Journal of Horticulture
ISSN: 2376-0354

Akram et al., J Hortic 2017, 4:1
DOI: 10.4172/2376-0354.1000192

Research Article Open Access

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

Mehnaz Akram[1], Sayed Hussain[2]*, Abdul Hamid[1], Sajid Majeed[1], Saeed Ahmed Chaudary[1], Zulifqar Ali Shah[1], Abid Yaqoob[1], Fozia Kayani[1], Uzma Arif[1], Kiran Fareed[1], Faiza Jamil[1], Zarfishan Mehmood[1], Saba Basher[1], Ayaz Ahmed Arif[1] and Naveed Akhter[1]

[1]*Department of Horticulture, University of Poonch Rawalakot, Pakistan*
[2]*Department of Agriculture, Abdul Wali Khan University Mardan, KP, Pakistan*

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 ofleaves 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 and120 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]. Chilies 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 tropicaland 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 chilies [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 Solanaceous 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 chilies 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.

***Corresponding author:** Sayed Hussain, Department of Agriculture, Abdul Wali Khan University Mardan, KP, Pakistan, Tel: 00923029153315; E-mail: syedhorti@gmail.com, sayedhussain@awkum.edu.pk

Received December 22, 2016; **Accepted** January 23, 2017; **Published** January 30, 2017

Citation: Akram M, Hussain S, Hamid A, Majeed S, Chaudary SA, et al. (2017) Interactive Effect of Phosphorus and Potassium on Growth, Yield, Quality and Seed Production of Chili (*Capsicum annuum* L.). J Hortic 4: 192. doi: 10.4172/2376-0354.1000192

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 Galacia 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 T_0 (Control); T_1 (P_0 K_{120} kg ha^{-1}); T_2 (P_{100} K_0 kg ha^{-1}); T_3 (P_{100} K_{120} kg ha^{-1}); T_4 (P150 K_0 kg ha^{-1}); T_5 (P_{150} K_{120} kg ha^{-1}); T_6 (P_{200} K_0 kg ha^{-1}) and T_7 (P_{200} K_{120} 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 selectedplants from each plant was counted from start of flowering up to the maturity of crop), number of fruits per plant (assessedby counting the number offruits 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 recordedby countingthe number of days from fruit initiation up to the ripening of the fruits), numberof 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% age was calculated by the following formula:

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

otal 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 T_3 (P_{100} K_{120} kg ha^{-1}) and T_1 (P_0 K_{120} kg ha^{-1}) attained the superiority and maximum plant height 53.00 cm and 51.33 cm respectively. T_1 (P_0 K_{120} kg ha^{-1}) with plant height of 51.33 cm was followed by T_7 (P_{200} K_{120} kg ha^{-1}) with 44.83 cm plant height. T_2 (P_{100} K_0 kg ha^{-1}) and T_5 (P_{150} K_{120} kg ha^{-1}) behaved equally with plant height of 36.33 cm and 35.67 cm, respectively. T_6 (P_{200} K_0 kg ha^{-1}) and T_4 (P_{150} K_0 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 T_3 (P_{100} K_{120} kg ha^{-1}) over all the other treatments and maximum number of branches (41.20) per plant were produced (Table 1). T_3 (P_{100} K_{120} kg ha^{-1}) was followed by T_7 (P_{200} K_{120} kg ha^{-1}) and T_1 (P_0 K_{120} 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 withpotassium 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 T_3 (P_{100} K_{120} kg ha^{-1}). Significant difference was noted between T_1 (P_0 K_{120} kg ha^{-1}) and T_7 (P_{200} K_{120} 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}

*T_3 (P_{100} K_{120} kg ha^{-1}), T_1 (P_0 K_{120} kg ha^{-1}), T_7 (P_{200} K_{120} kg ha^{-1}), T_2 (P_{100} K_0 kg ha^{-1}), T_5 (P_{150} K_{120} kg ha^{-1}), T_0 (Control), T_6 (P_{200} K_0 kg ha^{-1}) and T_4 (P_{150} K_0 kg ha^{-1})

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

Citation: Akram M, Hussain S, Hamid A, Majeed S, Chaudary SA, et al. (2017) Interactive Effect of Phosphorus and Potassium on Growth, Yield, Quality and Seed Production of Chili (*Capsicum annuum* L.). J Hortic 4: 192. doi: 10.4172/2376-0354.1000192

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 T_0 (Control). The maximum number of leaves (340.8) was obtained with the application of P_{100} K_{120} 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 asplant 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 T_3 (P_{100} K_{120} kg ha^{-1}) and T_7 (P_{200} K_{120} 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 T_3 (P_{100} K_{120} kg ha^{-1}) secured the highest position with 30.17 number of fruits per plant while T_7 (P_{200} K_{120} kg ha^{-1}) and T_1 (P_0 K_{120} 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)

T_3 ($P_{100}K_{120}$kg ha^{-1}) got highest position with maximum fruit length (9.0 cm) (Table 2). T3 is followed by T_1 (P_0 K_{120} kg ha^{-1}) with 8.167 cm fruit length. T_5 (P_{150} K_{120} kg ha^{-1}) and T_7 (P_{200} K_{120} kg ha^{-1}) behaved equally with non-significant differences between each other and fruit length of 6.867 cm was observed in each. T_4 (P_{150} K_0 kg ha^{-1}), T_6 (P_{200} K_0 kg ha^{-1}) and T_2 (P_{100} K_0 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 thatT_3 (P_{100} K_{120} kg ha^{-1}) and T_1 (P_0 K_{120} kg ha^{-1}) attained the superiority and maximum fruit girth 13.03 cm and 12.77 cm respectively was recorded in these treatments. T_1 (P_0 K_{120} kg ha^{-1}) was followed by T_5 (P_{150} K_{120} kg ha^{-1}) and T_7 (P_{200} K_{120} kg ha^{-1}) with 10.80 cm and10.27 cm fruit girth respectively. T_4 (P_{150} K_0 kg ha^{-1}) , T_6 (P_{200} K_0 kg ha^{-1}) and T_0 (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)

T_3 (P_{100} K_{120} kg ha^{-1}) attained the maximum fruit weight 465.5 g per plant (Table 2). T_3 (P_{100} K_{120} kg ha^{-1}) was followed by T_7 (P_{200} K_{120} kg ha^{-1}) and T_1 (P_0 K_{120} kg ha^{-1}) with 401.0 g and 285.6 g fruit weight per plant respectively. T_5 (P_{150} K_{120} kg ha^{-1}), T_4 (P_{150} K_0 kg ha^{-1}) and T_2 (P_{100} K_0 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. T_0 (Control) and T_6 (P_{200} K_0 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 respectivelywas 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 T_7 (P_{200} K_{120} kg ha^{-1}) and T_3 (P_{100} K_{120} kg ha^{-1}) got superiority with the largest duration of flowering 50.00 and 48.00 days respectively. T_2 (P_{100} K_0 kg ha^{-1}) , T_5 (P_{150} K_{120} kg ha^{-1}) and T_4 (P_{150} K_0 kg ha^{-1}) behaved equally with no significant differences among each other with flowering duration 46.67, 46.00 and 45.67 days respectively.T_1 (P_0 K_{120} kg ha^{-1}) and T_0 (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}	14.33d^{e}	6.233^{d}	9.100^{d}	266.0^{cd}	45.67^{c}

*T_3 (P_{100} K_{120} kg ha^{-1}), T_7 (P_0 K_{120} kg ha^{-1}), T_1 (P_{200} K_{120} kg ha^{-1}), T_5 (P_{100} K_0 kg ha^{-1}), T_2 (P_{150} K_{120} kg ha^{-1}), T_0 (Control), T_6 (P_{200} K_0 kg ha^{-1}) and T_4 (P_{150} K_0 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 T_0 (Control) attained the superiority and largest fruit ripening duration (80.33 days) was recorded in this treatment (Table 3). T_1 ($P_0 K_{120}$ kg ha^{-1}), T_6 ($P_{200} K_0$ kg ha^{-1}) and T_2 ($P_{100}K_0$ 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. T_3 ($P_{100} K_{120}$ kg ha^{-1}) and T_5 ($P_{150} K_{120}$ 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 T_5 ($P_{150} K_{120}$ kg ha^{-1}). This remarkable decrease in fruit ripening duration in T_3 ($P_{100} K_{120}$ 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 T_5 ($P_{150} K_{120}$ kg ha^{-1}) secured the highest position with 274.8 number of seeds per fruit. T_3 ($P_{100} K_{120}$ kg ha^{-1}) and T_4 ($P_{150} K_0$ kg ha^{-1}) produced 269.7 and 268.8 number of seeds fruit^{-1}, respectively and showed no significant difference between each other. T_2 ($P_{100} K_0$ kg ha^{-1}) and T_0 (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)

T_3 ($P_{100} K_{120}$ kg ha^{-1}) and T_6 ($P_{200} K_0$ kg ha^{-1}) attained the maximum weight of seeds 6.933 g each (Table 3). T_7 ($P_{200} K_{120}$ kg ha^{-1}), T_1 ($P_0 K_{120}$ kg ha^{-1})and T_5 ($P_{150} K_{120}$ 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. T_0 (Control) and T_4 ($P_{150} K_0$ 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 (%)

T_1 ($P_0 K_{120}$ kg ha^{-1}) attained the highest position with maximum fruit moisture 92.9% (Table 4). T_1 is followed by T_7 ($P_{200} K_{120}$ kg ha^{-1}) and T_5 ($P_{150} K_{120}$ 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 T_3 ($P_{100} K_{120}$ kgha^{-1}) and T_1 ($P_0 K_{120}$ kg ha^{-1}) respectively. T_1 is followed by T_5 ($P_{150}K_{120}$kg ha^{-1}) with (165.00 mg g^{-1}) total acidity in fruit. T_7 ($P_{200} K_{120}$ kg ha^{-1}) and T_2 ($P_{100} K_0$ 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 T_3 ($P_{100} K_{120}$ kg ha^{-1}) as compared to T_7 ($P_{200} K_{120}$ kg ha^{-1}) and T_2 ($P_{100} K_0$ 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})

T_7 ($P_{200} K_{120}$ kg ha^{-1}) attained the highest position with maximum ascorbic acid 176.66 mg 100 g^{-1} (Table 4). T_7 is followed by T_5 ($P_{150} K_{120}$ kg ha^{-1}) and T_1 ($P_0 K_{120}$ 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

*T_3 ($P_{100} K_{120}$ kg ha^{-1}), T_1 ($P_0 K_{120}$ kg ha^{-1}), T_7 ($P_{200} K_{120}$ kg ha^{-1}), T_5 ($P_{100} K_0$ kg ha^{-1}), T_6 ($P_{150} K_{120}$ kg ha^{-1}), T_2 (Control), T_0 ($P_{200} K_0$ kg ha^{-1}) and T_4 ($P_{150} K_0$ 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

*T_7 ($P_{100} K_{120}$ kg ha^{-1}), T_3 ($P_0 K_{120}$ kg ha^{-1}), T_1 ($P_{200} K_{120}$ kg ha^{-1}), T_5 ($P_{100} K_0$ kg ha^{-1}), T_2 ($P_{150} K_{120}$ kg ha^{-1}), T_6 (Control), T_4 ($P_{200} K_0$ kg ha^{-1}) and T_0 ($P_{150} K_0$ 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 T_3 (P_{100} K_{120} kg ha^{-1}) and T_2 (P_{100} K_0 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 T_7 (P_{200} K_{120} kg ha^{-1}) and T_3 (P_{100} K_{120} 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. T_1 (P_0 K_{120} kg ha^{-1}) and T_0 (Control) showed no significantdifference 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 T_3 (P_{100} K_{120} 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 and120 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.

References

1. Malik MN (1994) Horticulture. In: Baloch AF (ed.) Vegetable crops. National Book Foundation Islamabad, pp: 510-511.
2. Prasad BC, Kumar V, Gururaj HB, Parimalan R, Giridhar P (2006) Characterization of capsaicin synthase and identification of pungency factor capsaicin in pepper (*Capsicum* Spp.). P Natl Acad Sci 103: 13315-13320.
3. FAO (2007) Production Yearbook. Food and Agriculture Organization Rome.
4. http://finance.gov.pk/survey_1314.html
5. Olaniyi JO, AE Ojetayo (2010) The effect of organomineral and inorganic fertilizers on the growth, fruit yield and quality of pepper (*Capsicum frutescence* L.). J Anim Plant Sci 3: 1070-1076.
6. Shukla V, Naik LB (1993) Agro-techniques for solanaceous vegetables. In: Advances in Horticulture. Malhotra Publishing House, New Delhi, India 5: 364-399.
7. Daniel PS, Reid RJ, Ayling SM (1998) Phosphorus uptake by plants: From soil to cell. Plant Physiol 116: 447-453.
8. Saskatchewan AM (1999) Functions of phosphorus in plants. Better Crops 83: 1-6.
9. Shaheen AM, Mona M, Abdel M, Ali AH, Rizk FA (2007) Natural and chemical phosphorus fertilizers as affected onion plant growth, bulbs yield and its some physical and chemical properties. Aust J Basic Appl Sci 1: 519-524.
10. Lester GE, John LJ, Donald JM (2010) Impact of potassium nutrition on food quality of fruits and vegetables. Better Crops 94: 18-21.
11. AOAC (1970) Association of Official Analytical Chemists. Washington, DC, USA.
12. Yoshida S, Forno DA, Cock JH, Gomez KA (1976) Laboratory manual for physiological studies of rice. IRRI, Los Banos.
13. Anan T, Ito H, Mtsunga H, Monma S (1996) A simple method for determining the degree of pungency of peppers. Capsicum and Eggplant Nesletter 15: 51-54.
14. Steel RGD, Torrie JH, Bostan MA (1997) Principles and procedures of Statistics: A biometric approach (3rd edn.). Book Co. Inc., NY: McGraw Hill, pp: 178-182.
15. Fawzy ZF, Behairy AG, Shehata SA (2005) Effect of potassium fertilizer on growth and yield of sweet pepper plants (*Capsicum annuum* L.). Egypt J Agric Res 2: 599-610.
16. Gupta CR, Sengar SS (2000) Response of tomato (*Lycopersicon esculentum* Mill.) to nitrogen and potassium fertilization in acidic soil of Bastar. Vegetable Sci 27: 94-95.
17. El-Bassiony AM, Fawzy ZF, Abd El-Samad EH, Riad GS (2010) Growth, yield and fruit quality of sweet pepper plant (*Capsicum annuum* L.) as affected by potassium fertilization. J Am Sci 6: 722-729.
18. Kadam JR, Karthikeran S (2006) Effects of different combinations of soluble N P K through drip irrigation on contributing characters of yield and quality of chilies. Int J Plant Sci 1: 64-68.
19. Nassar HH, Barakat MA, El-Masry TA, Osman AS (2001) Effect of potassium fertilization and paclobutrazol foliar application on vegetative growth and chemical composition of sweet pepper. Egypt J Hortic 28: 113-129.
20. Chaudhry MI (1994) Soil and Fertilizer In: Horticulture. National Book Foundation, Islamabad, pp: 255-280.
21. Brady NC, Weil RR (2002) Phosphorus and Potassium (13th edn.). In: The Nature and properties of Soils, Pearson Education Inc, India, pp: 592-594.
22. Ahmed AUH, Ali R, Zamir SI, Mahmood N (2009) Growth, yield and quality performance of cotton cultivar BH-160 (*Gossypium hirsutum* L.) as influenced by different plant spacing. J Anim Plant Sci 19: 189-192.
23. Singegol HY, Patil HB, Patil DR (2007) Growth and yield of green chili (*Capsium annuum* L.) cv. Pusa Jwala as influenced by nitrogen and phosphorus. Asian J Hortic 2: 184-187.
24. Economakis C, Daskalaki A (2003) Effect of potassium nutrition on yield and quality of tomato plants grown with nutrient film technique under sodium chloride saline conditions. Acta Hortic 609: 337-339.
25. Deshpande RM, Lakhdive BA (1994) Effect of plant growth substances and phosphorus levels on yield and phosphorus uptake by cotton. PKV Res J 18: 118-121.
26. Murugan M (2001) Quality of chilli (*Capsicum annuum* L.) variety Co-3 as influenced by levels and sources of phosphorus and levels of nitrogen. Journal of Spices and Aromatic Crops 10: 1-5.