E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(6): 586-589
Received: 02-04-2024
Accepted: 07-05-2024

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Response of NPK, boron and Sulphur on yield and quality of passion fruit

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DOI: https://doi.org/10.33545/2618060X.2024.v7.i6Sh.1138

Abstract
Fruit, being a rich source of carbohydrate, protein, minerals, vitamins etc., are considered very much essential for proper growth and protection of human body from different diseases and disorders. Almost all types of fruit can be grown in one or the other parts of the country. China is the largest producer of fruits followed by India which now accounts for about 10 percent of world production. In India, horticultural crops occupy about 6.7 percent of gross area, contribute about 18 percent of gross value of agricultural output and 52 percent of total export earning in agriculture (Shukla, *et al*., 2004). However, due to explosion of population and wastage of the harvested produce, the per capita availability of fruits (40 gm against the recommended 120 gm per day) is far below the required level. Hence, it is urgently necessary to increase the availability of fruits by increasing the area and the productivity.

Keywords: Fruit, carbohydrate, protein, minerals

Introduction

Passion fruit is a native of Brazil and widely cultivated in South Africa, Australia, Newzealand and Indonesia. In India, it grows widely in Nilgiri hills, Kodaikanal, Coorg, Malabar, Kerala and Himachal Pradesh. It occupies an important place among the fruits grown in India. North Eastern parts of India have greater potential for establishing passion fruit globe on commercial scale. Recently, this fruit has come into prominence among the people of north eastern states of India particularly in Meghalaya, Manipur, Mizoram, Nagaland and Sikkim due to its pleasant aroma, rich flavor, prolific bearing habit and higher return even without much care.

Passion fruit is getting popularity and its cultivation is gradually increasing in India. Passion fruit is not used as a desert fruit because of its being high acidic in nature, it needs to be processed before consumption. Very few researches had been carried out regarding cultivation of this fruit. Hence, availability of research reviews about cultivation and storage is also very meager. Passion fruit is comparatively a new crop for the region. A few varieties are available in Jharkhand so there are less chances of variation. The passion fruit can be propagated from vine cutting and seeds. Vegetatively propagated clones are true to types. However, for large production and as easy procurement of planting material, propagation from seeds may be done. Hence, there is need to improve germinations and vigor of seedlings. For successful cultivation of this high value crop, manurial dose is to be standardized. There is also need to improve fruiting and quality of fruit. Presently, availability of research reviews about cultivation and quality parameters in Jharkhand is very meager. Keeping the above points in view, the present investigation was carried out.

Materials and Methods

An investigation was carried out on passion fruit *(Passiflora edulis f flavicarpa* Degrener) during winter season at vegetable section of horticulture farm under the Faculty of Agriculture, Birsa Agricultural University Kanke, Ranchi (Jharkhand) which falls in sub-humid, sub-tropical climate zone, The place is situated between 23.179 North latitude and 85˚19' East longitude and located at a height of 625 m above the mean seen level.

Experimental details
T_1 - NPK (300:150:150 g^{-1}vine)
T_2- NPK (250:125:125 g^{-1}vine)
T_3 - Boron (1.2 g^{-1} vine)
T_4 - Sulphur (24 g^{-1} vine)
T_5 - NPK (300:150:150 g^{-1}vine) + Boron (1.2 g^{-1} vine)
T_6 - NPK (250:125:125 g^{-1}vine) + Boron (1.2 g^{-1} vine)
T_7 - NPK (300:150:150 g^{-1}vine) + Sulphur (24 g^{-1} vine)
T_8 - NPK (250:125:125 g^{-1}vine) + Sulphur (24 g^{-1} vine)
T_9 -Control
T_{10} -Absolute control (without vermin compost)

(Note: - A uniform dose of 2kg vermicompost + 500 g lime per pit during planting)

Design, Plot size and Layout
Experimental Design - RBD
Treatments - 10
Replications - 3
Spacing - 3 x 2 m
Plot size - 4 pits/ line/ treatment
Total no. of plots - 30 lines with four plants in each line
No. of plants per line - 4
No. of plants per treatment - 4 x 3 = 12

Fruit characters

Fruit length and fruit breadth (cm)
Only fully matured fruit from each tagged plant was selected at random from each treatment and the length and breadth of five fruits were measured in cm with the help of slide calipers and then the average length and breadth was calculated.

Volume of fruit (cc)
The volume of individual fruit was taken by water displacement method. The same fruits which were used for measuring size and weight were also used for estimation of volume.

Weight of fruit (g)
The weight of individual fruit was taken with the help of physical balance. In this way total weight of all five individual fruits was obtained and then its average weight per fruit was calculated.

Quality characters

Estimation pulp percentage (%)
The weighed fruits were peeled the pulp were kept separately in each case. Each lot was weighed in each case. Each lot was weighed in quickest possible time on a physical balance. The percentage of pulp was determined as follows:

$$\text{Pulp percentage} = \frac{\text{Weight of pulp (g)}}{\text{Weight of fruit (g)}} \text{X } 100$$

Estimation juice percentage (%)
Juice percentage of fruits was recorded by adopting formula.

$$\text{Juice percent} = \frac{\text{Weight of juice (g)}}{\text{Weight of fruit (g)}} \text{X } 100$$

Estimation Total Soluble Solids (TSS) (^{0}Brix)
Total Soluble Solids (TSS) of the samples was estimated by Erma Hand Refractometer (0-32^{o}B) and the result was expressed in Degree Brix (^{o}B). The observed reading was corrected using temperature correction chart to obtain TSS value at 20^{o}C.

Estimation Acidity percentage (mg/100 g)
The titrable acidity is determined by titrating the juice against standard alkali solution (0.1N NaOH). 10ml of juice was taken by means of pipette and was transferred into 100ml volumetric flack and distilled water was added to make the volume 100 ml. 10 ml aliquot of diluted juice was pipette out and transferred in 250ml beaker. 1-2 drops of phenolphthalein indicator was added to the solution. The juice of conical flask was titrated against 0.1N NaOH solution. The alkali was added drop by drop to the conical flask with constant stirring until the end point was reached with disappearance of pink colour. The percentage of acidity was calculated from the following formula.

$$\text{\% of Acidity} = \frac{\text{Titre Volume x 0.1 x 64 x 10}}{\text{aliquot x 10}}$$

Total Sugar (%)
10ml of juice was hydrolyzed by adding 2 ml. of con. HC1. It was left for 24 hours. After that, it was neutralized by adding 40% NaOH solution. To ensure complete neutralization, blue and red litmus papers were used. This solution was then titrated against Fehling's A and B as reducing sugar titration and the percentage of total sugar was worked out. Total sugar as invert sugar was calculated as in % Reducing sugar making use of the titer value obtained in determination of total sugar after inversion % non-reducing sugar = (% Total invert sugar - % Reducing sugar originally present) x 0.95%
Total Sugar = (% Reducing Sugar + % non-reducing sugar)
* (10ml of Fehling solution = 0.95 gm of sugar)

Reducing Sugar (%)
10 ml of filtered juice was taken in a conical flask. 2 ml of lead acetate was added to it. It was made to shake and allowed to stand for 10 minutes and 2 ml of potassium oxalate was added. Then distilled water was added and volume was made up to 100ml. the solution was filtered through whatsman paper No.4 and the filtrate was collected in a conical flask. 5ml of each Fehling's solution A and B was taken in a conical flask to which 25ml of distilled water was added. This was kept on electric heater for boiling. 2-3 drops of methy1 blue indicator were dropped. The fehling's solution was also be titrated by filtered fruit juice. The appearance of brick red colour determined the end point. Reducing sugar was calculated by the following formula.

$$\text{\% Reducing Sugar} = \frac{\text{mg of invert sugar x Dilution x 100}}{\text{Titer x Water volume of the sample x 100}}$$

Non - reducing sugar (%)
The non-reducing sugar was calculated by deducting the reducing sugar from total sugar and subsequently multiplying with the necessary factor (0.95). The amount of non-reducing sugar estimated, was expressed in g/ 100 g of juice.

Vitamin 'C' (Ascorbic Acid) Content (mg/100 g)

Standardization of Dye
5ml of ascorbic acid solution was taken and 5ml of HPO_3 was added in a conical flask. A micro burette was filled with the dye solution and then the dye solution was titrated and the end point was reached with appearance of pink colour which persisted for 15 seconds. The dye factor was determined, i.e. mg of ascorbic acid per ml of dye, using following formula

$$\text{Dye factor} = \frac{0.5}{\text{Titer (burette reading)}}$$

2 ml of juice was taken in a conical flask and 8ml of 3% HPO_3 solution was added. This solution was titrated with standard dye 2, 6-Dichiorophenol-indophenol to a pink end point appearance. Titrated rapidly and made a preliminary determination of the titre. The ascorbic acid content of the sample calculated by the following formula

$$\text{Mg of ascorbic acid per 100ml of juice} = \frac{\text{Titer x Dye factor x Volume make up}}{\text{aliquot x Vol. of juice taken for estimation}} \text{X 100}$$

Results and Discussion

The treatment effects on fruit length, fruit breadth, fruit weight and fruit volume were significant. The maximum fruit length (7.68 cm), fruit breath (7.30 cm), fruit weight (82.50 g) and fruit volume (143.81 cc) were recorded in case of T_6 (application 250:125:125g NPK+ 1.2g Boron) which was closely followed or at par with the treatment T_5 ((300:150:150 g NPK) + 1.2 g Boron). The minimum was observed in case of absolute control.

The process of flowering and fruiting involve cell division, cell elongation and cell enlargement. The earliness of flowering and fruit setting may be explained in the light of the hypothesis advanced by Witter and Bukovac (1962), who suggested that practically every chemical or group of chemicals which enhance cell-division and cell-enlargement would likewise accelerate floral initiation and fruit setting. Early flower bud differentiation and fruit set with application of nitrogen alone and in presence of phosphorus, potash and boron might be due to accumulation of optimum quantity of carbohydrate reserves.

As we know, boron governs many physiological and bio-chemical plant processes. Application of boron resulted in promotion of flower, all possibly due to the promoting effect of boron on cell division and elongation process Dutta, (2004) [2].

Vine treated with NPKB (250:125:125:1.2 g/vine/year) showed the earliness in reproductive character and yield. Similar findings were observed by Natal *et al*., (2004) [5] and Russel, 1957) [9]. The application of different levels of NPKB was effective in increasing maximum fruit character and yield. It was observed that lower level of NPK induced more fruit length, fruit breath**,** fruit weight**,** fruit volume and yield than higher dose. Fruit weight is very important with respect to fruit quality as it adds towards fruit yield. Fruit weight follows yield trends. Like fruit size, significant increase in fruit weight, was also obtained with boron treatment. These observations are in consonance with Brahamchari *et al*., (1997) [1] and Haque and Ibrago (1994) [4] in guava. The possible reason behind increasing fruit weight might be due to hormonal mediated direct transport, accumulation and ensure balanced partitioning of photosynthetic assimilates to the developing fruit than by enabling the shoot to meet the nutritional requirement of fruits throughout their development.

Maximum content of fruit pulp percentage (33.49 %), fruit juice percentage (34.53 %), content of TSS (17.47 ^{0}B), acidity (2.28%), total sugar (11.48%), reducing sugar (4.79%), non-reducing sugar (6.69%) and ascorbic acid (15.56 mg/100 gm) were found with the application T_6 (250:125:125g NPK+ 1.2g Boron) closely followed by T_8. The minimum was recorded in (T_{10}) absolute control.

The probable cause may be due to medium dose of NPKB contributed to synthesis of essential constituent of protein and other compounds of great physiological process in plant metabolism resulting in increased TSS, acidity percentage, total sugar, reducing sugar, non-reducing sugar and ascorbic acid.

The increase in content of total soluble solids and total sugar might be due to quick metabolic transformation of starch and pectin into soluble sugars and rapid mobilization of photosynthetic metabolites and minerals from other parts of the plant to developing fruits. The increase in TSS content might have also diverted more solids towards developing fruits and also enhanced the conversion of complex polysaccharides into simple sugars. Similarly, increase in total sugar can also be attributed to the accumulation of oligosaccharides and polysaccharides in higher amount in these treatments.

Similarly, higher ascorbic acid (Vitamin-C) content was recorded with the addition of boron in soil. The perspective increase in ascorbic acid might be due to catalytic activity on its biosynthesis from its precursor glucose-6-phosphate or inhibition of its conversion into dehydro ascorbic acid by enzyme ascorbic acid oxidize or both2. Apart from this, boron facilitated sugar transport within the plant and it was also reported that borate reacted with sugar to form sugar borate complex which was more easily able to transverse (Gauch and Dugger, 1954) [3].

Application of NPKB (250:150:150:1.2 g/vine/year), might have stimulated synthesis of enzymes affecting the physiological process, which in turn hydrolyzed starch and helped in metabolic level in regulating vital physiological and biochemical processes which ultimately increased quality characters in fruits. The results agree with finding of Rath *et al*., (1980) [8] in mango, Rajput, and Chand, (1975) [7], Singh and Chonkar, (1983) [11] and Pathak and Pandey (1988) [6] in guava.

Table 1: Effect of different nutrient on Fruit and Quality of Passion fruit

Treatment		Fruit length (cm)	Fruit breath (cm)	Fruit weight (g)	Fruit volume (cc)	Pulp percentage	Juice percentage	TSS (˚Brix)	Acidity (%)	Total sugar (%)	Reducing sugar (%)	Non reducing (%)	Ascorbic acid (mg/100 g)
T_1	300:150:150 g NPK vine^{-1}	6.15	5.83	65.33	125.88	22.55	25.60	10.56	4.69	7.18	3.27	3.91	12.36
T_2	250:125:125 g NPK vine^{-1}	6.50	6.05	69.13	129.78	24.52	28.61	11.60	4.39	7.84	3.57	4.28	12.69
T_3	1.2 Boron g vine^{-1}	5.58	5.30	62.45	114.44	19.41	24.55	8.52	5.21	6.71	2.68	4.53	11.77
T_4	24 Sulphur g vine^{-1}	5.30	5.00	59.13	103.33	15.66	22.37	7.71	5.70	6.28	2.15	4.12	10.88
T_5	300:150:150:1.2g NPKB vine^{-1}	6.80	6.55	78.18	139.10	29.51	33.45	15.55	2.72	10.67	4.31	6.36	15.12
T_6	250:125:125:1.2 g NPKB vine^{-1}	7.68	7.30	82.50	143.81	33.49	34.53	17.47	2.28	11.48	4.79	6.69	15.56
T_7	300:150:150:24 g NPKS vine	6.25	5.98	69.23	132.03	24.48	28.65	12.43	3.81	8.42	3.79	4.63	13.29
T_8	250:125:125:24 g NPKS vine^{-1}	6.35	6.03	71.40	142.90	30.49	31.62	13.61	4.30	9.20	4.20	5.14	14.62
T_9	Control	5.60	5.25	61.78	105.58	16.62	22.64	7.39	5.72	6.13	1.69	4.44	10.11
T_{10}	Absolute Control	5.10	4.73	48.03	99.78	14.58	21.05	6.47	6.41	5.46	1.54	3.92	9.60
SE(m)		0.11	1.11	0.87	2.33	0.14	0.19	0.14	0.08	0.10	0.25	0.20	0.18
CD 5%		0.31	1.34	2.54	6.79	0.41	0.55	0.40	0.22	0.30	0.81	0.58	0.57
CV %		3.48	1.25	2.61	3.76	1.25	1.39	2.48	3.33	2.57	3.20	8.29	1.35

Summary and Conclusion

Treatment NPK+B (250:125:125+1.2) g^{-1} $vine^{-1}$ year showed the best result in both the years for reproductive characters, fruit character, yield, quality character (pulp and juice percentage, TSS, acidity percentage, total sugar, reducing sugar, non-reducing sugar and ascorbic acid) and storage.

Based on individual effect of NPK it can be safely concluded on the basis of findings that the application of lower dose of nitrogen, phosphorus, potash and boron 1.2 g^{-1} $vine^{-1}$ year are quite affecting in promoting growth and yield of passion fruit.

Hence annual application of NPK+B (250:125:125+1.2) g^{-1} $vine^{-1}$ year (nitrogen to be applied in three split doses) is recommended for high yield and quality of passion fruit vermi - compost 2 kg + lime 0.5 kg should be applied as basal dose.

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