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EFFECTS OF PHOSPHORUS AND POTASSIUM FERTILIZERS ON THE YIELD CONTRIBUTING CHARACTERS AND YIELD OF SUB-TROPICAL STRAWBERRY

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Abstract

Proper nutrient management is the key in fruit production for achieving higher yield and quality fruits. To evaluate the yield potential of tropical strawberry under different doses of phosphorus (P) and potassium (K) fertilization, the experiment was conducted at the research farm of the Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur. The treatments were designed in seven combined doses of phosphorus and potassium fertilizers viz. T_1 - P_0 K_{100} kg/ha, T_2 - P_{25} K_{100} kg/ha, T_3 - P_{50} K_{100} kg/ha, T_4 - P_{75} K_{100} kg/ha, T_5 - P_{50} K_0 kg/ha, T_6 - P_{50} K_{50} kg/ha and T_7 - P_{50} K_{150} kg/ha. The results showed that the treatment T_3($P_{50}K_{100}$ kg/ha) was the best considering yield and yield contributing attributes of strawberry. The highest number of flowers (9.67) and fruits (9.67) per plant, the heaviest (18.37 g) and largest (1895.1 mm^2) fruit and maximum fruit yield (16.17 t/ha) were also obtained from the treatment T_3. The combined application of 50 kg/ha phosphorus and 100 kg/ha potassium could be used to obtain higher yield for successful production of strawberry.

Keywords: Inorganic fertilizer, performance, growth, high value fruits.

Introduction

Strawberry (*Fragaria* x *ananassa* Duch.) is one of the most delicious, refreshing and soft fruits of the world widely appreciated for its characteristic aroma, bright red color, juicy texture, and flavor. It belongs to the family Rosaceae and is grown from the low- latitude tropics and subtropics to the colder high-latitude areas (Darnell *et al*., 2003). It is a small fruit of great nutritional and medicinal values and consumed in large quantities, either fresh or in prepared foods such as preserves, fruit juice, pies, ice creams, and milk shakes (Rahman, 2011). The world strawberry production reached 4.5 million tons in 2012, being the USA, Mexico, Turkey, Spain, Egypt, Russia, South Korea, Japan, Poland and Germany the main producers (FAO, 2012). In Bangladesh, it is now getting popularity and there has been a bright prospect of farming strawberry everywhere in the country (Anon., 2009).

Balanced use of different nutrient elements is one of the most important factors for exploiting the yield potential of strawberry. Strawberry is a crop that has rapid growth and is highly influenced by nutrient management. Due to its fast growth and development, the plant needs sufficient macronutrients in order to meet its demand (Medeiros *et al*., 2015). Among the

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mineral nutrients, P and K play important roles in the growth and yield of plant (Olaniyi and Ojetayo, 2010). Phosphorus is a constituent of nucleic acid, phospholipids and several enzymes which are of great importance in the transformation of energy within the plant system, metabolism and also inrespiration. It has beneficial effecton root development, growth and also hastens maturity as well as improves quality of crop (Meena *et al*., 2017). Potassium also plays a very important role in plant growth and metabolism which includes photosynthesis, enzymatic activities, and translocation of nutrients and water in the plant (Mandal *et al*., 2012). Furthermore, adequate Knutrition has also been associated with disease resistance, increased yields, fruit size, improved fruit color and increased shelf life of various fruits (Lester *et al*., 2010). So, there is a scope for increasing productivity and quality of strawberry in combination of P and K fertilizers under the agro-ecological condition in Bangladesh (Afroz *et al*., 2016). However, research works on nutrient management for strawberry cultivation is scanty in Bangladesh. Hence, the present study was undertaken to observe the influence of P and K fertilization on the yield of sub-tropical strawberry.

Materials and Methods

The experiment was conducted at the research field of the Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur from November 2016 to April 2017 in winter season. Seven different doses of triple super phosphate (TSP) and muriate of potash (MP) representing the treatments (T_1 - P_0 K_{100} kg/ha, T_2 - P_{25} K_{100} kg/ha, T_3 - P_{50} K_{100} kg/ha, T_4 - P_{75} K_{100} kg/ha, T_5 - P_{50} K_0 kg/ha, T_6 - P_{50} K_{50} kg/ha and T_7 - P_{50} K_{150} kg/ha) of the experiment were used in the experiment as the source of P and K nutrients, respectively. The experiment was designed in a Randomized Complete Block Design with three replications.The unit plot size was 1 m × 1 m accommodating six plants of Strawberry variety 'Rabi-2' in each plot having row and plant spacing of 60 cm × 30 cm, respectively. Well decomposed cowdung, urea, gypsum, zinc sulphate and boric acid were applied @ 5tons, 120kg, 140kg, 10kg and 10kg per ha, respectively. MP and TSP were applied as different doses based on the treatment combinations. Half dose of urea and MP and full dose of cowdung, TSP, gypsum, zinc sulphate and boric acid were applied during final land preparation. The rest of urea and MP were applied as top dressing. Intercultural operations like weeding, irrigation and pest control were done as and when necessary for better growth and development of plants.The parameters included in the study were number of leaves per plant, canopy spread (cm), number of runners per plant, days to flower initiation (days from time of planting to first flowering), number of flowers per plant, number offruits per plant, weight of individual fruit (g), size of fruit (mm^2), fruit color, fruit shape, fruit yield per plant (g), fruit yield per plot (kg), fruit yield per ha (t) and total soluble solids (TSS) (%). The size of fruit was measured with a digital slide calipers (Model: CD-6″ CSX, Mitutoyo, Japan). Fruit colour and shape were estimated according to IBPGR (Anon., 1986) standard scale. Fruit yield per hectare was calculated by the following formula:

$$\text{Fruit yield (t/ha)} = \frac{\text{Fruit yield per plot (kg)} \times 10000}{\text{Area of plot (m2)} \times 1000}$$

Total soluble solids (TSS) content of strawberry fruit pulp was estimated by hand refractometer (Model: Atago N1, Japan).

Data were analyzed by using Analysis of Variance (ANOVA) and treatment means were compared using Least Significant Difference (LSD) at 5% level of probability.

Results and Discussion

Different combinations of P and K fertilizers brought about significant variation on the growth parameters of strawberry (Table 1). The highest number of leaves (14.6) per plant was observed in the treatment T_6 followed by T_3 whereas it was the lowest (11.93) in T_1 which was statistically identical to T_2. Canopy spread varied significantly among the treatments. The maximum canopy spread (21.70 cm) was recorded in T_3 followed by T_4 (20.97 cm) and T_7 (20.33 cm) while the minimum (18.00 cm) was found in T_5. Variation in number of leaves per plant and canopy spread was mainly due to inherent characters of plant and environmental effect. Significant variation was also observed in respect of number of runners per plant of strawberry and it ranged from 3.00 to 5.27. The highest number of runner (5.27) per plant was produced by the treatment T_7 whereas the lowest (3.00) was found in T_5. Biswas *et al*. (2010) reported the ranges of runner between 0 to 31.33.

It was observed that the different levels of P and K exerted significant influence on days to flower initiation, number of flowers per plant and number of fruits per plant of strawberry (Table 2). The earliest (26.33 days) flower initiation was observed in T_3 while it was delayed (48.67 days) in T_5 followed by T_1 (42.33 days), T_2 (38.33 days) and T_6 (34.33 days). Variation regarding days to flower initiation occurred mainly due to the inherent characters of the genotypes, stage of growth, day length and temperature. The highest number of flowers per plant (9.67) was produced by the treatment T_3 which was statistically identical to T_4 (9.00). Number of fruits per plant is one of the most important yield contributing characters in all fruits as well as strawberry. The treatment T_3 also attained the highest position with maximum number of fruits (9.67) while the lowest number of flowers (5.60) and fruits (6.67)

Table 1. Growth characteristics of strawberry under different doses of P and K fertilizer

Treatments	No. of leaves/plant	Canopy spread (cm)	No. of runners/plant
T_1	11.93 e*	18.43 f	3.27 e
T_2	12.33 de	19.06 e	3.67 d
T_3	13.66 b	21.70 a	4.33 b
T_4	13.33bc	20.96 b	4.00 c
T_5	12.60 d	18.00 g	3.00 f
T_6	14.60 a	19.80 d	3.47 de
T_7	13.06 c	20.33 c	5.27 a
$LSD_{0.05}$	0.43	0.39	0.20
CV %	2.43	1.38	4.38

*Means bearing the same letter(s) in a column do not differ significantly at 5% level of probability by LSD

Table 2. Effect of varying levels of P and K on reproductive parameters of strawberry

Treatments	Days to flower initiation	Total number of flowers/plant	Total number of fruits /plant
T_1	42.33 b*	6.93 e	7.00 f
T_2	38.33 c	7.00 d	7.67 e
T_3	26.33 f	9.67 a	9.67 a
T_4	29.67 e	9.00 ab	8.93 b
T_5	48.67 a	5.60 f	6.67 g
T_6	34.33 d	7.60 cd	8.00 d
T_7	31.33 e	8.60bc	8.40 c
$LSD_{0.05}$	1.93	0.83	0.23
CV %	2.90	6.08	2.05

*Means bearing the same letter(s) in a column do not differ significantly at 5% level of probability by LSD

was recorded in the treatment T_5. Rahman and Ahmad (2010) reported that fruits per plant in fifteen strawberry lines ranged between 4 to 27 which more or less supported the above findings.

Different fruit and yield contributing characters are presented in Table 3. The treatment T_3 got superiority with the heaviest fruit (18.37 g) and the lightest (8.89 g) was recorded in T_1 which was statistically identical to the treatment T_5. The size of fruit (length and width) of strawberry also varied significantly among the treatments and it ranged from 990.8 mm^2 to 1895.1 mm^2. The largest fruit (1895.1 mm^2) was produced by the treatment T_3 which was significantly different from rest of the treatments while the smallest fruit (990.8 mm^2) was recorded in the treatment T_1. Biswas *et al.* (2010) also reported more or less similar fruit size of five strawberry genotypes (738 mm^2 to 2072.02 mm^2) which authenticated the present findings. The highest TSS (13.16 %) was found in the treatment T_7 while the lowest

Table 3. Effect of varying levels of P and K on fruit characteristics and yield attributes of strawberry

Treatments	Individual fruit weight (g)	Fruit size (mm^2)	Fruit TSS (%)	Fruit yield/ plant (g)	Fruit yield/ plot (kg)
T_1	8.89 f*	990.8 f	10.08 d	155.33 g	0.78 g
T_2	10.93 de	1113.6 de	11.00 c	220.00 e	1.10 e
T_3	18.37 a	1895.1 a	11.84 b	323.33 a	1.62 a
T_4	15.78 b	1560.5 b	12.15 b	285.33 b	1.43 b
T_5	9.63 ef	1022.1 ef	9.41 e	194.00 f	0.97 f
T_6	12.87 c	1321.5 c	10.48 d	264.00 c	1.32 c
T_7	11.79 cd	1212.3 d	13.16 a	246.00 d	1.23 d
$LSD_{0.05}$	1.82	105.07	0.49	5.81	0.03
CV %	7.8	4.64	3.06	2.5	2.5

*Means bearing the same letter(s) in a column do not differ significantly at 5% level of probability by LSD

TSS (9.41%) was recorded in the treatment T_5. Among the entries, the treatment T_3 secured the highest position with maximum fruit yield per plant (323.33 g) followed by the treatment T_4 (285.33 g) and fruit yield per plot (1.62 kg). The lowest yield of 155.33 g per plant and 0.78 kg per plot was obtained from the treatment T_1. Rahman and Ahmad (2010) found that yield per plant in fifteen strawberry lines were between 58 g to 853 g which supported the above findings to some extent.

Legard *et al.* (2000) recorded to have yield of strawberry per plot (7.2 m^2) ranged from 10.66 kg to 16.11 kg among three cultivars. Fruit colour and shape of strawberry were estimated according to IBPGR (Anon., 1986) standard scale (Table 4). For fruit colour, the highest score (5.88) was obtained by the treatment T_5 which had intermediate to dark red colour and the lowest score (4.04) was found in T_6 which had light intermediate red colour. In case of fruit shape, highest score (5.68) was recorded in the treatment T_2 which had bi-conical to almost cylindrical shape while it was the lowest (4.87) in the treatment T_6 which had conical to bi-conical shape.

Fruit yield per hectare was significantly influenced by varying levels of P and K fertilizers (Fig. 1). The result showed significant superiority of the treatment T_3 over all other treatments and produced the highest yield (16.17 t/ha) and the lowest yield (7.77 t/ha) was obtained from the treatment T_1. This finding was in agreement with the findings of Legard *et al.* (2000) who reported to have fruit yield of three strawberry cultivars ranged from 14.81 to 22.38 t/ha.

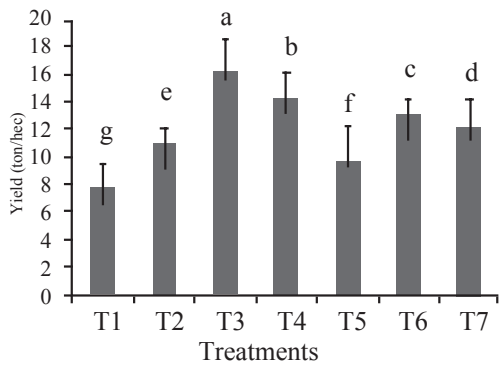

Fig. 1. Effects of different doses of P and K on fruit yield (t/ha) of strawberry. Error bars indicate the SEM. Each treatment was repeated three times.

Table 4. Fruit colour and shape of strawberry under different doses of P and K

Treatments	Fruit colour		Fruit shape	
	Score*	Remarks	Score**	Remarks
T_1	5.25	Intermediate red	5.07	Bi conical
T_2	4.98	Intermediate red	5.68	Bi conical to Almost cylindrical
T_3	4.92	Intermediate red	5.04	Bi conical
T_4	4.55	Light to intermediate red	4.88	Conical to Bi conical
T_5	5.88	Intermediate to dark red	5.03	Bi conical
T_6	4.04	Light to intermediate red	4.87	Conical to Bi conical
T_7	4.67	Light to intermediate red	5.62	Bi conical to Almost cylindrical

*Fruit color score: 1 = Very light red, 3 = Light red, 5 = Intermediate red, 7 = Dark red, 9 = Very dark red.

**Fruit shape score: 1 = Kidney, 2 = Oblate, 3 = Round, 4 = Conical, 5 = Bi-conical, 6 = Cylindrical, 7 = Wedged, 8 = Ovoid, 9 = Cordate

Conclusion

In this study, the author investigated whether P and K are important nutrients for vegetative growth and fruit yield of strawberry. The observed results positively supported the hypothesis that P and K are critical to regulate plant growth and yield. To determine the best combination of these two essential nutrients, it was found that combined application of P@ 50 kg/ha and K@ 100 kg/ha showed the highest performance for most of the characters as well as yield. Therefore, this dose may be recommended as an economically profitable fertilizer treatment for optimum performance of strawberry. Further study need to be conducted using organic and inorganic fertilizer as INM basis for making final recommendation to grow strawberry in the sub-tropical weather.

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