresh weight, stem fresh weight and leaf dry weight produced by Joneor variety with 41.25, 14.29 and 5.48 gm respectively (Table 4.15). While Sancho variety gave the lowest value for leaf fresh weight with 24.73 gm , and the lowest value due to plant dry weight and stem dry weight showed by the variety green sage with 7.93, 2.22 gm respectively.

Table 4.15. The means of plant forage weight for pea varieties.

	Autumn season					
Varieties	plant fresh weight(gm)	Leaf fresh weight(gm)	Stem fresh weight(gm)	plant dry weight(gm)	laef dry weight(gm)	stem dry weight(gm)
Avolla	50.02 a	30.64 a	19.38 a	9.63 a	6.28	3.35 a
Joneor	41.25 c	26.95 bc	14.29 d	7.96 c	5.48	2.47 bc
Sancho	41.70 c	24.73 c	16.96 c	8.70 a	5.99	2.71 b
Green Sage	42.15 c	24.88 c	17.27 c	7.93 c	5.66	2.26 c
Mamoth	45.97b	27.68 b	18.29 b	8.27 bc	5.68	2.58 b
LSD (p ≤ 0.05)	2.49	2.19	1.01	0.74	N.S	0.297
Spring season						
Varieties	plant fresh weight(gm)	Leaf fresh weight(gm)	Stem fresh weight(gm)	plant dry weight(gm)	laef dry weight(gm)	stem dry weight(gm)
Avolla	44.33 a	27.83 a	18.16 ab	9.10 a	5.84 a	3.32 a
Joneor	37.91 b	23.33 b	14.58 c	7.63 b	4.95 b	2.68 b
Sancho	38.41 b	21.66 c	16.75 b	8.30 b	5.59 a	2.70 b
Green Sage	39.33 b	22.16 bc	17.16 b	7.65 b	5.23 b	2.42 b
Mamoth	43.41 a	24.00 b	19.41 a	8.00 b	5.31 a	2.68 b
LSD (p ≤ 0.05)	2.61	1.90	1.92	0.80	0.54	0.54

At spring season there were highly significant differences among varieties for all characters except leaf dry weight and stem dry weight in which there were significant differences among varieties.

Maximum value recorded by Avolla variety for all characters except the character stem fresh weight, with 44.33, 27.83, 9.10, 5.84 and 3.32 gm for the character plant fresh weight, leaf fresh weight, plant dry weight, leaf dry weight, stem dry weight respectively.

While Mamoth variety gave maximum value from stem fresh weight with 19.41 gm. The lowest values for the characters plant fresh weight stem fresh weight, plant dry weight, leaf dry weight were produced by Joneor variety with 37.91, 14.58, 7.63 and 4.95 gm respectively.

While Sancho gave the lowest value for leaf fresh weight with 21.66gm and Green sage for the character stem dry weight with 2.425 gm. Previous workers reported significant differences between varieties due to forage yield of pea (Bilgili et al 2010); Turk et al 2011 and Abdolla 2015).

Table 4.16. The interaction effect of potassium fertilizer and varieties on plant forage weight (g).

Autumn season							
K- Fertilizer (K2O / ha)	Varieties	plant fresh weight(gm)	Leaf fresh weight(gm)	Stem fresh weight(gm)	plant dry weight(gm)	laef dry weight(gm)	stem dry weight(gm)
0	Avolla	43.06	25.73	17.33 c-d	8.19	5.70	2.49 ef
	Joneor	36.40	24.13	12.26 i	5.68	4.27	1.40 h
	Sancho	37.80	20.83	16.96 c-f	7.16	5.50	1.65 gh
	Green Sage	35.00	21.36	13.63 i	6.18	4.69	1.49 h
	Mamoth	41.00	25.76	15.23 e-h	6.92	5.50	1.41 h
40	Avolla	50.25	31.81	18.43 bc	9.09	6.35	2.74 de
	Joneor	41.60	27.56	14.03 hi	8.50	6.04	2.43 ef
	Sancho	42.16	25.36	16.80 c-f	8.09	5.58	2.50 ef
	Green Sage	41.46	25.06	16.40 d-g	8.69	5.49	3.20 b-d
	Mamoth	44.93	27.36	17.56 c-e	7.75	5.66	2.09 fg
60	Avolla	53.83	33.03	20.80 a	9.52	5.07	3.45 bc
	Joneor	40.00	25.50	14.50 g-i	8.13	5.74	2.38 ef
	Sancho	46.80	28.53	18.26 b-d	9.66	6.48	3.17 b-d
	Green Sage	45.60	24.96	20.63 a	7.04	5.60	1.42 h
	Mamoth	46.66	26.93	19.73 ab	8.25	5.05	3.19 b-d
80	Avolla	52.96	32.00	20.96 a	11.70	6.99	4.71 a
	Joneor	47.00	30.63	16.37 d-g	9.54	5.85	3.68 b
	Sancho	40.03	24.20	15.83 e-h	9.91	6.39	3.52 bc
	Green Sage	46.56	28.13	18.43 bc	9.79	6.84	2.94 c-e
	Mamoth	51.31	30.68	20.63 a	10.16	6.53	3.63 b
LSD ($p \leq 0.05$)		N.S	N.S	2.02	N.S	N.S	0.59
Spring season							
K- Fertilizer (K2O / ha)	Varieties	plant fresh weight(gm)	Leaf fresh weight(gm)	Stem fresh weight(gm)	plant dry weight(gm)	laef dry weight(gm)	stem dry weight(gm)
0	Avolla	39.333 d-f	24.667 bc	14.667 e-g	7.800	5.167	2.633
	Joneor	33.00 gh	20.66 de	12.33 g	5.30	3.90	1.40
	Sancho	34.33 f-h	18.00 e	16.33 d-f	6.90	5.03	1.86
	Green Sage	31.66 h	19.33 e	12.33 g	5.90	4.50	1.40
	Mamoth	40.33 c-e	23.33 b-d	17.00 c-f	6.60	5.00	1.60
40	Avolla	45.33 ab	28.66 a	16.66 d-f	8.46	5.86	2.83
	Joneor	37.66 e-g	24.33 b-d	13.33fg	8.36	5.46	2.90
	Sancho	39.00 d-f	21.66 b-e	17.33 c-e	7.63	5.13	2.50
	Green Sage	39.66 de	23.33 b-d	16.33 d-f	8.66	5.10	3.56
	Mamoth	42.33 c-e	23.33 b-d	19.00 b-d	7.50	5.30	2.20
60	Avolla	43.66 bc	29.66 a	20.67 a-c	9.16	5.93	3.23
	Joneor	37.66 e-g	21.00 c-e	16.66 d-f	7.73	5.03	2.70
	Sancho	42.33 c-e	23.33 b-d	19.00 b-d	9.20	6.10	3.10
	Green Sage	43.00 b-d	21.00 c-e	22.00 ab	6.73	5.16	1.56
	Mamoth	43.33 bc	24.66 bc	18.67 cd	8.06	4.76	3.30
80	Avolla	49.00 a	28.33 a	20.67 a-c	11.00	6.40	4.60
	Joneor	43.33 bc	27.33 a	16.00 d-g	9.13	5.40	3.73
	Sancho	38.00 d-g	23.66 b-d	14.33 e-g	9.46	6.10	3.36
	Green Sage	43.00 b-d	25.00 b	18.00 c-e	9.33	6.16	3.16
	Mamoth	47.66 ab	24.66 bc	23.00 a	9.83	6.20	3.63
LSD ($p \leq 0.05$)		5.22	3.81	3.85	N.S	N.S	N.S

Data in this Table 4.16 explain the interaction effect between potassium fertilizer and varieties due to plant forge weight of both seasons. At autumn season the stem fresh weight and steam dry weight respond high significantly to this effect. The interaction of 80 kg K_2O ha^{-1} with Avolla variety gave maximum values for these characters with 20.96 and 4.718 gm, respectively.

Table 4.17. Calculated (t) for the correlation coefficient.

Autumn season								
Characters	No. of pods / plant	Weight of pods / plant	Pod length	No. of seeds / pod	Weight of seeds / pod	100-seed weight	Biological weight / plant	Harvest Index
Weight of pods / plant (g)	4.937**							
Pod length (cm)	3.090**	3.402**						
No. of seeds / pod	2.786*	3.379**	2.907**					
Weight of seeds / pod (g)	5.026**	3.974**	4.458**	3.472**				
100-seed weight (g)	6.276**	5.865**	4.383**	2.377*	4.778**			
Biological weight / plant (g)	3.355**	6.785**	2.711*	3.296**	3.037**	3.188**		
Harvest Index	2.644*	3.679**	1.712	1.201	2.011	3.692**	0.673	
Seeds weight / plant (g)	5.753**	3.853**	3.532**	3.421**	6.272**	6.339**	2.740*	2.364*
Spring season								
Characters	No. of Pods /plant	Weight of pods / Plant	Pod length	No. of seeds / pod	Weight of seeds / pod	100-seed weight	Biological weight / plant	Harvest Index
Weight of pods / plant (g)	4.797**							
Pod length (cm)	3.724**	2.798*						
No. of seeds / pod	2.171*	2.392*	2.421					
Weight of seeds / pod (g)	5.496**	5.151**	4.635**	2.704*				
100-seed weight (g)	8.104**	4.473**	3.007**	1.760	3.932**			
Biological weight / plant (g)	2.329*	2.054	0.640	1.417	2.459*	2.091		
Harvest Index	-0.020	1.395	-0.110	-0.329	0.088	-0.136	-2.210	
Seeds weight / plant (g)	3.881**	14.238**	2.179*	2.333	3.673**	3.431**	2.315*	1.320

**. Correlation is significant at the 0.05 level (2-tailed) , $t_{0.05}(18)=2.101$*

***. Correlation is significant at the 0.01 level (2-tailed) , $t_{0.01}(18)=2.878$*

While the lowest values for these characters 12.26 and 1.40 was recorded by the interaction between 0 kg K_2O ha^{-1} and Joneor variety .

At spring season all characters respond non significantly to the interaction effect between potassium fertilizer and pea varieties except the character (stem fresh weight) which respond significantly to these effect.

The interaction of 80 kg K_2O ha^{-1} with Mamoth variety gave the highest stem fresh weight with 23.00 gm while the interaction of 0 kg K_2O ha^{-1} and Joneor variety gave the lowest value with 12.33 gm, and the same value recorded by the interaction of 0 kg K_2O ha^{-1} and Green sage variety.

Table 4.18. Correlation Coefficient.

	Autumn season								
Characters	**No. of pods / plant**	**Weight of pods / plant (g)**	**Pod length (cm)**	**No. of seeds / pod**	**Weight of seeds / pod (g)**	**100-seed weight (g)**	**Biological weight / plant (g)**	**Harvest Index**	**Seeds weight / plant (g)**
No. of pods / plant	1.000								
Weight of pods / plant (g)	0.758	1.000							
Pod length (cm)	0.589	0.626	1.000						
No. of seeds / pod	0.549	0.623	0.565	1.000					
Weight of seeds / pod (g)	0.764	0.684	0.724	0.633	1.000				
100-seed weight (g)	0.828	0.810	0.719	0.489	0.748	1.000			
Biological weight / plant (g)	0.620	0.848	0.538	0.614	0.582	0.601	1.000		
Harvest Index	0.529	0.655	0.374	0.272	0.428	0.657	0.157	1.000	
Seeds weight / plant (g)	0.805	0.672	0.640	0.628	0.828	0.831	0.543	0.487	1.000

Table 4.19. Path Coefficient Analysis.

	Autumn season							
Characters	**No. of pods / plant**	**Weight of pods / plant**	**Pod length**	**No. of seeds / pod**	**Weight of seeds / pod**	**100-seed weight**	**Biological weight / plant**	**Harvest Index**
No. of pods / plant	**0.164**	0.125	0.097	0.090	0.126	0.136	0.102	0.087
Weight of pods / plant (g)	-5.013	**-6.610**	-4.135	-4.118	-4.518	-5.355	-5.604	-4.330
Pod length (cm)	0.013	0.013	**0.021**	0.012	0.016	0.015	0.012	0.008
No. of seeds / pod	0.144	0.163	0.148	**0.261**	0.166	0.128	0.160	0.071
Weight of seeds / pod (g)	0.341	0.305	0.323	0.283	**0.446**	0.334	0.260	0.191
100-seed weight (g)	0.361	0.353	0.313	0.213	0.326	**0.436**	0.262	0.286
Biological weight / plant (g)	2.987	4.083	2.593	2.954	2.803	2.893	**4.815**	0.755
Harvest Index	1.8080	2.240	1.280	0.931	1.464	2.244	0.536	**3.419**
Seeds weight / plant (g) Correlation	**0.805**	**0.672**	**0.640**	**0.628**	**0.828**	**0.831**	**0.543**	**0.487**

Table 4.20. Correlation Coefficient.

Spring season									
Characters	**No. of pods / plant**	**Weight of pods / plant (g)**	**Pod length (cm)**	**No. of seeds / pod**	**Weight of seeds / pod (g)**	**100-seed weight (g)**	**Biological weight / plant (g)**	**Harvest Index**	**Seeds weight / plant (g)**
No. of pods / plant	1.000								
Weight of pods / plant (g)	0.749 **	1.000							
Pod length (cm)	0.660 **	0.551 *	1.000						
No. of seeds / pod	0.455 *	0.491 *	0.496 *	1.000					
Weight of seeds / pod (g)	0.792 **	0.772 **	0.738 **	0.538 *	1.000				
100-seed weight (g)	0.886 **	0.726 **	0.578 **	0.383 n.s	0.680 **	1.000			
Biological weight / plant (g)	0.481 *	0.436 n.s	0.149 n.s	0.317 n.s	0.501 *	0.442 n.s	1.000		
Harvest Index	-0.005 n.s	0.312 n.s	-0.026 n.s	-0.077 n.s	0.021 n.s	-0.032 n.s	-0.462 *	1.000	
Seeds weight / plant (g)	0.675 **	0.958 **	0.457 *	0.482 *	0.655 **	0.629 **	0.479 *	0.297 n.s	1.000

Table 4.21. Path Coefficient Analysis.

Autumn season								
Characters	No. of pods / plant	Weight of pods / plant (g)	Pod length (cm)	No. of seeds / pod	Weight of seeds / pod (g)	100-seed weight (g)	Biological weight / plant (g)	Harvest Index
No. of pods / plant	**0.146**	0.109	0.096	0.066	0.115	0.129	0.070	-0.001
Weight of pods / plant (g)	0.840	**1.122**	0.618	0.551	0.866	0.814	0.489	0.351
Pod length (cm)	0.059	0.049	**0.089**	0.044	0.066	0.052	0.013	-0.002
No. of seeds / pod	0.019	0.021	0.021	**0.042**	0.023	0.016	0.013	-0.003
Weight of seeds / pod (g)	-0.288	-0.281	-0.268	-0.196	**-0.364**	-0.247	-0.182	-0.008
100-seed weight (g)	-0.193	-0.158	-0.126	-0.084	-0.148	**-0.218**	-0.096	0.007
Biological weight / plant (g)	0.092	0.083	0.029	0.061	0.096	0.085	**0.192**	-0.088
Harvest Index	-0.0002	0.013	-0.001	-0.003	0.001	-0.001	-0.019	**0.042**
Seeds weight / plant (g) Correlation	**0.675 ** **	**0.958 ** **	**0.457 * ***	**0.482 * ***	**0.655 ** **	**0.629 ** **	**0.479 * ***	**0.297** n.s

Table 4.17 indicate to the simple correlation coefficient among characters at the autumn season. Number of pods per plant correlated positively

and high significantly with weight of pods per plant, pod length, weight of seeds per pod, 100 seed weight, biological weight per plant and seed weight per plant, while it correlated positively and significantly with number of seeds per pod, and harvest index.Weight of pods per plant recorded positive and highly significant correlation with pod length, number of seeds per pod, weight of seeds per pod, 100 –seed weight, biological weight per plant, harvest index and seed weight per plant.Pod length correlated high significantly and positively with number of seed per pod, weight of seeds per pod, 100-seed weight, and seeds weight per plant, and correlated with biological weight per plant positively and significantly. Number of seeds per pod recorded positive and highly significant correlation with weight of seeds per pod biological weight per plant and seed weight per plant, but correlated positively and significantly with 100-seed weight. The character weight of seeds per pod gave positive and highly significant correlation with 100-seed weight, biological weight per plant and seed weight per plant. The character 100-seed weight recorded positive and highly significant correlation with biological weight per plant, harvest index and seed weight per plant.Biological weight per plant and harvest index recorded positive and significant correlation with seed weight per plant.

Data in Table 4.19 indicate to the path coefficient between characters and seed weight per plant.At autumn season. Maximum positive direct effect in seed weight per plant recorded by biological weight per plant with 4.81, while maximum negative direct effect in seed weight per plant recorded by weight of pod/plant with (-6.61). Maximum positive indirect effect in seed weight per plant was 4.08 recorded by weight of pod per plant via biological weight per plant, while maximum negative indirect (-5.60) effect was recorded by biological weight per plant via weight of pods per plant.

Data in Table 4.20 confirm that the character number of pods per plant recorded positive and highly significant correlation with weight of pods per plant, pods length, weight of seeds per pod, 100-seed weight, and seed weight per plant, while it correlated positively and significantly with number of seeds

per pod and biological weight per plant. Weight of pods per plant gave positive and highly significant correlation with weight of seeds per pod, 100-seed weight and seed weight per plant, while it correlated positively and significantly with pod length and number of seed per pod.The character pod length gave positive and highly significant correlation with weight of seed per pod and 100-seed weight, but it correlated positively and significantly with number of seed per pod, and seed weight per plant. Number of seed per pod gave positive and significant correlation with weight of seeds per pod gave positive and highly significant correlation with 100-seed weight and seed weight per plant, while it correlated significantly and positively with biological weight per plant. 100-Seed weight recorded positive and highly significant correlation with seed weight per plant, and biological weight per plant recorded negative and significant correlation with harvest index and positive and significant correlation with seed weight per plant.

The path coefficient analysis between the characters and seed weight per plant at spring season represent in Table 4.21 The character weight of pods per plant recorded maximum positive direct effect in seed weight per plant with 1.12, while weight of seeds per pod recorded maximum negative direct effect in seed weight per plant with (-0.36). Maximum positive indirect effect in seed weight per plant 0.86 was recorded by weight of seeds per pod via weight of pods per plant, while maximum negative indirect effect (-0.28) was recorded by number of pods per plant via weight of seeds per pod.

5. CONCLUSIONS

According to our results, the following conclusion can be drawn.

1.It was clearly observed the prominent role of potassium, in which the application of (80 kg K_2O ha^{-1}) recorded maximum value for most growth and yield characters, this due to its great role in plant vigor and accelerate up take of some other nutrients.

2.Potassium fertilizer has a significant effect on the yield attributes of pea and gives the highest net returns and increasing soil fertility and economical status.

3. Varieties are differed in respect to philological, yield and some yield related traits, and were highly affected by environments.

4. High magnitude of variability among varieties contributed to yield components indicating that the Avolla variety recorded superior values for yield and most important components.

5. It was confirmed that the pea yields were liable to significant fluctuation with the changes in environment across the growing seasons.

6. The results showed that the winter season was better to cultivation of pea varieties under Suleimani condition.

6. RECOMMENDATIONS

1. Further investigation were required due to these varieties under different environmental conditions and different cultulard practices to ensure their performances.

2. The presence of significant diversity within these varieties confirms to have a great interest in providing variable materials to further studies.

3. According to our results we can recommend the application of (80 kg K_2O ha^{-1}, while further studies regarding the application of potassium is needed, which may lead to significant promotion of growth and yield pea crop.

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