INTRODUCTION
CHAPTER I

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Vegetables constitute the most important food next to cereals and milk. It has been well advocated in solving food and nutritional problem. Our world population is expanding nearly 40 per cent and it will be 8 billion in 2020. More than 80% of this population will live in today's developing world. An estimated 2 billion people suffer from malnutrition due to lack of vitamins and essential minerals on their food. Vegetables are good source of carbohydrate, vitamins and minerals particularly calcium, iron and magnesium and these are essential for building nourishment and help to generate resistance against various diseases. It is also interesting to note that one hectare of vegetable crop produces much more calories than cereals.

India is the major exporter of vegetables and annually earned approximately 246 million dollar from export, ranking 10th position in the world (Shanmugasundram, 2004). Before independence, vegetable production of our country was nearly 20 million tonnes and now it is about 93.92 million tonnes from 6.25 million hectare of land with a productivity of 15 t/ha (Rai and Pandey, 2004). Although India achieve remarkable goal of higher production by increasing nearly 78.41 per cent production with increase of only 0.42 per cent vegetable cultivated area. The credit goes to invention of high-yielding varieties (O.P. and hybrid) and adoption of improved production and protection technologies. Now, India is the second largest vegetable producer in the world, but per capita
vegetable availability is only 210 g per day and it is, lower than the minimum requirement of 280 g per capita per day. Simultaneously our country's population is increasing at the rate of 1.8 per cent so, our vegetable requirement in 2010 will be around 135 million tonnes (Kallo and Pandey, 2002). To meet out desired vegetable production target, we need to increase our vegetable productivity upto 200-300 per cent. The further expansion on vegetable cultivated land is not possible, although it shrinks day by day due to tremendous population pressure, so solution to feed the bursting population only comes through genetic packet i.e. seed, because by the use of good quality seeds only, desired massive production target can be achieved. If seeds are good enough in quality then only all the production technology could enhance the productivity of the crop. In India quality seeds are still lacking even thoughtful seeds are not available in desired quantity, and about 78.86 tonnes vegetable seeds are deficient than its requirement (Arora, 1998).

Nature has endowed India with many precious gifts, wherein lies its immense potential for the agriculture sector. The vast diversity of land, soil and agro-climatic conditions offer us unique competitiveness to grow a wide range of vegetable crops. Important vegetable crops grown in the country are potato, tomato, onion, brinjal, cabbage, cauliflower, okra and pea.

Okra, (*Abelmoschus esculentus* (L.) Moench) belonging to family Malvaceae is native of South Africa and predominated in tropics and subtropics of the world. Cultivated okra is polyploid in nature (Joshi and Hardas, 1956). The somatic (2n) chromosome number in the genus *Abelmoschus* ranges from 72 to
There are 30 species, under genus *Abelmoschus* in the old world and four species in the new world (Joshi *et al*., 1974). *A. esculentus* is only species known to be cultivated.

India is the largest producer of okra in the world, occupying 0.36 million hectare with 3.50 million tonnes production with average productivity of 9.72 t/ha. Whereas, world's produces 4.90 million tonnes from 0.79 million hectare land with average productivity 6.20 tonnes/ha during the year 2002 (Shanmugasundram, 2004). Okra is widely cultivated, during kharif, rabi and summer season in Chhattisgarh. In the state, it occupies an area of 11068 ha with production of 0.628 lakh tonnes with the productivity of 6.00 tonnes / ha (Anonymous, 2005).

Okra is very important vegetable due to its wide adoptability among every age group, community, society and part of the world. It has multiple uses like fresh fruits are used as vegetable, sun-dried (Africa, India), frozen and sterilized (USA). The root and stems of okra are used for cleaning of cane juice in preparation of Jiggery. It has been reported to have an average nutritive value (ANV) of okra is 3.21, which is higher than tomato, brinjal and most of the cucurbits (Grubbon, 1977). Okra dry seed contain 13-22 per cent edible oil along with 20-24 per cent protein. Thus, the refined seed oil is used as common edible oil substitute. Seed oil of okra is also used in soap, cosmetic industry and vanaspati, while protein is used for fortified food preparation. Seed cake is very good as animal food and it also helps to increases milk production. Roasted and grind okra seeds are used as a coffee substitute (Martin, 1982). The fruit, seed,
fruit shell and stem (after fruit harvest and seed extraction) are very useful for paper and cardboard industry due to its higher fibre content. Okra has many medicinal properties and it is helpful in goiter disorder due to its higher iodine content. Leaves are used in inflammation and dysentery. The fruits help incase of renal colic leucorrhoea and general weakness. Seeds are used as medicinal treatments against genitourinary disorder and chronic dysentery (Nandkarni, 1927).

Okra has tremendous export potential as fresh vegetable. India exports okra mainly to West Asia, Western Europe and the United States. It ranks eighth position in area under vegetable crops and occupies second position after onion in export of fresh vegetable of our country. The demand of fresh okra is more in external markets for green, tender and 6-9 cm long fruits. Among suitable varieties, Pusa Sawani, Parbhani Kranti, Varsha Uphar and Pusa A-4 have established in the areas raising the crop mainly for export (Varmudy, 2001).

To obtain maximum income from okra crop, it is very essential to achieve maximum production per unit area. Despite all necessary facilities for cultivation, we can not be hopeful about the success of crop, if poor quality seeds are used. Good seeds are basic and most important input requiring relatively less cost, amongst all the input involved in the production of okra crop. Hence, pure and quality seeds are prerequisite for successful cultivation of the crop. Scientific seed production in India is yet to get a sound footing largely due to non-availability of region specific appropriate information on its production practices. This has resulted in the reluctance of growers to take up the seed production of
okra commercially. There is a great demand of fresh seeds every year. In India, vegetable seed industry does not provide sufficient amount of seed, demanded by the vegetable growers, particularly in case of okra condition is very poor. Every year nearly 4645.81 tonnes of okra seed is required while availability is only 4292.73 tonnes i.e. nearly 92.40 tonnes seed is less available (Arora, 1998). The Chhattisgarh plains have a lot of scope for okra seed production due to favourable agro-climatic condition particularly mild winter during growing season of the crop, which offers a good potential for okra seed production.

Okra seed crop is influenced by several factors i.e. temperature, photoperiod, rainfall, time of sowing, irrigation, spacing and fertilizer application. Plant density and amount of nutrients applied to the crop play an important role in determining the seed yield of the crop.

Proper plant spacing is an essential requirement, as too closer or wider spacing is undesirable for the cultivation of the crop. Proper spacing provides good condition for root development and it also enables plants to get optimum light for food synthesis, which directly affects the seed yield. Plant density is considered as an important factor in adjusting the optimum crop stand for stepping up the seed yield. It varies considerably from variety-to-variety, region to region and amount of nutrients applied. Several workers demonstrated the significance of optimum plant population in okra to increase seed yield per unit area (Birbal et al., 1995; Fondgo et al., 1999; Yadav and Dhankar, 1999; Muhammad et al., 2002 and
Sajjan et al., 2004 etc), as poor plant population per unit area decreases total yield while optimum plant population increase fruit and seed yield considerably. It seems that when okra plant spaced closely together in the rows reaches maximum $\text{CO}_2$ exchange rate, leaf area index and early as well as higher production (Whitehead and Singh, 2002). Yield of crop is the result of final plant population, which depends on the plant spacing. In the condition of sufficient soil moisture and nutrients, higher population is necessary to utilize other growth factors efficiently. After soil moisture and nutrients are not limiting, the yield of crop is regulated by solar radiation. The level of plant population should be such that maximum solar radiation is intercepted.

Okra is a heavy feeder and required ample amount of nutrients. The amount and type of fertilizer varies from place to place, depending on the soil and the agro-climatic conditions. Nitrogen is very important nutrient for high and healthy seed production of okra. Even a good variety may produce poor yield if proper amount of nitrogen is not provided. Nitrogen is the chief constituent among the several elements occurring in the plants. It is a constituent of proteins, enzymes, hormones, vitamins, alkaloids, chlorophyll etc. Plant growth is adversely affected due to deficiency of nitrogen as nitrogenous compounds are involved in most essential and vital compounds, which are prerequisite for plant growth and development. Due to this reason, nitrogen is required in sufficient quantities and its deficiency will not tolerate by crop particularly seed producing crops.
Plant spacing and amount of nitrogen application are inter-related and affect adequately growth, development and ultimately quality as well as quantity of the produce. Therefore, farmers should be aware for appropriate plant spacing with proper amount of nitrogen application to get maximum produce from per unit area. Ample research work has been reported on okra for producing green pods, but studies on seed production of okra are meager particularly in agro-climatic condition of Chhattisgarh. Considering these facts, the present investigation entitled “Studies on response of different planting densities and nitrogen levels on seed yield of okra (Abelmoschus esculentus (L.) Moench)” was undertaken with the following objectives:

1. To find out the effect of different plant spacing on growth and seed yield of okra,

2. To study the effect of different nitrogen levels on growth and seed yield of okra,

3. To find out most appropriate combination of nitrogen level and plant spacing to get maximum seed yield,

4. To workout the economics of the different treatments.