Effect of different spacing and NPK combination on plant growth, fruit yield and fruit quality of strawberry (Fragaria × ananassa) cv. Winter dawn

Abstract

The present investigation entitled Effect of different Spacing and NPK combonation on plant growth, fruit yield and fruit quality of Strawberry (Fragaria ×ananassa Duch.) Winter Dawn was carried out in the department of Horticulture, Prayagraj, Naini Agriculture Institute, Sam Higginbottom Institute of Agriculture, Technology and sciences, Prayagraj in the year 2023-2024. The experiment was performed to find out the most suitable treatment combination for better yield and profitability to farmers. The experiment was laid out in a factorial Randomized Complete Block Design with twelve treatments and three replications. The treatments comprise of different spacing with the combination of different NPK levels. Result obtained in present investigation showed that the treatment T5 (25×30cm+100:120:80 NPK kg/ha) was found to be best in terms of yield and fruit quality viz, Days taken to first flower appearance, number of flowers per plant, days to fruit bud development, number of fruits per plant, fruit set, fruit yield, TSS, pH of the juice, acidity, weight of fruit, length diameter. The B: C ratio was highest in the treatment T5 (25×30cm+100:120:80 NPK kg/ha) with 5.08.

Keywords*:*NPK, pH, Yield, Quality, Winter Dawn, Strawberry

Introduction

Strawberry (Fragaria × ananassa Duch.) is one of the most popular soft fruit crops cultivated in temperate regions of the world for its fresh fruits. It is a member of family Rosaceae, with a chromosome number of 2n = 56 is a hybrid of genus Fragaria. Strawberry is an example of aggregate fruit. Strawberry keeps unique taste, flavour, and excellent source of vitamins, potassium, fibre and sugars. As compared to other berry fruits, strawberries contain a higher percentage of vitamin C, phenolics and flavonoids (**Hakkinen and Torronen, 2000)**.

The favourable soil pH range for strawberry is about 4.6-6.5. Strawberry is the most important fruit plants for both fresh consumption and food processing in the temperate and subtropical areas. In North India, area under strawberry is increasing rapidly due to its remunerative prices. Annual world production of strawberry is increasing from 3 to more than 4 thousand MT. About 98% of the production occurs in the Northern Hemisphere, though production is expanding in the South (**Hummer, 2009**). In India it is commercially grown in Mahabaleshwar (Maharastra), Haryana, Punjab, Uttar Pradesh, Jammu and Kashmir, Uttarakhand and low hills of Himanchal Pradesh. Optimum plant spacing ensures proper growth and development of plant resulting in maximum yield of the crop and the best use of land. The system of planting, runners is usually planted along with the row at about 0.9 m apart and 0.45 m between the plants. Organic manures like vermicompost, FYM, compost, bio fertilizers etc. have been utilized in agriculture as a significant source of organic manure. These manures help not only in bridging the existing wide gap between the nutrient removal and supply but also in insuring balanced nutrient proportion, by enhancing response efficiency, and maximizing crop productivity of desired quality. Vermicomposts are products derived from the accelerated biological degradation of organic wastes by earthworms and microorganisms. Earthworms consume and fragment the organic wastes into finer particles

by passing them through a grinding gizzard and derive their nourishment from microorganisms that grow upon them. The process accelerates the rates of decomposition of the organic matter, alter the physical and chemical properties of the material, leading to a humification effect in which the unstable organic matter is fully oxidized and stabilized**.** The fruit quality and yield of fruits can be increased by using the FYM and vermicompost which are helpful to reduce fruit drops and increase fruit yield and quality and improve the physic – chemical properties of fruits and also increase the marketability as well as demand of fruits. Hence this investigation is done for better quality of fruits and increasing profitability.

Strawberry has rapid growth (two to three months) and is extremely affected by environmental conditions such as temperature, light, salinity, water quality and nutrient availability. Because of its speed of development, the crop needs adequate macronutrient absorption to meet photosynthetic demand and fruit growth. The need for photosynthesis and rapid growth of strawberry plants is reported to require a high acquisition of macronutrients. Knowledge of crop nutritional requirement is important in developing profitable crop with better quality **(Li et al.,2010).** In plant growth and development, nitrogen (N), phosphorus (P) and potassium (K) are essential macronutrients. Playing a particular role in various physiological and morphological aspects as essential molecules associated with various fundamental metabolic processes **(Takehisaet al., 2013).** Nitrogen (N) is known as the most limiting nutrient to plant growth and development and its availability determines crop yield and quality. Phosphorus is an important nutrient and plays an important role in reproduction, vigor and general health of all plants. It is often referred as an energy source because during the photosynthesis it helps to store and transfer energy in plants **Gastal & Lemaire (2002**). Potassium increases crop yield and improves quality. It is required for numerous plant growth processes such as enzyme activation and stomatal activity **Prajapati and Modi (2012**).

Materials and Methods

Field experiments for studying effect of different spacing and NPK combination on plant growth, fruit yield and fruit quality of strawberry were performed during 1st November2023 to 3rd March 2024 at the Horticultural Research Field, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj (25.43° N latitude 81.84° E longitude) India. The soil at the location is Loam and Sandy Loam. Prayagraj district has a sub-tropical climate and the average maximum temperature ranges between 43°C - 47°C which may go as high as 48°C during peak summers. The experiment was laid out in Factorial Randomized Complete Block Design with twelve treatments replicated three. The twelve treatments consist of (25×15cm+75:80:50NPK Kg/ha) T1, (25×15cm+100:120:80NPK kg/ha) T2, (25×15cm+125:160:110 NPK kg/ha) T3, (25×30cm+75:80:50 NPK kg/ha) T4, (25×30cm+100:120:80NPKkg/ha) T5, (25×30cm+125:160:110NPK kg/ha) T6, (25×45cm+75:80:50NPK kg/ha) T7,

(25×45cm+100:120:80NPK kg/ha) T8, (25×45cm+125:160:110NPKkg/ha) T9, (45×45cm+75:80:50NPK kg/ha) T10, (45×45cm+100:120:80NPK kg/ha) T11,

(45×45cm+125:160:110NPK kg/ha) T12. All the doses of NPK combination were applied at the time of planting and during flowering initiation and observations were recorded on plant height (cm), number of leaves per plant, plant spread (cm), petiole length (cm), Days taken to first flower appearance, number of flowers per plant, days to fruit bud development, number of fruits per plant, fruit set, fruit yield, TSS, pH of the juice, acidity, weight of fruit, length diameter.

Result and Discussion

Growth Characters

Result on different spacing and NPK combination indicated that T8 (25×45cm +100:120:80 NPK kg/ha) recorded maximum plant height (cm) of 10.91cm (30DAT), 12.52cm (60DAT), 14.91cm (90DAT) whereas minimum plant height (cm) of 7.25cm (30DAT), 8.56cm (60DAT), 10.90cm (90DAT) was recorded in T3 (25×15cm +125:160:110 NPK kg/ha), T8 (25×45cm +100:120:80 NPK kg/ha) recorded maximum number of leaves per plant of 4.80 (30DAT), 12.93(60DAT), 16.33 (90DAT) whereas minimum number of leaves per plant of 3.20 (30DAT), 10.33 (60DAT), 12.33 (90DAT) was recorded in T3 (25×15cm +125:160:110 NPK kg/ha), T8 (25×45cm +100:120:80 NPK kg/ha) recorded maximum plant spread (cm) of 16.26cm (30DAT), 21.52cm (60DAT), 32.55cm (90DAT) whereas minimum plant spread (cm) of 12.53cm (30DAT), 17.83cm (60DAT), 29.12cm (90DAT) was recorded in T3 (25×15cm +125:160:110 NPK kg/ha), T8 (25×45cm +100:120:80 NPK kg/ha) recorded maximum plant spread (cm) of 16.26cm (30DAT), 21.52cm (60DAT), 32.55cm (90DAT) whereas minimum plant spread (cm) of 12.53cm (30DAT), 17.83cm (60DAT), 29.12cm (90DAT) was recorded in T3 (25×15cm +125:160:110 NPK kg/ha), T8 (25×45cm +100:120:80 NPK kg/ha) recorded maximum petiole length (cm) of 8.51cm (30DAT), 10cm (60DAT), 12.04cm (90DAT) whereas minimum petiole length (cm) of 4.36cm (30DAT), 5.61cm (60DAT), 7.71cm (90DAT) was recorded in T3 (25×15cm +125:160:110 NPK kg/ha). Enhancement of growth might be attributed to the role of NPK, and proper nutrition at the development stage is essential for the growth (Ali *et al. 2023*). The application of NPK fertilizer (Bhagat *et al.* 2022) in strawberry (Table 1-4).

Flowering and fruiting characters

Result on different spacing and NPK combination indicated that T5 (25×30cm +100:120:80 NPK kg/ha) recorded maximum days to first flowering 68.13 whereas minimum days to first flowering 45.66 recorded in T3 (25×15cm +125:160:110 NPK kg/ha), T5 (25×30cm +100:120:80 NPK kg/ha) recorded maximum number of flowers per plant of 3.93 (60DAT), 4.80 (75DAT),8.13 (85DAT) whereas minimum number of flowers per plant of 1.20 (60DAT), 4.20 (75DAT), 6.80 (85DAT) was recorded in T3 (25×15cm +125:160:110 NPK kg/ha), T5 (25×30cm +100:120:80 NPK kg/ha) recorded maximum days taken to fruit bud development 75.13 whereas minimum days to first flowering 60.87 recorded in T3 (25×15cm +125:160:110 NPK kg/ha), T5 (25×30cm +100:120:80 NPK kg/ha recorded maximum number of fruits per plant of 1.73 (75DAT), 4.93 (90DAT), 9.53 (105DAT) whereas minimum number of fruits per plant of 0.80 (75DAT), 4.00 (90DAT), 5.87 (105DAT) was recorded in T3 (25×15cm +125:160:110 NPK kg/ha), T5 (25×30cm +100:120:80 NPK kg/ha) recorded maximum fruit set (%) 79.33 whereas minimum fruit set (%) 53.33 recorded in T3 (25×15cm +125:160:110 NPK kg/ha). The result are with accordance to the finding of (Chandra *et al*. 2021)· reported effect of nitrogen, phosphorus and potassium on growth and yield which enhanced flower bud initiation (Dar *et al.* 2013)reported of organic, inorganic fertilizers and plant spacing on the growth and yield (Islam *et al.* 2017). Enhanced flowering and fruiting in strawberry (Table5-6).

Yield parameters

Result on different spacing and NPK combination indicated that T5 (25×30cm +100:120:80 NPK kg/ha) recorded maximum fruit yield per plant 176.15g whereas minimum fruit yield per plant 145.05g recorded in T3 (25×15cm +125:160:110 NPK kg/ha), T5 (25×30cm

+100:120:80 NPK kg/ha) recorded maximum fruit yield per plot 1.17kg whereas minimum fruit yield per plot 0.71kg recorded in T3 (25×15cm +125:160:110 NPK kg/ha), T5 (25×30cm +100:120:80 NPK kg/ha) recorded maximum fruit yield (t/ha) 13.27 whereas minimum fruit yield (t/ha) 9.43 recorded in T3 (25×15cm +125:160:110 NPK kg/ha), T5 (25×30cm +100:120:80 NPK kg/ha) recorded maximum fruit weight 32.81g whereas minimum fruit weight 19.42g recorded in T3 (25×15cm +125:160:110 NPK kg/ha). It was observed that the yield of fruits per unit area was inversely related to the plant spacing i.e., the closer plant spacing produced the higher yield of fruits per plot and per hectare. Similar kind of findings was reported by (Ughade and Mahadkar 2015). Thus higher yield of fruits was mainly contributed by the higher plant population per unit area in closer spacing. The result of integrated nutrient management on growth, yield reported by (Wani *et al. 2013*). The maximum yield per plant was recorded in the plants treated with NPK levels conferred greater ability to produce higher yield (Table 7-11).

Chemical parameters

Result on different spacing and NPK combination indicated that T5 (25×30cm +100:120:80 NPK kg/ha) recorded minimum pH of the juice 3.53 whereas maximum pH of the juice 4.01 recorded in T3 (25×15cm +125:160:110 NPK kg/ha), T5 (25×30cm +100:120:80 NPK kg/ha) recorded maximum TSS of the juice 9.98 ºBrix whereas minimum TSS of the juice 8.38 ºBrix recorded in T3 (25×15cm +125:160:110 NPK kg/ha), T5 (25×30cm +100:120:80 NPK kg/ha) recorded minimum acidity (%) of the juice 0.67% whereas maximum acidity (%) of the juice 0.79% recorded in T3 (25×15cm +125:160:110 NPK kg/ha). This result got the support with the findings of Sharma *et al.* (2020) in strawberryeffect of different tree spacingsand combined doses of poultry manure and vermicompost on growth and yield Kar *etal.*(2019) Table (12-16).

Table 1 Effect of different spacing and NPK levels on Plant Height (cm) at (30,60,90 DAT)

	F1	**F2**	**F3**	**Mean**	**F1**	**F2**	**F3**	**Mean**	**F1**	**F2**	**F3**	**Mean**
S1	3.95	7.95	7.25	6.38	5.97	9.51	8.56	8.01	9.19	11.99	10.90	10.28
S2	7.4	6.4	6.95	6.95	8.67	7.83	8.22	8.24	10.87	10.13	10.53	10.51
S3	10.29	10.91	6.77	9.33	11.66	12.52	8.33	10.84	13.92	14.91	10.62	13.15
S4	7.49	9.57	8.55	8.54	8.72	10.80	9.71	9.74	11.13	13.16	11.96	12.08
Mean	7.28	8.72	7.19		8.76	10.16	8.70		11.28	12.55	11.00	
Factors	F test	SE(d)	C.D.		F test	SE(d)	C.D.		F test	SE(d)	C.D.	
Factor S	S	0.157	0.328		S	0.162	0.339		S	0.168	0.351	
Factor F	S	0.136	0.284		S	0.141	0.294		S	0.146	0.304	

Factor(S×F)	S	0.272	0.568		S	0.281	0.587		S	0.292	0.609	

Table .2 Effect of different spacing and NPK levels on Number of leaves per plant at (30,60,90 DAT)

	F1	**F2**	**F3**	**Mean**	**F1**	**F2**	**F3**	**Mean**	**F1**	**F2**	**F3**	**Mean**
S1	**2.53**	**3.80**	**3.20**	**3.18**	**5.26**	**11.40**	**10.33**	**9.00**	**7.26**	**13.40**	**12.33**	**11.00**
S2	**3.87**	**3.67**	**3.73**	**3.76**	**11.20**	**10.53**	**10.80**	**10.84**	**13.93**	**13.20**	**14.00**	**13.71**
S3	**3.93**	**4.80**	**4.00**	**4.24**	**11.06**	**12.93**	**11.33**	**11.78**	**13.80**	**16.33**	**14.27**	**14.80**
S4	**4.07**	**4.13**	**3.40**	**3.87**	**11.53**	**11.13**	**10.93**	**11.20**	**14.13**	**14.20**	**13.33**	**13.89**
Mean	**3.60**	**4.10**	**3.58**		**9.77**	**11.50**	**10.85**		**12.28**	**14.28**	**13.48**	
Factors	F test	SE(d)	C.D.		F test	SE(d)	C.D.		F test	SE(d)	C.D.	
Factor S	**S**	**0.167**	**0.349**		**S**	**0.353**	**0.738**		**S**	**0.385**	**0.804**	
Factor F	**S**	**0.145**	**0.302**		**S**	**0.306**	**0.639**		**S**	**0.334**	**0.696**	
Factor(S×F)	**S**	**0.290**	**0.605**		**S**	**0.612**	**1.278**		**S**	**0.667**	**1.393**	

Table .3 Effect of different spacing and NPK levels on plant spread (cm) at (30.60,90 DAT)

	F1	**F2**	**F3**	**Mean**	**F1**	**F2**	**F3**	**Mean**	**F1**	**F2**	**F3**	**Mean**
S1	**8.38**	**13.06**	**12.53**	**11.32**	**9.67**	**18.28**	**17.83**	**15.26**	**15.49**	**28.85**	**29.12**	**24.48**
S2	**14.15**	**14.03**	**11.94**	**13.38**	**19.13**	**18.45**	**17.15**	**18.24**	**30.21**	**29.01**	**27.65**	**28.96**
S3	**13.12**	**16.26**	**11.88**	**13.75**	**17.98**	**21.52**	**16.96**	**18.82**	**28.59**	**32.55**	**26.69**	**29.27**
S4	**14.10**	**11.38**	**12.45**	**12.64**	**19.31**	**16.64**	**14.65**	**16.87**	**29.59**	**27.32**	**25.86**	**27.59**
Mean	**12.44**	**13.68**	**12.20**		**16.52**	**18.72**	**16.65**		**25.96**	**29.43**	**27.33**	
Factors	F test	SE(d)	C.D.		F test	SE(d)	C.D.		F test	SE(d)	C.D.	
Factor S	**S**	**0.277**	**0.578**		**S**	**0.262**	**0.547**		**S**	**0.468**	**0.977**	
Factor F	**S**	**0.240**	**0.500**		**S**	**0.227**	**0.473**		**S**	**0.405**	**0.846**	
Factor(S×F)	**S**	**0.480**	**1.001**		**S**	**0.454**	**0.947**		**S**	**0.811**	**1.693**	

Table 4 Effect of different spacing and NPK levels on petiole length (cm) at (30,60,90 DAT)

	F1	F2	F3	Mean	F1	F2	F3	Mean	F1	F2	F3	Mean
S1	**2.51**	**5.63**	**4.36**	**4.17**	**3.69**	**6.74**	**5.61**	**5.35**	**5.87**	**8.89**	**7.77**	**7.51**
S2	**4.77**	**4.29**	**4.81**	**4.62**	**6.21**	**5.45**	**5.93**	**5.88**	**8.36**	**7.66**	**8.03**	**8.02**
S3	**8.05**	**8.51**	**4.55**	**7.04**	**9.39**	**10**	**5.91**	**8.34**	**11.54**	**12.04**	**7.83**	**10.47**
S4	**5.16**	**7.14**	**6.20**	**6.17**	**6.42**	**8.41**	**7.47**	**7.44**	**8.39**	**10.47**	**9.63**	**9.50**
Mean	**5.12**	**6.39**	**4.98**		**6.43**	**7.66**	**6.23**		**8.54**	**9.76**	**8.31**	
Factors	F test	SE(d)	C.D.		F test	SE(d)	C.D.		F test	SE(d)	C.D.	
Factor S	**S**	**0.165**	**0.344**		**S**	**0.158**	**0.330**		**S**	**0.149**	**0.311**	
Factor F	**S**	**0.143**	**0.298**		**S**	**0.137**	**0.285**		**S**	**0.129**	**0.269**	
Factor(S×F)	**S**	**0.285**	**0.596**		**S**	**0.273**	**0.571**		**S**	**0.258**	**0.538**	

Table5 Effect of different spacing and NPK levels on days taken to first flower appearance

	F1	F2	F3	Mean
S1	54.93	58.20	45.66	52.60
S2	53.93	68.13	57.93	60.33
S3	51.13	58.67	56.27	55.36
S4	53.00	53.27	52.46	52.91
Mean	53.57	59.57	53.08	
Factors	**F test**	**SE(d)**	**C.D.**	
Factor S	S	2.037	4.251	
Factor F	S	1.764	3.682	
Factor(S×F)	S	3.258	7.364	

Table 6 Effect of different spacing and NPK levels on number of flowers per plant at (60,75,85 DAT)

	F1	F2	F3	Mean	F1	F2	F3	Mean	F1	F2	F3	Mean
S1	**0.53**	**1.60**	**1.20**	**1.11**	**1.60**	**4.33**	**4.33**	**3.40**	**3.13**	**6.47**	**6.80**	**5.47**
S2	**1.53**	**3.93**	**1.47**	**2.31**	**4.53**	**4.80**	**4.80**	**4.91**	**6.93**	**8.13**	**7.13**	**7.48**
S3	**1.33**	**1.40**	**1.67**	**1.47**	**4.20**	**4.67**	**4.67**	**4.58**	**6.87**	**7.93**	**7.53**	**7.44**
S4	**1.07**	**0.93**	**1.00**	**1.00**	**4.47**	**4.40**	**4.40**	**4.53**	**7.40**	**7.60**	**7.20**	**7.40**
Mean	**1.12**	**1.97**	**1.33**		**3.70**	**4.82**	**4.55**		**6.08**	**7.53**	**7.17**	
Factors	F test	SE(d)	C.D.		F test	SE(d)	C.D.		F test	SE(d)	C.D.	
Factor S	**S**	**0.124**	**0.258**		**S**	**0.225**	**0.470**		**S**	**0.292**	**0.609**	
Factor F	**S**	**0.107**	**0.224**		**S**	**0.195**	**0.407**		**S**	**0.253**	**0.527**	
Factor(S×F)	**S**	**0.214**	**0.448**		**S**	**0.390**	**0.813**		**S**	**0.505**	**1.055**	

Table 7 Effect of different spacing and NPK levels on days taken to fruit bud development.

	F1	F2	F3	Mean
S1	66.60	70.87	60.87	69.11
S2	67.87	75.13	64.93	69.31
S3	64.60	71.47	68.80	68.29
S4	66.93	66.80	65.88	66.53
Mean	66.50	71.07	65.12	
Factors	**F test**	**SE(d)**	**C.D.**	
Factor S	NS	2.060	------	
Factor F	S	1.784	3.723	
Fator(S×F)	NS	3.567	-------	

Table 8 Effect of different spacing and NPK levels on number of fruits per plant at (75,90,105 DAT)

	F1	F2	F3	Mean	F1	F2	F3	Mean	F1	F2	F3	Mean
S1	**0.267**	**1.07**	**0.80**	**0.71**	**1.53**	**3.73**	**4.00**	**3.09**	**2.73**	**5.93**	**5.87**	**4.84**
S2	**1.00**	**1.73**	**0.73**	**1.16**	**3.80**	**4.93**	**4.13**	**4.29**	**6.13**	**9.53**	**6.60**	**7.42**
S3	**1.20**	**0.93**	**1.13**	**1.09**	**3.67**	**4.33**	**4.27**	**4.09**	**6.20**	**7.13**	**6.67**	**6.67**
S4	**1.27**	**0.53**	**0.60**	**0.80**	**4.40**	**3.87**	**4.07**	**4.11**	**6.80**	**6.47**	**6.07**	**6.44**
Mean	**0.93**	**1.07**	**0.82**		**3.35**	**4.22**	**4.12**		**5.47**	**7.27**	**6.30**	
Factors	F test	SE(d)	C.D.		F test	SE(d)	C.D.		F test	SE(d)	C.D.	
Factor S	**S**	**0.102**	**0.213**		**S**	**0.209**	**0.437**		**S**	**0.257**	**0.536**	
Factor F	**S**	**0.088**	**0.184**		**S**	**0.181**	**0.379**		**S**	**0.222**	**0.464**	
Factor(S×F)	**S**	**0.177**	**0.369**		**S**	**0.363**	**0.757**		**S**	**0.444**	**0.928**	

Table 9 Effect of different spacing and NPK levels on fruit set (%)

	F1	F2	F3	Mean
S1	66.60	70.87	60.87	69.11
S2	67.87	75.13	64.93	69.31
S3	64.60	71.47	68.80	68.29
S4	66.93	66.80	65.88	66.53
Mean	66.50	71.07	65.12	
Factors	**F test**	**SE(d)**	**C.D.**	
Factor S	NS	2.060	------	
Factor F	S	1.784	3.723	
Factor (S×F)	NS	3.567	-------	

Table 10 Effect of different spacing and NPK levels on fruit yield per plant (g)

	F1	**F2**	**F3**	**Mean**
S1	94.97	164.78	145.05	139.94
S2	162.58	176.15	181.37	173.37
S3	155.47	150.85	148.48	151.60
S4	136.17	123.93	116.76	125.62
Mean	137.30	153.93	147.92	
Factors	**F test**	**SE(d)**	**C.D.**	
Factor S	S	1.952	4.074	
Factor F	S	1.690	3.528	
Factor (S×F)	S	3.381	7.056	

Table 11 Effect of different spacing and NPK levels on fruit yield per plot (kg)

	F1	**F2**	**F3**	**Mean**
S1	0.50	0.92	0.71	0.71
S2	1.05	1.17	0.67	0.96
S3	0.65	0.89	0.79	0.77
S4	0.74	0.53	0.84	0.72
Mean	0.73	0.89	0.75	
Factors	**F test**	**SE(d)**	**C.D.**	
Factor S	S	0.040	0.083	
Factor F	S	0.034	0.072	
Factor (S×F)	S	0.069	0.144	

Table 12 Effect of different spacing and NPK levels on fruit weight (g)

	F1	**F2**	**F3**	**Mean**
S1	11.26	26.43	20.43	19.34
S2	22.05	32.81	25.87	26.91
S3	19.42	27.52	16.79	21.24
S4	24.82	16.28	19.48	20.19
Mean	19.39	25.76	20.76	
Factors	**F test**	**SE(d)**	**C.D.**	
Factor S	S	0.620	1.294	
Factor F	S	0.537	1.121	
Factor (S×F)	S	1.074	2.241	

Table 13 Effect of different spacing and NPK levels on pH of the juice

	F1	F2	F3	Mean
S1	3.42	4.95	4.01	4.13
S2	3.59	3.53	3.40	3.60
S3	4.34	3.72	3.91	3.99
S4	4.34	2.87	3.73	3.65
Mean	3.92	3.77	3.84	
Factors	**F test**	**SE(d)**	**C.D.**	
Factor S	S	0.175	0.365	
Factor F	NS	0.151	-------	
Factor (S×F)	S	0.303	0.632	

Table 14Effect of different spacing and NPK levels on TSS of the juice

	F1	F2	F3	Meanffff
S1	7.72	8.20	8.38	8.10
S2	11.25	9.45	8.86	10.54
S3	9.98	10.66	10.23	10.29
S4	6.39	10.76	9.62	8.23
Mean	8.83	9.77	9.27	
Factors	**F test**	**SE(d)**	**C.D.**	
Factor S	S	0.227	0.474	
Factor F	S	0.197	0.410	
Factor (S×F)	S	0.393	0.821	

Table 15 Effect of different spacing and NPK levels on acidity (%) of the juice

	F1	F2	F3	Mean
S1	0.82	0.95	0.79	0.85
S2	0.76	0.67	0.73	0.69
S3	0.72	0.78	0.70	0.74
S4	0.71	0.76	0.81	0.73
Mean	0.75	0.74	0.76	
Factors	**F test**	**SE(d)**	**C.D.**	
Factor S	S	0.040	0.083	
Factor F	NS	0.034	-------	
Factor (S×F)	S	0.069	0.143	

Table 16 Effect of different spacing and NPK levels on length diameter

	F1	F2	F3	Mean
S1	1.05	1.34	1.29	1.23
S2	1.62	1.56	1.26	1.47
S3	1.25	1.32	1.72	1.43
S4	1.42	1.55	1.39	1.45
Mean	1.33	1.44	1.41	
Factors	**F test**	**SE(d)**	**C.D.**	
Factor S	S	0.033	0.068	
Factor F	S	0.028	0.059	
Factor (S×F)	S	0.056	0.118	

Conclusion

From the above experiment finding it is concluded that the treatment T5 (25×30cm+100:120:80 NPK kg/ha) was found to be best in terms of yield and fruit quality viz, Days taken to first flower appearance, number of flowers per plant, days to fruit bud development, number of fruits per plant, fruit set, fruit yield, TSS, pH of the juice, acidity, weightoffruit.

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