

Interactive Effect of Phosphorus and Potassium on Growth, Yield, Quality and Seed Production of Chili (*Capsicum annuum* L.)

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Abstract

Phosphorus (P) and potassium (K) play an important role in growth of chili. An adequate amount of P and K exerts significant effect on the growth, yield, quality and seed production of this crop. To evaluate suitable dose of P and K for different growth, yield, quality and seed production parameters of the exotic land race of chili which was brought from Spain (paradon), and aim to improve it through selection under environmental conditions of Rawalakot. An experiment was laid out in randomized complete block design (RCBD) with eight different treatments. Maximum plant height (53 cm), number of branches per plant (41.20), number of leaves per plant (340.8), number of flowers per plant (90.83), number of fruits per plant (30.17), fruit length (9 cm), fruit girth (13.03), weight of fruit per plant (465.5 g), weight of 1000 seeds (6.93 g), acidity (169.67 mg g⁻¹) and Phosphorus percentage (0.3153) was observed in T3 when applied 100 kg ha⁻¹ of P and 120 kg ha⁻¹ of K. Best results regarding most of the growth, yield and quality parameters of chili crop was observed in T3 therefore, combined application of 100 kg ha⁻¹ of P and 120 kg ha⁻¹ of K could be recommended to farmers for best growth and yield of this crop under agro climatic conditions of Rawalakot.

Keywords: Chili; Growth; Phosphorus; Potassium; Quality; Yield

Introduction

Chilli (*Capsicum annuum* L.) belongs to the family *solanaceae* and has a tremendous economic importance [1]. It is also very popular among the people for its medicinal value because the extract of chili is used in different pharmaceutical products. The pungency in chilli is due to the presence of a volatile alkaloid 'Oleoresin capsaicin', a major alkaloid among capsaicinoids produced only in *Capsicum* fruits [2]. Chillies are highly nutritive and contain a high proportion of digestible proteins, carbohydrates, minerals and vitamins. The sweet pepper commonly known as chili is the world's third most important vegetable after tomato and potato [3]. Chili is an important vegetable crop used as condiment, salad and food spice. It is cultivated in Pakistan on an area of 62.7 thousand hectares with the production of 145.8 thousand tons. The total production of chili in Pakistan during the year 2013-14 was 145.1 thousand tons. It is cultivated at an area of 62.5 thousand hectares [4]. A wide range of the germplasm of this crop is available in our country. However, improved varieties having better taste, quality, disease resistance and high yield, are needed to be introduced because an introduction is a source of variable genes to improve the existing genetic material for evolving better varieties.

Chilli thrives best in a wide range of cultivation, being grown under both tropical and subtropical regions of Pakistan [1]. It is available in previous literature that the effect of potash (K) is mostly on the quality of fruits and vegetables. Among so many plant mineral nutrients, the P and K elements play an important role in the growth and yield of chillies [5]. Furthermore, potassium plays very important role in plant growth and metabolism which includes photosynthesis, enzymatic activities, and translocation of nutrients and water in the plant. The Solanaceae group of vegetables (tomato, eggplant, chili and bell peppers) generally takes up large amounts of nutrients that have specialized functions and should be supplied to plant at the right time with suitable quantity [6]. When chillies are adequately supplied with the essential nutrients through fertilization it improves their yield, quality and enhance maturity.

After nitrogen (N), phosphorus (P) is the second most frequently

limiting macronutrient for plant growth. Phosphorus (P) is a component of key molecules such as nucleic acids, phospholipids, and ATP [7]. An adequate supply of P is required for optimum growth and reproduction. It is involved in several key plant functions, including energy transfer, photosynthesis, transformation of sugars and starches, nutrient movement within the plant and transfer of genetic characteristics from one generation to the next [8]. Phosphorus promotes root growth and provides resistances to root diseases [9].

Although K is not a constituent of any organic molecule or plant structure, it is involved in numerous biochemical and physiological processes vital to plant growth, yield, quality, and stress tolerance. In addition to stomatal regulation of transpiration and photosynthesis, potassium is also involved in photophosphorylation, enhance enzyme activation, turgor maintenance, and stress tolerance. Adequate K nutrition has also been associated with increased yields, fruit size, increased soluble solids and ascorbic acid concentrations, improved fruit color, increased shelf life, and shipping quality of many horticultural crops [10].

The present research was conducted to determine the optimum levels of phosphorus and potash for growth, yield, quality and seed production of an exotic genetic material of chilli crop which is collected as an introduction from Spain and improved through single plant selection under the agro-climatic conditions of Rawalakot, Azad Jammu and Kashmir.

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Materials and Methods

An experiment was conducted to know the effect of varying levels of phosphorus and potassium on growth, yield, quality and seed production of an exotic land race of chili (Padron). The collected samples from Galicia province of Spain (Padron) were used as plant material to test its performance under agro climatic conditions of Rawalakot, Azad Jammu and Kashmir. The experiment was designed in accordance with Randomized Complete Block Design (RCBD) with eight treatments such as T₀ (Control); T₁ (P₀ K₁₂₀ kg ha⁻¹); T₂ (P₁₀₀ K₀ kg ha⁻¹); T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹); T₄ (P₁₅₀ K₀ kg ha⁻¹); T₅ (P₁₅₀ K₁₂₀ kg ha⁻¹); T₆ (P₂₀₀ K₀ kg ha⁻¹) and T₇ (P₂₀₀ K₁₂₀ kg ha⁻¹) and three replications. There were twenty four plots with size 1.0 × 1.5 m² and each plot had three rows of plants with P×P and R×R distance of 30 cm and 45 cm respectively.

The parameters included in the study were plant height (cm) (was measured from the soil surface to the apical top with a measuring tape), number of leaves per plant, and number of branches per plant (were calculated by counting the leaves and branches of each plant from randomly selected plants and then average was calculated), number of flowers per plant (number of flowers of the selected plants from each plant was counted from start of flowering up to the maturity of crop), number of fruits per plant (assessed by counting the number of fruits from each plant at the time of picking of the fruits and then average was calculated), fruit length (cm) (length of fruit was taken with the help of measuring tape), fruit girth (cm) (fruit diameter was measured with the help of vernier caliper), fruit weight per plant (g) (It was measured with the help of balance and their average was taken), flowering duration (Days from start of flowering up to end of flowering were counted from each treatment and then average was worked out), duration of fruit ripening (it was recorded by counting the number of days from fruit initiation up to the ripening of the fruits), number of seeds per fruit (It was taken by counting the total number of seeds from each fruit and then average was calculated), weight of 1000 seeds (g) (It was taken by counting the thousand seeds and then their weight was calculated with the help of electric balance), total fruit moisture (%) (The fresh and dry weight of the samples was noted and fruit moisture % was calculated by the following formula:

$$\text{Moisture (\%)} = \frac{\text{wt. of fresh sample} - \text{wt. of sample after drying}}{\text{wt. of sample}} \times 100$$

Total acidity in fruit (mg g⁻¹) was determined by the following formula:

$$\text{Total acid} = \frac{1/10 \times \text{Equiv. wt. of acid} \times \text{normality of NaOH} \times \text{titre}}{10}$$

Total ascorbic acid in fruit (mg 100 g⁻¹) was quantitatively determined according to 2, 6 dichloroindophenol-dye method [11], while total phosphorus in fruit (%) was measured using the method

described by Yoshida et al. [12], and total capsaicin content in fruit (mg 100 g⁻¹) was determined by the method of Anan et al. [13]. The collected data was analyzed by using the Analysis of Variance (ANOVA) Technique and difference among the treatment means was compared by using Least Significant Difference (LSD) Test at 5% probability level [14].

Results and Discussion

Plant height (cm)

Data in Table 1 pertaining to the height of plant of chili in response to varying levels of phosphorus and potash, revealed the significant differences with each other. Treatment T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹) and T₁ (P₀ K₁₂₀ kg ha⁻¹) attained the superiority and maximum plant height 53.00 cm and 51.33 cm respectively. T₁ (P₀ K₁₂₀ kg ha⁻¹) with plant height of 51.33 cm was followed by T₇ (P₂₀₀ K₁₂₀ kg ha⁻¹) with 44.83 cm plant height. T₂ (P₁₀₀ K₀ kg ha⁻¹) and T₅ (P₁₅₀ K₁₂₀ kg ha⁻¹) behaved equally with plant height of 36.33 cm and 35.67 cm, respectively. T₆ (P₂₀₀ K₀ kg ha⁻¹) and T₄ (P₁₅₀ K₀ kg ha⁻¹) stood at bottom with 29.67 cm and 29.50 cm plant height respectively. The maximum plant height (53.00 cm) was obtained with the application of 100 kg P and 120 kg of K. The obtained results are in harmony with those of Fawzy et al. [15] on sweet pepper and Gupta and Sengar [16], on tomato, in which they observed that with the increase of phosphorous dose application, promotes plant height as compared to low rate of phosphorous.

Number of branches per plant

Result showed significant superiority of T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹) over all the other treatments and maximum number of branches (41.20) per plant were produced (Table 1). T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹) was followed by T₇ (P₂₀₀ K₁₂₀ kg ha⁻¹) and T₁ (P₀ K₁₂₀ kg ha⁻¹) with 32.03 and 24.67 number of branches per plant, respectively. Rest of all the treatments behaved equally with non-significant differences amongst each other. The minimum number of branches (15.00) per plant was recorded when no fertilizer was applied (control). The maximum number of branches (41.20) per plant was obtained with the application of 100 kg of P and 120 kg of K ha⁻¹. Phosphorus is absorbed by plants in larger amounts than any other mineral element except nitrogen and possibly calcium. Our findings are in accordance with the previous results of El-Bassiony et al. [17], who observed that maximum plant height, number of branches per plant, number of leaves per plant, fresh weight and dry weight of leaves were noted in the plant treated with potassium of 200 kg/fed followed by 100 kg/fed and 50 kg/fed.

Number of leaves per plant

Data in Table 1 revealed that maximum numbers of leaves (340.8) per plant were recorded in T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹). Significant difference was noted between T₁ (P₀ K₁₂₀ kg ha⁻¹) and T₇ (P₂₀₀ K₁₂₀ kg ha⁻¹) with 306.5 and 260.2 number of leaves per plant respectively. Rest of all

S/N	Treatments*	Plant height (cm)	No of branches plant ¹	No of leaves plant ¹
1	T ₃	53.00 ^a	41.20 ^a	340.8 ^a
2	T ₁	51.33 ^a	24.67 ^c	306.5 ^b
3	T ₇	44.83 ^b	32.03 ^b	260.2 ^c
4	T ₂	36.33 ^c	15.17 ^d	222.2 ^d
5	T ₅	35.67 ^c	17.67 ^d	224.2 ^d
6	T ₀	34.50 ^{cd}	15.00 ^d	169.2 ^e
7	T ₆	29.67 ^d	17.67 ^d	221.7 ^d
8	T ₄	29.50 ^d	15.03 ^d	211.2 ^d

T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹), T₁ (P₀ K₁₂₀ kg ha⁻¹), T₇ (P₂₀₀ K₁₂₀ kg ha⁻¹), T₂ (P₁₀₀ K₀ kg ha⁻¹), T₅ (P₁₅₀ K₁₂₀ kg ha⁻¹), T₀ (Control), T₆ (P₂₀₀ K₀ kg ha⁻¹) and T₄ (P₁₅₀ K₀ kg ha⁻¹)

Table 1: Effect of varying levels of phosphorous and potassium on vegetative growth parameter's.

the treatments except control behaved equally with non-significant differences amongst each other. The least number of leaves per plant (169.2) was recorded with T₀ (Control). The maximum number of leaves (340.8) was obtained with the application of P₁₀₀ K₁₂₀ kg ha⁻¹, with the increasing dose of P, resulted in decreasing number of leaves per plant. Increasing plant vegetative growth, yield as well as fruit quality and chemical composition due to increasing P fertilization levels have been reported by many workers on different crops. In context of potassium (K), maximum growth parameters such as plant height, number of leaves per plant, number of branches per plant as well as fresh weight and dry weights of leaves were observed, when applied with the dose of 200 kg/fed followed by 100 kg/fed and 50 kg/fed [17].

Number of flowers per plant

Treatment T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹) and T₇ (P₂₀₀ K₁₂₀ kg ha⁻¹) attained the superiority and maximum number of flowers per plant 90.83 and 85.33, respectively was recorded in these treatments (Table 2). Number of flower per plant is an important factor contributing the final yield of a plant with regard of number of flowers per plant as a result of P and K application it was noted that P alone did not exert any effect on increasing the number of flowers per plant as compared to control. The results about number of flowers per plant are supported by the findings of Kadam and Karthikeran [18], who got better results with the application of potassium fertilizer in chili.

Number of fruits per plant

Treatment T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹) secured the highest position with 30.17 number of fruits per plant while T₇ (P₂₀₀ K₁₂₀ kg ha⁻¹) and T₁ (P₀ K₁₂₀ kg ha⁻¹) produced 25.33 and 18.50 number of fruits per plant respectively (Table 2). The least number of fruits per plant (12.50) was recorded with control (no fertilizer). Plants treated with 100 kg of P and 120 kg of K ha⁻¹ produced the maximum number of fruits (30.17), which was 2.4 times more as compare to those plants which were not treated with any fertilizer (control). The results related to fruits are in accordance [15,19], where they proposed that potassium fertilization levels significantly affect fruit quality parameters and plant chemical composition.

Fruit length (cm)

T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹) got highest position with maximum fruit length (9.0 cm) (Table 2). T₃ is followed by T₁ (P₀ K₁₂₀ kg ha⁻¹) with 8.167 cm fruit length. T₅ (P₁₅₀ K₁₂₀ kg ha⁻¹) and T₇ (P₂₀₀ K₁₂₀ kg ha⁻¹) behaved equally with non-significant differences between each other and fruit length of 6.867 cm was observed in each. T₄ (P₁₅₀ K₀ kg ha⁻¹), T₆ (P₂₀₀ K₀ kg ha⁻¹) and T₂ (P₁₀₀ K₀ kg ha⁻¹) also behaved equally with non-significant differences among them and 6.233 cm, 6.167 cm and 6.133 cm fruit length respectively, was recorded in these treatments. The minimum fruit length (5.367 cm) was recorded in the treatment where

no fertilizer was applied (control). The maximum fruit length (9.0 cm) was observed when plants were treated with 100 kg of P and 120 kg of K ha⁻¹ [17] reported that the fruit measurements expressed as fruit length, average fruit weight and vitamin C content, as well as leaves chemical composition (N, P, K and total chlorophyll) were increased with increasing potassium fertilization rate.

Fruit girth (cm)

Data in Table 2 showed that T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹) and T₁ (P₀ K₁₂₀ kg ha⁻¹) attained the superiority and maximum fruit girth 13.03 cm and 12.77 cm respectively was recorded in these treatments. T₁ (P₀ K₁₂₀ kg ha⁻¹) was followed by T₅ (P₁₅₀ K₁₂₀ kg ha⁻¹) and T₇ (P₂₀₀ K₁₂₀ kg ha⁻¹) with 10.80 cm and 10.27 cm fruit girth respectively. T₄ (P₁₅₀ K₀ kg ha⁻¹), T₆ (P₂₀₀ K₀ kg ha⁻¹) and T₀ (Control) behaved equally with non-significant differences amongst each other, fruit girth 9.1 cm, 9.0 cm and 8.833 cm was recorded in these treatments respectively. Phosphorus takes part in plant metabolism and many important regulatory processes in the plant. The above results are in conformity with the findings of Fawzy et al. and Nasar et al. [15,19] on pepper, they proposed that potassium fertilization levels significantly affected fruit quality parameters and plant chemical composition.

Weight of fruit per plant (g)

T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹) attained the maximum fruit weight 465.5 g per plant (Table 2). T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹) was followed by T₇ (P₂₀₀ K₁₂₀ kg ha⁻¹) and T₁ (P₀ K₁₂₀ kg ha⁻¹) with 401.0 g and 285.6 g fruit weight per plant respectively. T₅ (P₁₅₀ K₁₂₀ kg ha⁻¹), T₄ (P₁₅₀ K₀ kg ha⁻¹) and T₂ (P₁₀₀ K₀ kg ha⁻¹) behaved equally with no significant difference between each other and weight of fruits 285.6 g, 266.0 g and 239.4 g were recorded in these treatments respectively. T₀ (Control) and T₆ (P₂₀₀ K₀ kg ha⁻¹) also behaved equally with no significant difference each other and 148.5 g and 137.1 g weight of fruit per plant respectively was recorded in these treatments. Steel et al. [14] reported that potassium had beneficial effects on nutrient uptake by plants and was particularly important for the transport and availability of micro-nutrients needed for optimal plant growth and development.

Flowering duration

Table 2 showed that T₇ (P₂₀₀ K₁₂₀ kg ha⁻¹) and T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹) got superiority with the largest duration of flowering 50.00 and 48.00 days respectively. T₂ (P₁₀₀ K₀ kg ha⁻¹), T₅ (P₁₅₀ K₁₂₀ kg ha⁻¹) and T₄ (P₁₅₀ K₀ kg ha⁻¹) behaved equally with no significant differences among each other with flowering duration 46.67, 46.00 and 45.67 days respectively. T₁ (P₀ K₁₂₀ kg ha⁻¹) and T₀ (control) also showing equally non-significant differences with 39.67 and 39.67 days respectively. Phosphorus improves the quality of the crop and hastens flowering [20].

S/N	Treatments*	No. of flowers plant ⁻¹	No. of fruits plant ⁻¹	Fruit length (cm)	Fruit growth (cm)	Weight of fruit plant ⁻¹ (g)	Flowering duration
1	T ₃	90.83 ^a	30.17 ^a	9.00 ^a	13.03 ^a	465.5 ^a	48.00 ^{ab}
2	T ₇	85.33 ^a	25.33 ^b	6.867 ^c	10.27 ^{bc}	401.0 ^b	50.00 ^a
3	T ₁	69.50 ^b	18.50 ^c	8.167 ^b	12.77 ^a	303.7 ^c	39.67 ^e
4	T ₅	66.67 ^{bc}	16.17 ^{cd}	6.867 ^c	10.80 ^b	285.6 ^{cd}	46.00 ^{bc}
5	T ₂	42.33 ^e	14.00 ^{de}	6.133 ^d	9.933 ^c	239.4 ^d	46.67 ^{bc}
6	T ₀	53.00 ^d	12.50 ^e	5.367 ^e	8.833 ^d	148.5 ^e	39.67 ^e
7	T ₆	57.83 ^{cd}	15.17 ^{de}	6.167 ^d	9.000 ^d	137.1 ^e	43.33 ^d
8	T ₄	54.17 ^d	14.33 ^{de}	6.233 ^d	9.100 ^d	266.0 ^{cd}	45.67 ^c

T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹), T₇ (P₂₀₀ K₁₂₀ kg ha⁻¹), T₁ (P₀ K₁₂₀ kg ha⁻¹), T₅ (P₁₅₀ K₁₂₀ kg ha⁻¹), T₂ (P₁₀₀ K₀ kg ha⁻¹), T₀ (Control), T₆ (P₂₀₀ K₀ kg ha⁻¹) and T₄ (P₁₅₀ K₀ kg ha⁻¹)

Table 2: Effect of varying levels of phosphorous and potassium on reproductive growth parameter's.

Duration of fruit ripening

Our results revealed that T₀ (Control) attained the superiority and largest fruit ripening duration (80.33 days) was recorded in this treatment (Table 3). T₁ (P₀ K₁₂₀ kg ha⁻¹), T₆ (P₂₀₀ K₀ kg ha⁻¹) and T₂ (P₁₀₀ K₀ kg ha⁻¹) behaved equally with no significant difference amongst each other with 73.00, 72.67 and 69.67 number of days for fruit ripening, respectively. T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹) and T₅ (P₁₅₀ K₁₂₀ kg ha⁻¹) also showed no significant difference between each other with 60.33 and 60.67 number of days, respectively. The smallest fruit ripening duration (60.33 days) was noted in the treatment T₅ (P₁₅₀ K₁₂₀ kg ha⁻¹). This remarkable decrease in fruit ripening duration in T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹) is might be due to optimum supply of phosphorus in combination with potash, as phosphorus enhances flowering, fruiting and early maturity in crops [21].

Number of seeds per fruit

Data in Table 3 showed that T₅ (P₁₅₀ K₁₂₀ kg ha⁻¹) secured the highest position with 274.8 number of seeds per fruit. T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹) and T₄ (P₁₅₀ K₀ kg ha⁻¹) produced 269.7 and 268.8 number of seeds fruit⁻¹, respectively and showed no significant difference between each other. T₂ (P₁₀₀ K₀ kg ha⁻¹) and T₀ (Control) also behaved equally with no significant difference between each other, and remained at the bottom with 240.7 and 239.2 number of seeds per fruit, respectively. The above results are supported by Ahmed et al. [22], who reported that the increasing rates of phosphorus fertilizer greatly affected the number of seeds per fruit.

Weight of 1000 seeds (g)

T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹) and T₆ (P₂₀₀ K₀ kg ha⁻¹) attained the maximum weight of seeds 6.933 g each (Table 3). T₇ (P₂₀₀ K₁₂₀ kg ha⁻¹), T₁ (P₀ K₁₂₀ kg ha⁻¹) and T₅ (P₁₅₀ K₁₂₀ kg ha⁻¹) behaved equally with no significant difference between each other, 1000 seed weight 6.700 g, 6.633 g and 6.567 g was recorded in these treatments respectively. T₀ (Control) and T₄ (P₁₅₀ K₀ kg ha⁻¹) also behaved equally with no significant difference with each other and 6.00 g and 5.900 g seed weight was recorded in

these treatments respectively. Singegol et al. [23] investigated that higher phosphorus resulting in higher yield and uptake of nitrogen, phosphorus and potassium was significantly higher with higher level of nitrogen and phosphorus.

Total fruit moisture (%)

T₁ (P₀ K₁₂₀ kg ha⁻¹) attained the highest position with maximum fruit moisture 92.9% (Table 4). T₁ is followed by T₇ (P₂₀₀ K₁₂₀ kg ha⁻¹) and T₅ (P₁₅₀ K₁₂₀ kg ha⁻¹) with total 91.81% and 91.660% moisture in fruit respectively. The least fruit moisture (90.15%) was recorded in fruits of those plants treated with no fertilizer (control). The above results show that application of potassium alone or in combination with phosphorus increased the total moisture content of fruit in chilli in the experiment but phosphorus alone did not show significant difference as compared to control. The above results are supported by El-Bassiony et al. [17], who stated that potassium fertilizers have great effect on fruit quality parameters of *capsicum annum*.

Total acidity in fruit (mg g⁻¹)

Data regarding treatment means in Table 4 revealed that maximum value for total acidity in fruit of chilli (169.67 mg g⁻¹) and (166.00 mg g⁻¹) in the treatment T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹) and T₁ (P₀ K₁₂₀ kg ha⁻¹) respectively. T₁ is followed by T₅ (P₁₅₀ K₁₂₀ kg ha⁻¹) with (165.00 mg g⁻¹) total acidity in fruit. T₇ (P₂₀₀ K₁₂₀ kg ha⁻¹) and T₂ (P₁₀₀ K₀ kg ha⁻¹) showed no significant differences between each other with (157.00 mg g⁻¹) and (156.67 mg g⁻¹) total acidity content, respectively. This significant increase in total acidity contents in fruits of plants treated with T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹) as compared to T₇ (P₂₀₀ K₁₂₀ kg ha⁻¹) and T₂ (P₁₀₀ K₀ kg ha⁻¹) is might be due to the role of potassium in fruit quality, where it is known as the quality nutrient because of its important effects on fruit quality parameters [17].

Total ascorbic acid in fruit (mg 100 g⁻¹)

T₇ (P₂₀₀ K₁₂₀ kg ha⁻¹) attained the highest position with maximum ascorbic acid 176.66 mg 100 g⁻¹ (Table 4). T₇ is followed by T₅ (P₁₅₀ K₁₂₀ kg ha⁻¹) and T₁ (P₀ K₁₂₀ kg ha⁻¹) these treatments showed no significant

S/N	Treatments*	Duration of fruit ripening	Numbers of seeds fruit ⁻¹	Weight of 1000 seeds(g)
1	T ₃	60.67 ^d	269.7 ^{ab}	6.933 ^a
2	T ₁	73.00 ^b	258.5 ^{bc}	6.633 ^{ab}
3	T ₇	64.67 ^c	253.0 ^{cd}	6.700 ^{ab}
4	T ₅	60.33 ^d	274.8 ^a	6.567 ^{ab}
5	T ₆	72.67 ^b	266.3 ^{abc}	6.933 ^a
6	T ₂	69.67 ^b	240.7 ^d	6.267 ^{bc}
7	T ₀	80.33 ^a	239.2 ^d	6.00 ^c
8	T ₄	64.00 ^{cd}	268.8 ^{ab}	5.900 ^c

T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹), T₁ (P₀ K₁₂₀ kg ha⁻¹), T₇ (P₂₀₀ K₁₂₀ kg ha⁻¹), T₅ (P₁₅₀ K₁₂₀ kg ha⁻¹), T₆ (P₂₀₀ K₀ kg ha⁻¹), T₂ (Control), T₀ (P₂₀₀ K₀ kg ha⁻¹) and T₄ (P₁₅₀ K₀ kg ha⁻¹)

Table 3: Effect of varying levels of phosphorous and potassium on seed production parameter's.

S/N	Treatments*	Total fruit moisture (%)	Total acidity in fruit (mg g ⁻¹)	Total ascorbic acid in fruit (mg 100g ⁻¹)	Total phosphorus in fruit (%)	Total capsaicin content in fruit (mg 100g ⁻¹)
1	T ₇	91.810 ^b	157.00 ^d	176.66 ^a	0.2933 ^{ab}	129.17 ^a
2	T ₃	91.120 ^{bc}	169.67 ^a	167.64 ^{ab}	0.3153 ^a	128.17 ^{ab}
3	T ₁	92.900 ^a	166.00 ^{ab}	163.71 ^{abc}	0.2567 ^{bc}	116.67 ^e
4	T ₅	91.660 ^{bc}	165.00 ^{abc}	167.00 ^{ab}	0.2720 ^{ab}	124.67 ^{bc}
5	T ₂	91.04 ^{bcd}	156.67 ^d	158.57 ^{bc}	0.3100 ^a	121.97 ^{cd}
6	T ₆	90.88 ^{bcd}	160.00 ^{cd}	163.31 ^{abc}	0.3080 ^{ab}	125.33 ^{abc}
7	T ₄	90.46 ^{cd}	160.33 ^{bcd}	160.83 ^{bc}	0.2940 ^{ab}	119.23 ^{de}
8	T ₀	90.15 ^d	160.00 ^{cd}	148.37 ^c	0.2115 ^c	115.87 ^e

T₇ (P₂₀₀ K₁₂₀ kg ha⁻¹), T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹), T₁ (P₀ K₁₂₀ kg ha⁻¹), T₅ (P₁₅₀ K₁₂₀ kg ha⁻¹), T₂ (P₁₀₀ K₀ kg ha⁻¹), T₆ (Control), T₄ (P₁₅₀ K₀ kg ha⁻¹) and T₀ (P₂₀₀ K₀ kg ha⁻¹)

Table 4: Effect of varying levels of phosphorous and potassium on chemical composition of chilli.

difference for total ascorbic acid contents in the fruit with the value of 167.64 mg 100 g⁻¹ and 167.00 mg 100 g⁻¹, respectively. The least value for total ascorbic acid contents in fruit (148.37 mg 100 g⁻¹), was recorded in fruits of those plants treated with no fertilizer (control). Economakis and Daskalaki [24] reported that potassium not only increased fruit yields but also improved fruit quality by increasing dry matter and vitamin C contents, as well as increasing sugar content and titra table acidity levels in tomato.

Total phosphorus in fruit (%)

Our results revealed that T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹) and T₂ (P₁₀₀ K₀ kg ha⁻¹) attained the highest position with maximum fruit phosphorus content (0.3153%) and (0.3100%) respectively (Table 4). Rest of all the treatments except control behaved equally with non-significant differences amongst each other. The least fruit phosphorus content (0.2115%) was recorded in fruits of those plants treated with no fertilizer (control). The above findings are in conformity by Deshpande and Lakhdive [25], they reported that phosphorus application increased P uptake and content in leaf, stem and reproductive part like seed.

Total capsaicin content in fruit (mg 100 g⁻¹)

Data in Table 4 showed that T₇ (P₂₀₀ K₁₂₀ kg ha⁻¹) and T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹) attained the highest position with maximum capsaicin content 129.17 mg 100 g⁻¹ and 128.17 mg 100 g⁻¹ respectively. T₁ (P₀ K₁₂₀ kg ha⁻¹) and T₀ (Control) showed no significant difference for capsaicin content in fruit with the value of 116.67 mg 100 g⁻¹ and 115.87 mg 100 g⁻¹, respectively. The least value for total capsaicin content mg 100 g⁻¹ in fruit (115.87 mg 100 g⁻¹) was recorded in fruits of those plants treated with no fertilizer (control). These results are supported by Murugan [26], who reported that the capsaicin content of green and ripe fruits and of dry pods increased with phosphorus application, although the variation between phosphorus rates was not significant.

Conclusion

From the above mentioned results it is clearly established that P and K are critical nutrients for vegetative growth parameters, total fruit yield, fruit quality and chemical composition of sweet chili plants. In terms of effect of these nutrients alone or in combination, it can be concluded on the basis of above results that P alone did not exert any effect on growth and quality parameters of chili crop as compared to control. However, K alone or in combination with P had a significant effect on growth, yield, quality and seed production of sweet chili under the climatic conditions of Rawalakot. Among various used treatments T₃ (P₁₀₀ K₁₂₀ kg ha⁻¹) showed best results regarding most of the growth, yield and quality parameters of chili crop. Therefore, combined application of 100 kg ha⁻¹ of P and 120 kg ha⁻¹ K could be recommended for farmers as an economically fit fertilizer treatment for optimum chili performance under Rawalakot conditions. However, further investigation is recommended with other plant nutrients to obtain maximum benefit from fertilizer applied.

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