Effect of plant population density and graded levels of phosphorus, potassium, and nitrogen on tomato growth, flowering, fruiting, and yield

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Abstract:

The optimal quantities of phosphorus, potassium, and nitrogen, in addition to the appropriate plant population density, might vary based on the particular circumstances that are present as well as the type of tomato that is being cultivated. In order to determine the optimal levels for maximizing development, flowering, fruiting, and production in a given setting, it is vital to test the soil, create nutrient management strategies, and take into consideration the individual requirements of the tomato cultivar.

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Introduction:

Because of the unique nutrients it contains, tomatoes are considered one of the most significant "protective foods" in the world. It is one of the most adaptable vegetables and has a broad range of applications in the traditional cuisine of India. Tomatoes are the most popular canned vegetable, despite the fact that potatoes and sweet potatoes are the most widely grown vegetables in the world. Tomatoes are an important part of a diet that is both healthful and well-balanced. Minerals, vitamins, the necessary amino acids, carbohydrates, and dietary fibres are all found in abundance in them. According to Bose and Som (1990), tomatoes are an excellent source of vitamin B and vitamin C, as well as iron, calcium, and phosphorus. Adoption of high producing varieties, suitable crop management practises including accurate and balanced fertilisation, timely watering, and control of diseases and insect pests are required for increased tomato output. High yielding varieties may be found online.

The administration of potassium results in an increase in the number of flowers, the length of the peduncle, the amount of fruit set, and the total number of fruits (Besford and Maw, 1975). Potassium plays a crucial part in the maintenance of a healthy balance of physiological functions

as well. It is not a component of organic structures, but it affects enzymatic activity (over sixty enzymes need potassium in order to be activated), the translocation of photosynthates, and it significantly increases the productivity and quality of fruits and vegetables after harvest (Mengel and Kirkby, 1987). The authors Cakmak (2005), Chapagain and Wiesman (2004), Dorai (2005), and Oded and Uzi (2002) state that potassium is the most effective cation for tomato plants and that it plays a significant part in the improvement of numerous post harvest quality features in tomato fruits and in virtually all vegetables. Potassium is the most efficient cation for tomato plants. Potassium has a critical role in the development of several post harvest quality traits in tomato fruits and in almost all vegetables. When soils are deficient in accessible potassium, it is normal to anticipate a positive response from the crop to an application of potassium. On the other hand, there are a lot of findings that show a beneficial crop response to K fertilisation even in soils that already have a high K status.

The natural mineral known as "polyhalite" has been given the commercial name "polysulphate." Polyhalite is found in sedimentary marine evaporation and is composed of a hydrated sulphate of potassium, calcium, and magnesium, with the formula: K2Ca2Mg (SO4)4•2(H2O). Polysulphate is a registered trademark. The deposits that may be found in Yorkshire, which is located in the United Kingdom, often have the following components: K2O: 14%, SO3: 19.2%, MgO: 3.6%, and CaO: 12%. Polyhalite is a kind of fertiliser that supplies plants with four essential nutrients: sulphur, potassium, magnesium, and calcium. It may give desirable answers to the problem of crop nutrition. In addition, the nutrient release from polyhalite is much slower than that of other S-containing fertilisers, which Ozkan et al. (2020) suggest may also be relevant for the availability of potassium in the soil.

The term "plant population density" refers to the number of individual plants that may be found within a given area or volume. In most cases, it is determined by counting the number of plants that are present in a certain area, expressed as a ratio, such as one plant for every square metre or one hectare. There is a wide range of potential variation in the population density of plants, depending on the species, the habitat, and a number of other ecological parameters.

When there are a lot of plants in a given area, there may be intense competition for limited resources like water, nutrients, and sunshine. Because of the competition, individual plant sizes may become smaller, growth rates may slow down, and the plants may experience an increase in stress. On the other hand, low population densities could enable plants to have access to more nutrients and develop with more vigour.

The study of agriculture, forestry, and ecological research all place a significant emphasis on the topic of plant population density. It is common practise in agricultural contexts for farmers to regulate plant population densities in order to improve crop yields, minimise the danger of

disease and insect infestation, or both. When it comes to forestry, having a grasp of the natural population density of different tree species is helpful for both the sustainable management and the planning of forest resources.

Ecologists investigate the population density of plants in order to get a better understanding of the dynamics of plant communities. These dynamics include species interactions, biodiversity, and succession. Ecologists are able to acquire valuable insights into the health and stability of ecosystems via the study of changes that occur over time in population density.

It is important to keep in mind that particular recommendations for plant population densities might vary greatly depending on the type of plant in question, the cultivation practises that are used, and the management objectives that are sought after.

Variations in soil conditions, climate, cultivar, and management practises, as well as plant population density and graded quantities of phosphorus, potassium, and nitrogen, may all have an impact on the growth, flowering, fruiting, and output of tomatoes. On the other hand, I can provide you with some general information on the effects that these factors could have on tomato plants:

1. Plant Population Density:

- When there are more tomato plants in a given space, there is more of a chance that they will be in direct competition with one another for available resources like light, water, and nutrients.
- When there are more plants in a given area, each plant may get less sunlight, which may result in decreased rates of photosynthesis and slower overall plant development.
- An increase in competition might result in a lower plant size, less branching on the plant, and fewer fruits being set on the plant.

2. Phosphorus (P):

- Phosphorus is necessary for the growth of tomato plants, the formation of their roots, and the production of their fruit.
- Phosphorus levels that are adequate encourage rapid vegetative growth, early blooming, and the setting of fruit.
- If there is not enough phosphorus, the plant may not develop properly, the blossoming process may be delayed, and less fruit will be produced.

3. Potassium (K):

- Tomato plants rely heavily on potassium to maintain general plant health, as well as to control the flow of water and nutrients throughout the plant.
- Potassium levels that are adequate help to better root growth, disease resistance, and overall fruit quality.
- A lack of potassium may cause a reduction in plant development, an increase in the likelihood that the plant will get infected with a disease, and a degradation in the quality of the fruit.

4. Nitrogen (N):

Sufficient nitrogen levels encourage vigorous vegetative growth, lush foliage, and increased flower formation.

- However, excessive nitrogen can result in excessive vegetative growth at the expense of fruit development, leading to reduced yields.
- Nitrogen is essential for promoting leafy growth and the production of chlorophyll in tomato plants.

Material and Method:

Research on the influence of plant population density (spacing) and graded levels of nitrogen, phosphorus, and potassium on the development, blooming, fruiting, fruit quality, and yield of tomato (Lycopersicon esculentum, Mill) cv. Utkal Kumari has been carried out throughout the 2020–2021 and 2021–2020 academic years. The experiment was carried out using a design known as a split plot, which included a total of 54 different treatment combinations. Each treatment was reproduced four times.

Soils of the experimental plot

For the purpose of determining the initial physical and chemical state of the soil, composite soil samples were collected from the experimental plot.

Experimental details

A split plot design was used for the experiment in both years, and there were a total of 54 different treatments, with each treatment being reproduced four times.

Selection of plants

In these kinds of trials, it is not feasible to conduct a comprehensive examination of each individual plant in the population. It has also been established that all plants under the jurisdiction of a treatment have equal opportunities and facilities to grow and develop. This is something that has been established. Because of this, some of the representative samples taken from the public were chosen at random in order to conduct in-depth personality studies on them. As a result, five plants were chosen at random from each individual plot. The chosen plants were given tags in order to keep track of the various observations.

Study of Characters

The observations were recorded so that the differences in the characteristics of the plants that were produced in each replication's various treatments could be studied.

Statistics

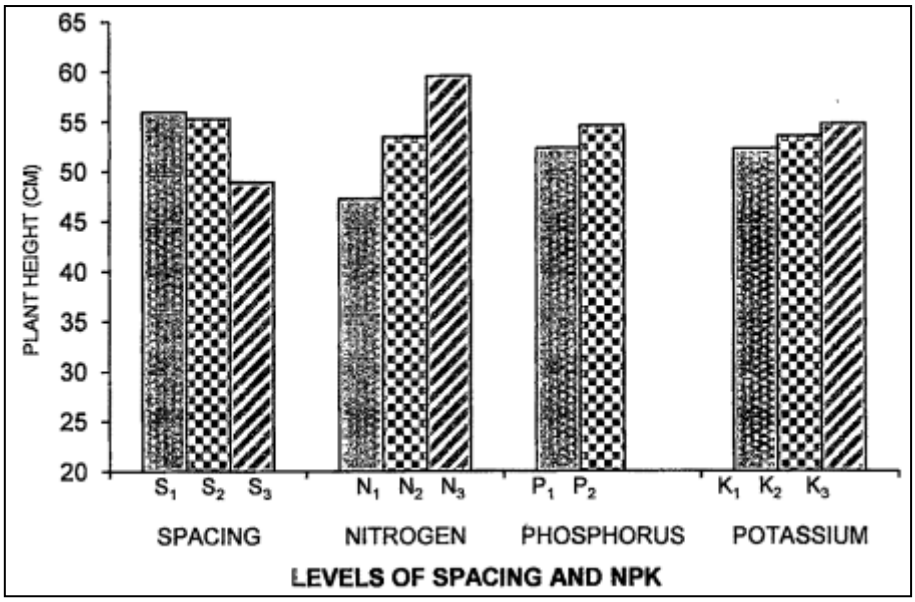
The data that were acquired over the course of the inquiry were analysed using an analysis of variance using a split plot design. This design was described by Panse and Sukhatme (1978). The 'F' (Variance ratio) test was used in order to determine whether or not the treatment effect was statistically significant. The significance of the difference in treatment means between clinically meaningful treatments was determined by using the chi-square test with a significance threshold of 5%, as shown above.

C.D. at the 5% level of significance - t Er, df at the 5% level of significance multiplied by 1-414 times S.E.(m) The data from the two years were evaluated independently. Tables, curves, and diagrams have been used to represent the findings wherever it was deemed important to do so.

Result:

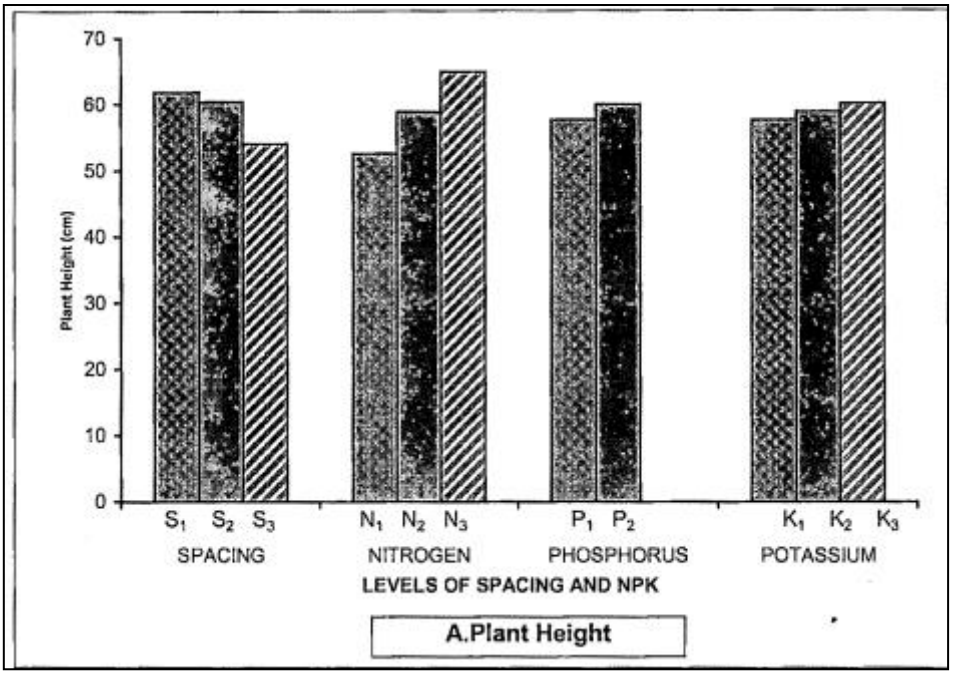
Vegetative growth characters

The data that was acquired for the plant height of tamato cv Utkal Kumari showed that various treatments and the combinations of those treatments had a significant impact at various phases of plant development. The results of the experiment showed that varying concentrations of nitrogen had a stunning impact, and virtually all of the findings held true over both years of testing (Figures 1&2).



(A) Plant Height

Figure 1: Treatments effect of tomato on vegetative growth characters for the year 2020



(A) Plant Height

(B)

Figure 2: Effect of treatments on vegetative growth characters of tomato for the year 2021

Flowering characters

According to the information that was collected and shown in Figures 3 and 4, the longer distance between plants was found to have a substantial impact on the total number of days it took for the first flowers to appear in both years. During each of those years, the greatest number of days, which came out to 33.58 and 35.87 respectively, was recorded when wider spacing (S3) was used. During the years 2020 and 2021, the number of days with the greatest plant density (Si) were, respectively, the fewest at 31.87 and 33.64.

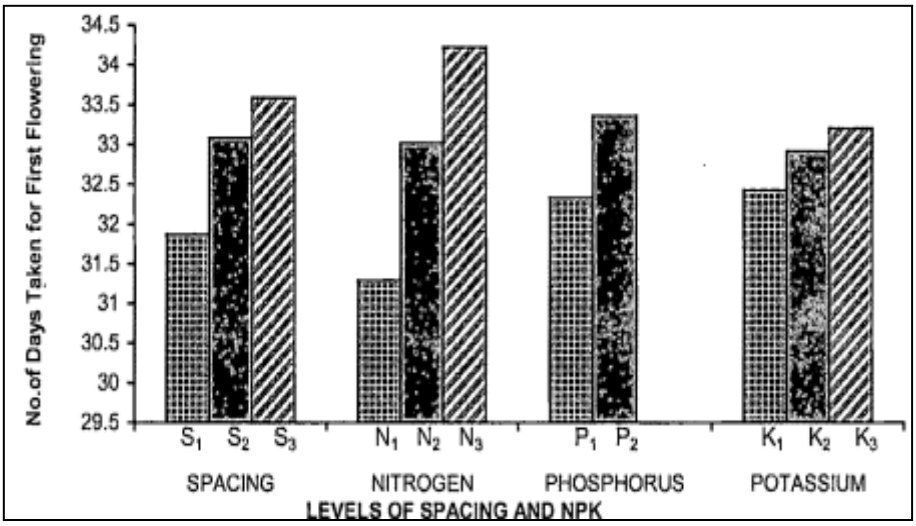


Figure 3: Treatments effect of tomato on flowering characters for the year 2020

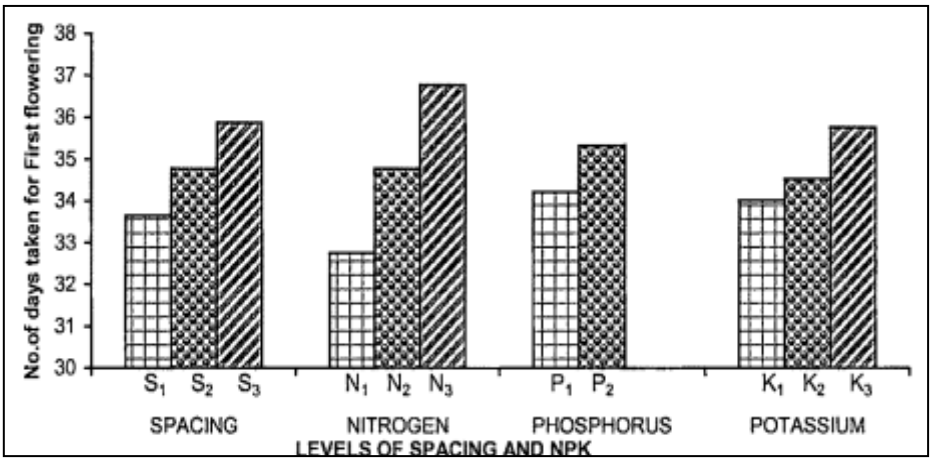


Figure 4: Treatments of tomato on effect flowering characters for the year 2021

Fruit set characters

A review of the data that was collected and is graphically shown in Figure 5 reveals that there is a correlation between the amount of nitrogen in the soil and the length of time it takes for the first fruit to form.

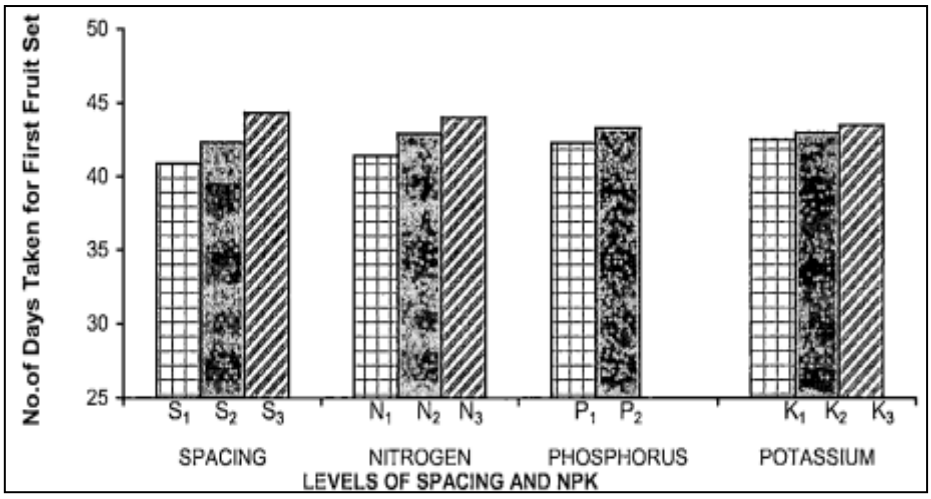


Figure 5: Treatments effect of tomato on fruit set characters for the year 2020

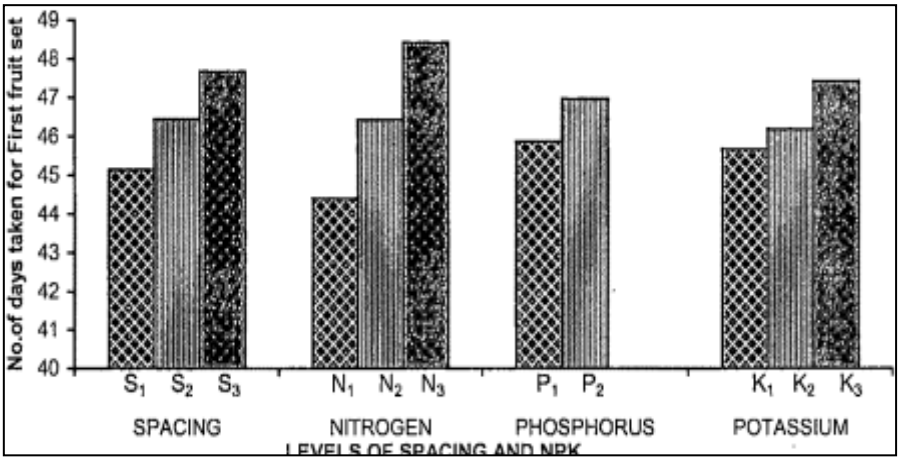


Figure 6: Treatments effect of tomato on fruit set characters for the year 2021

Fruiting characters of tomato

In general, a rise in the degree of N, P, and K fertilisation as well as wider spacing led to an increase in the quantity of fruits produced per plant (Figures 7 & 8). The increasing amounts of nitrogen resulted in a rise in the number of fruits produced in both 2020 and 2021. The highest average number of fruits was 20.00 and 18.59 under N3 (180 kg N/ha), while the lowest number of fruits obtained in both years was 18.27 and 15.05 respectively. N2 was superior than N-i both in 2020 and 2021, as shown by the higher average number of fruits produced with N2 treatment (19.72 vs. 15.98 respectively).

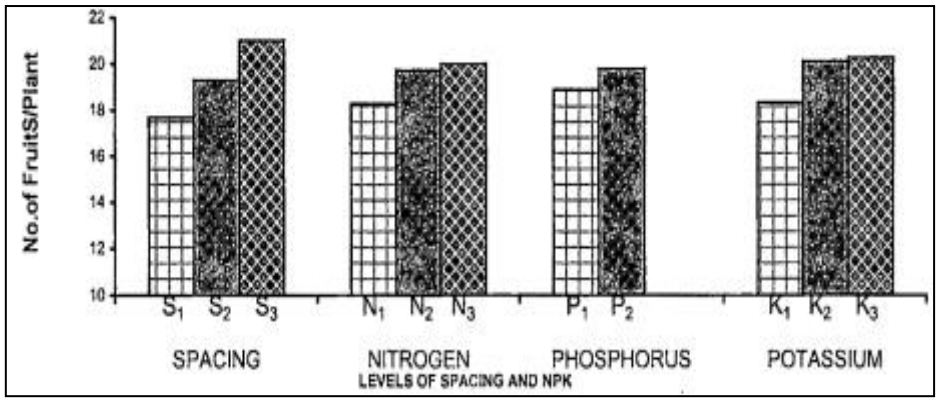


Figure 7: Treatments effect of tomato on fruiting characters for the year 2020

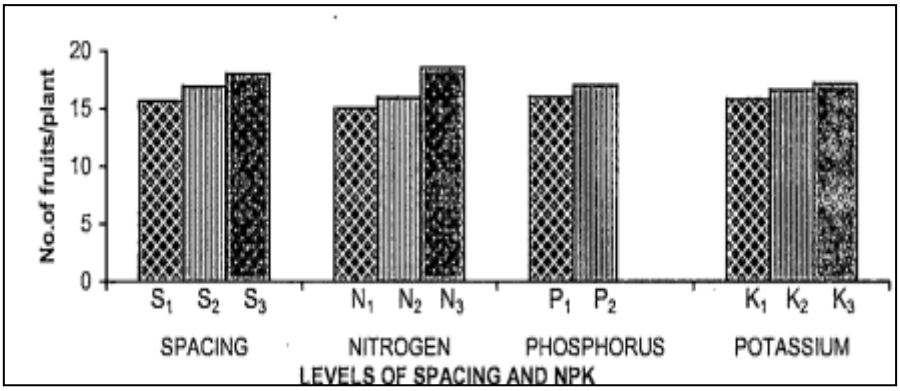


Figure 8: Treatments effect of tomato on fruiting characters for the year 2021

Conclusion:

Tomato development, flowering, fruiting, and yield may be affected differently by plant population density as well as graded levels of phosphorus, potassium, and nitrogen depending on a number of variables including soil conditions, climate, cultivar, and management practises.

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