CHAPTER- II

REVIEW OF LITERATURE

The productivity of rajmah crop being a complex phenomenon and it is governed by numerous endogenous and exogenous factors. It can be enhanced by adopting suitable agro-techniques viz., use of improved varieties, timely sowing with appropriate spacing and maintaining optimum plant stand, proper irrigation scheduling, fertilizer management and proper measure to minimize losses through weeds, insect-pest and diseases. Spacing and fertilizers have a vital importance for harvesting potential production under different agro-climatic conditions.

An attempt has been made to highlight a brief review of research work done pertaining to response of rajmah to spacing and fertility levels under varying agro climatic situations in India and abroad. The topic has been divided in to following broad sub-heads.

2.1 Effect of spacing

2.2 Effect of fertility levels

2.3 Interaction effect of spacing and fertility levels

2.1 Effect of Spacing

Ahlawat (1996) conducted a field experiment at New Delhi, India to study the comparative performance of french bean varieties and their response to plant density and phosphate fertilizers. He found that plant density did not affect the seed yield and lower plant density of 2, 22,000 plantsha⁻¹ showed significant increase in pods plant⁻¹.

Koli and Akashe (1995) studied the response of row spacing, plant density and N level on yield of french bean. They reported that the yield were similar at densities of 2, 22, 222 plants and 3, 33, 333 plants ha⁻¹ and were decreased under 4, 44,444 plants ha⁻¹.

Singh and Behera (1998) conducted an experiment to study the effect of french bean to fertilizers and spacing. Results revealed that closer spacing of 35 x 25cm produced significantly the maximum green pod yield.
A field experiment was conducted during rabi season of 2003-2004 to study the effect of row spacing (25, 50 or 75 cm) and densities (1,00,000, 2,00,000, 3,50,000 and 5,00,000 plants ha\(^{-1}\)). Horn et al. (2000) reported that decrease in row spacing resulted in reduction of yield in french bean.

A field experiment was conducted during the winter seasons of 1996–97 and 1997–98 at Baraut, Uttar Pradesh to study the response of french bean (Phaseolus vulgaris L.) to plant density and N application. Dhanjal et al. (2001) found that lowest plant density of 250 x 10\(^3\) plants ha\(^{-1}\) recorded markedly higher values of growth and yield attributes, except plant height which was maximum with the highest plant density of 500 x 10\(^3\) plants ha\(^{-1}\). Medium plant density (333 x 10\(^3\) plants ha\(^{-1}\)) resulted in markedly higher yield than lower and higher plant densities. Higher plant density resulted in the highest stover yield. Lower and medium plant densities recorded higher harvest index over higher plant density.

Field experiment was carried out to study effect of plant density and row spacing on green pod yield of faba bean at Southern Spain during 2000-2001 and 2001-2002 growing seasons. Nadal and Maoreno (2006) reported that the plants were grown at three densities 11, 17 and 33 plants m\(^{-2}\)(i.e. at 90, 60 and 30cm row spacing), among them optimum density for faba bean was 33 plants m\(^{-2}\). Immature green pod yields generally increased as population density increased.

The experiment was conducted at the Agricultural University of Urmia, Iran during 2003 to study the effect of row spacing and inter row spacing on common bean (Phaseolus vulgaris L.). Jafroudi et al. (2007) reported that the highest grain yield of 4.19 t ha\(^{-1}\) was recorded at 30cm row spacing and 5cm intra row spacing. The number of pods plant\(^{-1}\), number of grains plant\(^{-1}\) and grain weight plant\(^{-1}\) increased with decrease in spacing. They also observed that by increasing the spacing, the first pod trait had higher height. However, the grain protein content was not affected by the spacing.

Effect of plant density on vegetative growth and yield performance of french bean under North Indian condition during rabi season of 2006 at Parbhani studied by Pawar et al. (2007). They reported that closer spacing of 30 x 10cm (3.33 lakh plants ha\(^{-1}\)) recorded significantly higher plant height, grain and straw yields as well as biological yield. Whereas, wider spacing of 45 x 15 cm (1.48 lakh plants ha\(^{-1}\))
noted significantly higher branches, functional leaves, mean leaf area, grains pod\(^{-1}\), pod weight and test weight.

Samih Abubaker (2008) conducted an experiment at Rum Agricultural Farm, Jordan during 2007 to study the effect of plant density on flowering date, yield and quality attributes of bush bean. He observed that significantly higher seed yield was recorded when crop was sown at 20x 30cm spacing. He also reported that days to 50% flowering, stem diameter, fresh and dry pod weight, N, P, K and protein content noted significantly higher under wider spacing of 60x 60cm.

An experiment was conducted during rabi seasons of 2005-06 and 2006-07 to study the effect of spacing on growth and yield of french bean. Chakravorty et al. (2009) found that different spacing significantly influenced the various growth, yield attributes and pod yield of french bean. Among the different row spacing, closer spacing of 15 x 10 cm recorded significantly maximum plant height, pod length, pod width, pods plant\(^{-1}\), pod weight, pod yield plant\(^{-1}\) and pod yield were recorded under closer spacing. Whereas, branches plant\(^{-1}\) and leaves plant\(^{-1}\) were significantly maximum under wider spacing of 30 x 25cm.

The experiment was undertaken during 2001-02 to determine the effect of plant density on the yield component and yield of haricot bean at Dire Dawa, Ethiopia. Abate et al. (2012) found that significantly higher pod bearing branch, pod width, 100 seed weight, harvest index and seed yield were recorded under 15.6 plants m\(^{-2}\).

A study was conducted at the College of Agriculture, Kirkuk University, Iraq to investigate the effect of planting distance on yield of faba beans during the winter season of 2009 and 2010. The result indicated that both the interactions between plant distance and different varieties of beans and that of the distance between plants were significant differences for the varieties of bean based on percentage of growth, plant height, branches plant\(^{-1}\), pod length and number of seed pod\(^{-1}\). (Amer et al., 2012).

Field and Nkumbula (2012) conducted an experiment to study the effect of plant density on yield and quality of green bean during rabi season at Lincolan College, New Zealand during 1980-81. They found that after sowing the crop at 150, 300, 380 and 450 mm between-row distances and within-row distances of 70 or 140
mm, total pod yield and the yield of processable pods showed significant quadratic responses to increasing plant population density. A plant population density more than 40 plants m$^{-2}$ produced a total pod yield in excess of 3.0 kg m$^{-2}$. Plant population density was a more important determinant of yield than planting arrangement.

Kazemi et al. (2012) studied the effect of plant density on yield and yield components of white bean (*Phaseolus vulgaris* L.) cultivars at Agricultural and Natural Resources Research Centre of Ilam, Iran during 2009-2010. Experimental result showed that plant density had significant effect on number of branches, number of pods plant$^{-1}$, grain yield, biological yield and harvest index. The plant density of 13 plants m$^{-2}$ produced maximum number of branches (28.5), number of pods plant$^{-1}$ (42.1), grain yield (2,393 kg ha$^{-1}$), biological yield (5,761 kg ha$^{-1}$) and harvest index (41.6%).

An experiment was carried out during winter season at the Horticultural Farm, Jomo Kenyatta University of Agriculture and Technology, Kenya to study the effect of intra row spacing on growth and yield of french bean. Mureithi et al. (2012) reported that increasing intra-row spacing from 10 to 15 to 20 cm resulted in significant increase in all the growth parameters viz., plant height, branches plant$^{-1}$, number of leaf plant$^{-1}$, leaf area and plant dry weight.

A field trial was conducted at College of Agricultural Studies, University of Science and Technology, Sudan to study the effect of spacing and sowing date on french bean during winter season of 2011-2012. Ayoub and Abdalla (2014) reported that plant height, dry matter plant$^{-1}$, days to 50% flowering, number of pods plant$^{-1}$, pod length, pod diameter and pod yield plant$^{-1}$ hectare$^{-1}$ recorded significantly maximum when french bean was sown at 20cm spacing and 2 plant hill$^{-1}$.

Influence of plant spacing on yield and yield components of snap bean (*Phaseolus vulgaris* L.) were studied during 2010-2011 at Jimma, South-Western Ethiopia by Getachew et al. (2014). They found that snap bean spaced at 40cm $\times$ 7cm resulted in the highest total marketable pod yield, total unmarketable pod yield, total number of pods plant$^{-1}$, dry weight of pods, plant height and dry weight of shoot and root.

The field trial was conducted at Department of Horticulture, Faculty of Agriculture and Natural Resources, Mutare, Zimbabwe by Tuarira and Moses (2014)
to evaluate the effect of plant density on green bean seed production. Result showed that maximum plant height was observed under higher plant density of 3, 20,000 plant ha\(^{-1}\). Lowest density recorded maximum branches and pods plant\(^{-1}\) as well as seeds pod\(^{-1}\). Significantly highest 100 seed weight and seed yield ha\(^{-1}\) were obtained under 2, 22,222 plants ha\(^{-1}\).

The field experiment was carried out to study the effect of spacing on growth and yield of common bean during 2012 cropping season at Keker, Mizan-Tepi University, South-Western, Ethiopia. A common bean planted with 30cm X 5cm spacing produced significantly higher plant height. However, a common bean planted at 50cm X 15cm spacing recorded significantly more number of leaves. The time required to reach 50% flowering increased with increase in spacing. Maximum seed yield was produced under 40 x 15cm spacing (Woldesenbet, 2014).

The experiment was conducted at Mansehra, Baffa (Pakistan) during 2013 to study the response of french bean to plant spacing. Ahmed et al. (2016) reported that plant spacing of 15cm recorded maximum days to flowering and seed maturity. Maximum fresh pod yield plant\(^{-1}\), number of seed pod\(^{-1}\) and seed yield ha\(^{-1}\) were recorded at spacing of 45cm.

Kalita et al. (2016) carried out an experiment from rabi 2008-09 to 2010-11 to study the yield potentials of the rajmah at different spacing on sandy loam soil at Assam Agricultural University, Shillongani,. Assam. They reported that 30 x 10cm spacing was suitable for getting higher seed yield, gross and net return as well as B:C ratio.

The field experiments were conducted during the two growing summer seasons of 2013 and 2014 at the experimental farm of vegetables at Kaha, Egypt in order to investigate the effect of seed size and plant density on growth and seed yield of snap bean. Results showed a higher plant density (33 plants m\(^{-2}\)) gave the highest values of plant length and seed yield, while lower plant density (22 plants m\(^{-2}\)) recorded higher values of plant dry weight, seed weight plant\(^{-1}\), 100 seed weight, protein and NPK content (Yehia et al. 2016).
2.2 Effect of Fertility Levels

Koli and Akashe (1995) studied the response of row spacing, plant density and N level on yield of french bean. They reported that the 60 kg N ha$^{-1}$ produced highest seed yield of french bean.

Singh and Behera (1998) conducted an experiment to study the effect of french bean to fertilizers and spacing. Results revealed that application of 62.5-100-100 kg N-P$_2$O$_5$-K$_2$O ha$^{-1}$ produced significantly the maximum green pod yield.

Adrizal et al. (1999) study the response of french bean to NPK fertilizers at screen cattle in Bandar Buat during 1997-1998. They concluded that from the different six rate of NPK, application of 22.5+135 + 60 kg N+ P$_2$O$_5$+ K$_2$O ha$^{-1}$ found significant for growth and yield attributes like plant height, plant spread, number of branches, seed and stover yields.

The field experiment was conducted to study the response of french bean to fertilizer levels in mid-hills of north-western Himalayas during crop growing season. Thakur et al. (1999) revealed that application of NPK @ 75.0-64.5-62.3 kg ha$^{-1}$ produced significantly higher seed yield.

An experiment was conducted during the winter seasons of 1996–97 and 1997–98 at Baraut, Uttar Pradesh to study the response of french bean (Phaseolus vulgaris L.) to plant density and N application. Dhanjal et al. (2001) found that the growth and yield attributes and yields (grain and stover) increased with increasing rates of N up to 120 kg/ha. This level of N also recorded higher harvest index over no nitrogen.

An experiment was undertaken at Mymensingh, Bangladesh during rabi seasons of 2001 and 2002 to study the effect of sowing date and fertilizer on french bean. Begum et al. (2003) reported that application of 90-50-120 kg NPK ha$^{-1}$ recorded significantly higher pod length, number of seeds pod$^{-1}$, pod weight plant$^{-1}$, seed weight plant$^{-1}$, pod and seed yields.

Field trial was conducted to study the response of french bean to fertility levels and moisture regimes at A.S. College, C.C.S.U., Lakhati, Buland Sahara, U.P. during rabi seasons of 1994-95 and 1995-96. Singh et al. (2003) reported that significantly maximum pods plant$^{-1}$, pod length, seeds pod$^{-1}$, 100 seed
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weight, seed yield, B:C ratio and NPK uptake by grain and straw were recorded when crop was fertilized with 120-90-45 kg NPK ha⁻¹.

The field experiment was carried out during the two successive seasons of 2003 and 2004 in Wadi El-Mulaak area, Ismialia to study the effect of different levels of NPK on growth, yield and quality of snap bean under the new reclaimed land conditions. Abdel et al. (2005) found that increasing the level of NPK resulted in a positive response in the vegetative growth. Yield increased as the level of NPK increases. Pod length, thickness and fiber content were not significantly affected by the level of NPK application.

An experiment was carried out at Belvatigi (Karnataka) during rabi 2003-04 to 2005-06 to study the response of french bean to phosphorus levels. Chaudhary et al. (2008) reported that application of phosphorus significantly increases the seed and pod yields.

An investigation was undertaken during rabi season of 2005-06 at Department of Agronomy Farm, MAU, Parbhani to study the performance of french bean genotypes under different fertility levels. Maske et al. (2009) reported that application of 150:75:75 NPK kg ha⁻¹ recorded significantly taller plant, more functional leaves, leaf area, branches plant⁻¹, pod dry weight, pods plant⁻¹, seed yield plant⁻¹, 100 seed weight, seed, straw and biological yields. Harvest index was higher when crop was fertilized with 120-60-60 kg NPK ha⁻¹.

Sherawat and Singh (2009) conducted a field trial during rabi seasons of 2003-04 and 2004-05 at Janta Vedic Post Graduate College, Baraut (Uttar Pradesh) to study the effect of nitrogen and potassium on growth and yield of french bean. They reported that plant height, branches plant⁻¹, pods plant⁻¹, pod length, 100 grain weight, grain and straw yields were significantly maximum when crop was fertilized with 180 kg N and 60 kg K₂O ha⁻¹.

A field study was conducted to assess the effect of nitrogen doses on growth and yield of french bean during 2006-07 and 2007-08. Singh et al. (2009) revealed significantly maximum plant height, days to 50% flowering, branches plant⁻¹, pods plant⁻¹, pod diameter, pod length, seeds pod⁻¹, 100 pod weight and green pod yield plant⁻¹ plot⁻¹ were recorded when french bean was fertilized with 180 kg N ha⁻¹.
An investigation was undertaken at Field Research Centre, of Department of Seed Science and Technology, H.N.B. Garhwal University, Srinagar during rabi 2007. Singh and Chauhan (2009) recorded highest biomass of whole plant of french bean under NPK treatment.

Suleiman et al. (2009) conducted an experiment at Experimental Farm of the Faculty of Agriculture, University of Khartoum at Shambat in order to study the response of common bean to phosphorus. Result showed that application of phosphorus had no any significant effect on growth and yield attributes; except crude protein and phosphorus content in grain and straw.

Field trials were carried out at BARI Regional Station, Jamalpur and BARI Central Farm, Joydebpur (Bangladesh) during 2005-2006 to study the response of different levels of nitrogen and phosphorus on growth and yield of french bean. Sen et al. (2010) reported that application of nitrogen @ 150 or 200 kg ha\(^{-1}\) recorded significantly higher plant height, pod length, pods plant\(^{-1}\) and pod yield. Similarly, application of phosphorus @ 60 kg ha\(^{-1}\) produced significantly higher pod length, pod width, pods plant\(^{-1}\) and pod yield at both the locations. Maximum gross return was noted when crop was fertilized with 150-60 kg NP ha\(^{-1}\), while maximum net return was obtained under 150-40 kg NP ha\(^{-1}\).

Shubhashree et al. (2011) conducted an experiment during rabi 2006 at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad on black clay soil to study the response of rajmah (Phaseolus vulgaris L.) to levels of N, P\(_2\)O\(_5\) and K\(_2\)O. The results revealed that significantly maximum dry matter plant\(^{-1}\), pods plant\(^{-1}\), seeds pod\(^{-1}\), grain weightplant\(^{-1}\), grain yield and NPK uptake were observed when crop was fertilized with 120-75-60 kg N-P\(_2\)O\(_5\)-K\(_2\)O ha\(^{-1}\).

A field experiment was conducted at the Research Farm, ICAR Research Complex for NEH Region, Mizoram during 2009-2010 to find out the effect of vermicompost, NPK fertilizer and organic mulch on crop growth, nodulation and pod yield of french bean (Phaseolus vulgaris L.) in mild-tropical climate during dry season 2009-2010. The results showed that the shoot length, number of primary branches, shoot fresh weight and shoot dry weight were increased by 28-63% through application of NPK 8:13:10 kg ha\(^{-1}\) + vermicompost 3.75 t ha\(^{-1}\) and by 5-50% in organic mulching treatments (Singh et al. 2011).

Salehin and Rahman (2012) studied the effect of zinc and nitrogen fertilizers and their application method on yield and yield components of rajmah (Phaseolus vulgaris L.) at
University of Development Alternative, Dhaka (Bangladesh) during 2011. The results showed that the application of nitrogen @ 90 kg ha\(^{-1}\) recorded significantly higher seed yield, 100 seed weight, pods plant\(^{-1}\), seeds pod\(^{-1}\), plant height and days for maturity.

An experiment was conducted at Agricultural Research Farm of S.D.J. (P.G.) College, Chandeshwar, Azamgarh (UP) during rabi seasons of 2010-11 and 2011-12on a silty loam soil. Dwivedi et al. (2013) revealed that the application of 100 kg N and 60 kg P\(_2\)O\(_5\) ha\(^{-1}\) produced significantly taller plant, more pods plant\(^{-1}\), seeds pod\(^{-1}\), 1000 seed weight and seed yield as well as higher B:C ratio during both the years in rajmah crop.

A field experiment was conducted from 2003-04 to 2005-06 at MKVP, Parbhani (Maharashtra) to study the effect of nitrogen and phosphorus on french bean. Lad et al. (2014) reported that higher dose of nitrogen (150 kg N ha\(^{-1}\)) and phosphorus (75 kg P\(_2\)O\(_5\)ha\(^{-1}\)) produced significantly higher plant height, branches plant\(^{-1}\), leaves plant\(^{-1}\), dry matter plant\(^{-1}\), pods plant\(^{-1}\), pod dry weight plant\(^{-1}\), seeds pods\(^{-1}\), 100 seed weight, seed yield, harvest index, protein content, gross and net return during individual years and in pooled results, while BCR was higher under 100 kg N and 50 kg P\(_2\)O\(_5\) ha\(^{-1}\).

Tuuko and Mohammed (2014) conducted an experiment to study the response of common bean to different levels of phosphorus and its effect on growth, dry matter yield and yield components of the crop at the Arba Minch Farm Field, Ambo University, Ethiopia during 2011. The results showed that the application of phosphorus significantly increased dry matter yield, plant height, branches plant\(^{-1}\), pods plant\(^{-1}\), seeds pod\(^{-1}\) and seed yield.

The experiment was conducted at Agricultural Research Station, University of Agriculture, Baffa (Pakistan) during 2006 to study the effect of nitrogen, phosphorus and potash on yield of french bean. Ali et al. (2015) found that the application of 120-90-90 kg N-P\(_2\)O\(_5\)-K\(_2\)O ha\(^{-1}\) recorded significantly higher plant height, more branches plant\(^{-1}\), pod length, pod weight, pod yield, net income and B:C ratio.

Kashinath and Ramakrishna (2015) carried out a greenhouse trail at College of Agriculture, Bangalore to study the response of french bean varieties to NPK fertilization during Kharif1996. They found significantly higher pod yield and
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NPK uptake at different growth stages with the application of 62.5-100-75 kg NPK ha\(^{-1}\).

A field trial was conducted to study the effect of chemical phosphorous fertilizer on growth and yield of green bean at Khomam, Guilan province, Northern Iran during 2014. Moghaddam and Aminpanah (2015) reported that the application of phosphorus @ 100 kg ha\(^{-1}\) recorded significantly higher plant height, pods plant\(^{-1}\), pod yield and NP content in pod.

An experiment was conducted at Agricultural Research Station, Baffa (Pakistan) during 2014 to study the effect of NPK levels on growth and yield of french bean. Shahid et al. (2015) reported that significantly maximum plant height, branches plant\(^{-1}\), pod length, pod weight, pod yield and gross and net return were recorded when crop was fertilized with 120 kg N, 90 kg P\(_2\)O\(_5\) and 90 kg K\(_2\)O ha\(^{-1}\).

Field experiments were conducted at Areka Agricultural Research Centre and Kokate Research Station in Southern Ethiopia during 2014 to study the response of french bean to phosphorus. Shanka et al. (2015) reported that the application of phosphorus @ 92 kg ha\(^{-1}\) recorded significantly higher pods plant\(^{-1}\), seed weight, dry biomass yield, pods plant\(^{-1}\) and grain yield.

A field experiment was conducted during rabi 2012-13 at College Agronomy Farm, Anand Agricultural University, Anand (Gujarat) to find out the optimum dose of nitrogen for rajmah. Motaka et al. (2016) reported that economically optimum dose of nitrogen for rajmah was 138.57 kg ha\(^{-1}\) under middle Gujarat conditions.

Zahida et al. (2016) working at Research Farm, Department of Agronomy, Faculty of Agriculture, Wadura, SKUAST-Kashmir (J&K) to find out the effect of nutrient management on productivity and quality of french bean during kharif 2012. Results revealed that the yield attributes and grain yield increased significantly over control and highest pods plant\(^{-1}\), seedspod\(^{-1}\), pod length, 100-seed weight and seed yield were recorded with application of 125% RDF. Significantly highest growth and quality parameters \textit{viz.}, plant height, primary and secondary branches, total dry weight, protein content and protein yield were also recorded with application of 125% RDF.
2.3 Interaction effect of spacing and fertility Levels

Dwivedi et al. (1994) conducted an experiment to study the response of french bean to plant density and nitrogen levels. The crop was sown at inter row spacing of 30, 45 and 60cm with an intra-row spacing of 8 cm and fertilized with 40, 60, 80 and 100 kg N ha\(^{-1}\). They observed that seed yield was the highest at the density of 4,00,000 plants ha\(^{-1}\) with the application of 80 kg N ha\(^{-1}\).

Koli and Akashe (1995) studied the response of row spacing, plant density and N level on yield of french bean. They reported that the yield were similar at densities of 2, 22, 222 plants and 3, 33,333 plants ha\(^{-1}\) and were decreased under 4, 44,444 plants ha\(^{-1}\). They also reported that 60 kg N ha\(^{-1}\) produced highest seed yield of french bean.

Singh and Behera (1998) conducted an experiment to study the effect of french bean to fertilizers and spacing. Results revealed that application of 62.5-100-100 kg N-P\(_2\)O\(_5\)-K\(_2\)O ha\(^{-1}\) and closer spacing of 35 x 25cm produced significantly the maximum green pod yield.

Field experiment was conducted during the winter seasons of 1996–97 and 1997–98 at Baraut, Uttar Pradesh to study the response of french bean (Phaseolus vulgaris L.) to plant density and N application. Dhanjal et al. (2001) found that lowest plant density of 250 x 10\(^3\) plants ha\(^{-1}\) and 120 kg N ha\(^{-1}\) recorded markedly higher values of growth attributes like number of branches, dry matter, pods plant\(^{-1}\), seeds pod\(^{-1}\) and harvest index except seed yield which was maximum with the medium plant density of 333 x 10\(^3\) plants ha\(^{-1}\) with nitrogen 120 kg ha\(^{-1}\). Maximum plant height and stover yield were recorded with highest plant density of 500 x 10\(^3\) plants ha\(^{-1}\) with same fertilizer dose 120 kg N ha\(^{-1}\).

Moniruzzaman et al. (2009) carried out an experiment at Agricultural Research Station, Raikhali, Bangladesh during winter season of 2005-06 to study the performance of french bean as influenced by spacing and nitrogen application. Results revealed that 250 x10\(^3\) plants ha\(^{-1}\) and fertilizer dose 120 kg N ha\(^{-1}\) significantly increase the values of plant height, pod length, pod width, number of green pods plant\(^{-1}\), green pod weight plant\(^{-1}\) and green pod yield t ha\(^{-1}\)mi

Shrikanth et al. (2008) carried out a field experiment during kharif season of 2006-07 to find out the effect of spacing and fertilizer levels on crop growth and
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seed yield of french bean at University of Agricultural Sciences, Dharwad. The result showed that spacing of 45 x 15cm with fertilizer dose of 33:67:33 kg NPK ha\textsuperscript{-1} increases growth parameters like plant height, pod yield ha\textsuperscript{-1} and seed yield ha\textsuperscript{-1} and spacing of 60cm x 15cm with fertilizer dose 33:67:33 increases number of branches plant\textsuperscript{-1}, plant dry matter production, days to 50% flowering, days to flower initiation, days to pod initiation, days to crop maturity, number of pods plant\textsuperscript{-1}, pod yield plant\textsuperscript{-1} and seed yield plant\textsuperscript{-1} highest at harvest.

Chaudhry (2009) conducted an experiment during the winter seasons of 1992-93 and 1993-94 at Kanpur (U.P.) to study the effect of row spacing, seed rate and nitrogen levels on growth and yield of french bean. The row spacing 40 cm and nitrogen dose of 160 kg ha\textsuperscript{-1} produced more dry weight of plant, number of branches, number of pods plant\textsuperscript{-1}, number of grains pod\textsuperscript{-1} and grain weight plant\textsuperscript{-1}. While grain and stover yields of french bean increased with 30 cm row spacing and 160 kg ha\textsuperscript{-1} nitrogen.

Field investigation was carried out at the Horticulture Farm of Bangladesh Agricultural University to study the influence of nitrogen and spacing on french bean during the 2000-2001. Raheman (2010) reported that the interaction effect of highest level of N 90 kg ha\textsuperscript{-1} and the plant spacing of 30 x 20cm produced highest plant height, number of leaves, number of branches, pod length, number of seeds pod\textsuperscript{-1}, fresh weight of plant, root length and dry matter. While pod yield, pod weight plot\textsuperscript{-1}, harvest index, gross return, net return and B: C ratio were maximum with application of 90 kg N ha\textsuperscript{-1} and 30cm x 15cm spacing.

Field trial was carried out to evaluate the effect of row spacing and nitrogen fertilizer on growth and yield of green beans during the 2011-12 at Islamic Azad University, Lahijan, Iran. Rana and Majid (2014) showed that the plant spaced with 40cm x 20cm and fertilized with nitrogen 50 kg ha\textsuperscript{-1} recorded significantly, higher number of pods plant\textsuperscript{-1}, biomass production, harvest index and green pod yield.