Review of Literature
REVIEW OF LITERATURE

The work done on the performance of linseed cultivars and their response to nitrogen and zinc has been briefly reviewed in this chapter, here under.

Effect of nitrogen

A perusal of the summary of available literature would show that nitrogen affected the performance of linseed favourably; however, the degree of response of the crop to the nutrients depended on the farming situations. McGregor (1960) reported that linseed responded well to high level of residual nitrogen but would often be poorly benefitted due to direct application of this nutrient. The frequency and magnitude of response were larger after several years.

Kanwar and Joshi (1963) reported 22.4 kg N ha\(^{-1}\) as the optimum dose for linseed crop. Khan et al., (1963) recorded 22.4 and 46.3 per cent more of linseed yield when fertilized with 30 and 60 kg N ha\(^{-1}\), respectively over the plots devoid of nitrogen application. Mathur and Kavitkar (1963) found 67.3 kg N ha\(^{-1}\) to be the optimum dose for linseed.
Abdul Kareem (1966) found that nitrogen applied at 21 kg N donum\(^{-1}\) alone or in combination with P or K increased the seed yield considerably. The results reported by Singh et al., (1966) indicated that the response curve for nitrogen application in respect of linseed crop was linear. Shchibraev and Tyurin (1970) were of the opinion that N and N P combination increased the photosynthetic efficiency of linseed and thereby its productivity. Pande et al., (1970) observed that the increasing levels of nitrogen favoured the productivity of seed and straw of linseed significantly resulting in an increased net profit. Bhan and Singh (1973) obtained the highest seed yield with the application of 60 kg N ha\(^{-1}\), while Rao (1973) obtained significant response of linseed to nitrogen upto 120 kg N ha\(^{-1}\).

Tomar and Singh (1973) obtained significantly higher yield over control with 35 kg N ha\(^{-1}\) under rainfed conditions at Kota (Rajasthan). Results reported by Singh et al., (1974) showed 15.7 per cent more seed yield with addition of 30 kg N ha\(^{-1}\) over control.

Panwar and Bhardwaj (1976) obtained the highest average seed yield at 80 kg N ha\(^{-1}\). Sahu (1976) obtained the highest productivity with 60 kg N ha\(^{-1}\) under rainfed
conditions while, Nema et al., (1977) and Bhan (1980) observed 30 kg N ha$^{-1}$ as the most beneficial dose under similar conditions.

Yayock and Quinn (1977) obtained a linear response of linseed in respect of yield to increasing levels of nitrogen upto 88 kg ha$^{-1}$. El-Nekhlawy et al., (1978) reported an increasing trend in the productivity with the increasing levels of nitrogen, Singh and Singh (1978) obtained an increase of 33 per cent in seed yield with 40 kg N ha$^{-1}$ over no application of that nutrient. Singh et al., (1982), Sitaram (1982), Chawla and Singh (1983), and Yadav and Singh (1984) reported that the linseed yields were enhanced significantly upto 60 kg N ha$^{-1}$. Tomar (1984) also recommended 60 kg N ha$^{-1}$ as the optimum dose for linseed when supported with 40 kg P$_2$O$_5$ & 20 kg K$_2$O ha$^{-1}$ under irrigated conditions at Jabalpur (M.P.).

Sonania (1985) reported 120.72, 54.35 and 17.19 per cent more seed yield with 90 kg N ha$^{-1}$ when compared to 0, 30 and 60 kg N ha$^{-1}$ respectively. Tomar et al., (1985) also reported a considerable increase in yield with the increasing doses of nitrogen. Dwivedi and Patel (1987) obtained the highest yield (10.45 q ha$^{-1}$) of linseed with
the application of 60 kg N ha\(^{-1}\), the magnitude of increase in yield being 57, 43 and 18 per cent over 0, 30 and 90 kg N ha\(^{-1}\), respectively. Similar findings were also reported by Raghuwanshi et al., (1987). On the other hand, Hafez et al., (1988) could get the response of linseed in respect of yield upto 40 kg N ha\(^{-1}\) only, beyond which the yield was reduced significantly. Jain et al., (1989) observed that the seed yield of linseed was enhanced significantly with the increasing levels of nitrogen upto 60 kg N ha\(^{-1}\). The maximum seed yield of 19.5 q ha\(^{-1}\) was recorded at 60 kg N ha\(^{-1}\), while the lowest (8.0 q ha\(^{-1}\)) was under the plot receiving no nitrogen.

Khurana (1989) also recorded an increasing trend in seed yield with the added doses of nitrogen. Yadav et al., (1990) observed significant increase of 12.7 per cent and 28.2 per cent in yield due to the application of 60 kg N ha\(^{-1}\) when compared to 30 kg N ha\(^{-1}\) and no application of nitrogen, respectively. The response to further increase in nitrogen level upto 80 kg N ha\(^{-1}\) was not significant. However, Khotle and Sharma (1990) obtained the maximum seed yield of linseed at 90 kg N ha\(^{-1}\).
Effect of nitrogen on yield components:

There are many reports indicating positive response of linseed crop in respect of its yield components to applied nitrogen. Increased nitrogen supply usually resulted in an increase in most of the yield components; especially, number of branches and capsules plant$^{-1}$ (Dybing, 1964; Prashar et al., 1968; Singh, 1968; Al-Shamma and Jabro, 1972; Moursi and Hariri, 1977; Reddi, 1983; Al-Mukhtar and El-Hariri, 1984; Nayital and Singh, 1984).

Gad and El-Farouk (1978) reported that in dual-purpose flax grown under dry-land conditions, the application of nitrogen up to 30 kg ha$^{-1}$ resulted in an increase in technical length, fibre percentage, number of capsule plant$^{-1}$ and seed weight whereas irrigated dual purpose flax would require 72 kg N ha$^{-1}$ for expressing the maximum response in respect of these yield components (Hamdi et al., 1971).

The number of capsules plant$^{-1}$ appeared to be the most responsive yield component of linseed to fertilizer application (Blackman and Bunting, 1954; Dybing, 1964; Singh, 1968; Hamdi et al., 1971). Blackman and Bunting (1954)
summarized the results of 25 field trials with linseed in Britain and reported that application of 35 kg N ha\(^{-1}\) increased mean seed yield by about 12 per cent and most of this was attributed to an increase in number of capsules plant\(^{-1}\) rather than an increase in number of seeds capsule\(^{-1}\) or test-weight.

Khadkara (1951) observed a significant increase in plant height and branching of all linseed varieties included in the trial with 22.2 kg N ha\(^{-1}\). There was also a favourable effect on the number of capsules plant\(^{-1}\) and 1000 seed weight, while the number of seeds capsule\(^{-1}\) remained unaffected. However, Baporikar (1952) reported from IARI New Delhi, that neither the number of capsules plant\(^{-1}\) nor the 1000-seed weight was significantly affected by the application of nitrogen.

Tiwari (1956) found that the addition of nitrogen increased the primary branches and number of capsules, while plant height remained unaffected. Sahay (1957) observed that the application of nitrogen increased the all round growth and development of the plant and decreased the mortality of buds significantly. Singh (1968) reported that the height of the plant was influenced significantly by the
nitrogen application while the basal branches of the plant did not exhibit any appreciable change due to that.

Pande et al., (1970) reported that increasing levels of nitrogen enhanced the height, number of branches, capsules and seed weight, seed and straw yield significantly. They were of the opinion that increased yield could be attributed to the similar increase in seed weight plant$^{-1}$.

Rai and Singh (1977) concluded that very high doses of nitrogen often stimulated the growth of vegetative parts of linseed which could inflict more harms than the favourable effects on crop. El-Nekhlaway et al., (1978) obtained increased plant height with applied nitrogen; however, the difference between 30 and 60 kg N fedden$^{-1}$ doses were not significant. The 1000-seed weight and CP content also increased significantly. Singh et al., (1982) obtained 6.1 and 3.0 per cent increase in test-weight of linseed due to application of 60 : 30 : 0 kg N : P : K ha$^{-1}$ over no addition of fertilizer and 30 : 15 : 0 kg N : P : K ha$^{-1}$, respectively.

Raghuwanshi et al., (1987) observed that application of 60 kg N ha$^{-1}$ resulted in maximum plant height, branches
plant\textsuperscript{-1}, dry shoot weight, capsules plant\textsuperscript{-1}, dry matter yield and seed yield plant\textsuperscript{-1} of linseed grown on a moderate sodic soil (\texttt{ESP 30}). Mukherjee \textit{et al.}, (1987) reported that application of nitrogen doses upto 120 kg N ha\textsuperscript{-1} increased the number of capsules plant\textsuperscript{-1} and seed yield significantly but had no effect on oil content of seeds.

Kafey \textit{et al.}, (1988) concluded that application of 40 kg N ha\textsuperscript{-1} increased the number of primary branches and capsules plant\textsuperscript{-1} significantly as compared to other levels of nitrogen. The number of seeds capsule\textsuperscript{-1} and test-weight were at their maximum with 40 kg N ha\textsuperscript{-1}. Yadav \textit{et al.}, (1990) reported that the increasing levels of nitrogen increased the yield attributing parameters of linseed variety J-23, the maximum number of branches and capsules plant\textsuperscript{-1}, seeds capsule\textsuperscript{-1} and test-weight being at 90 kg N ha\textsuperscript{-1}.

\textbf{Effect of nitrogen on seed oil concentration and seed protein content:}

Seed oil concentration usually decreases with increasing nitrogen supply (Blackman and Bunting, 1951; Gupta \textit{et al.}, 1961; Beech and Norman, 1964; Dybing, 1964; Saxena and Sinha, 1966; Singh, 1968; Singh \textit{et al.}, 1968; Hamdi \textit{et al.}, 1971; Rao, 1973; Filipescu and Simota, 1977; El-Nekhlawy \textit{et al.}, 1978; Dai and Zhang, 1981), especially at application rates
above 50 kg N ha$^{-1}$ (Dybing, 1964; Wood head and Neilson, 1976; Yayock and Quinn, 1977; Singh and Singh, 1978) as found for other oilseed crops such as sunflower (Steer et al., 1984).

Moderate nitrogen application; however, sometimes increase both linseed yield and seed oil concentration, (Gupta et al., 1961; Khan et al., 1963; Abdul Kareem 1966; Pande et al., 1970).

Yermonos et al., (1964) observed that nitrogen fertilization tended to depress oil content slightly in flax. However, because of higher seed yields, oil production per acre on fertilized plots was much higher than in the check.

Singh and Singh (1978) obtained increased seed protein content with increasing levels of nitrogen and phosphorus. Whereas, Verma and Swarnkar (1986) found N.P.S combination as highly effective for seed yield and oil content of linseed.

Mukherjee et al., (1987) did not obtain any response of nitrogen fertilization upto 120 kg N ha$^{-1}$ on oil content of linseed.
Rafey et al., (1988) got maximum oil concentration (40.3%) with no nitrogen level.

**Differential response of genotypes to nitrogen and zinc:**

Considerable variation existed within many crop species in their ability to acquire and use nutrients (Clark, 1982) and to tolerate mineral toxicities (Foy et al., 1978; Epstein, 1980).

Johnson (1932) suggested that linseed cultivars responded differently to changes in soil fertility, and Garber (1960) reported that N, P, and K fertilizer application increased oil yield in some but not all of the fiber flax and linseed cultivars tested. According to Matheson (1976), linseed cultivars differed substantially in their response to nitrogen and it appeared that linseed lines of European origin were more responsive to this nutrient than those of Indian ancestry. Blackman and Bunting (1951) and Yayock & Quinn (1977) also noticed differences in the behaviour of cultivars towards the supply of nitrogen.

Effect of nitrogen application on physico-chemical characteristics of different varieties of linseed was adjudged
during 1987-88 at Kanpur, U.P. (Anonymous, 1987-88). The highest oil content was recorded at the level of 30 kg N ha\(^{-1}\) followed by 60 kg N ha\(^{-1}\) over all other levels (0, 90 and 120 kg N ha\(^{-1}\)), while protein content was the highest at 120 kg N ha\(^{-1}\). The application of nitrogen at various doses could not show any definite trend in respect of change in the iodine value. Varieties behaved differently in terms of oil and protein content, some others analysed 233 varieties/strains/species of linseed for seed and quality components of oil and reported varietal differences of about 18 per cent for oil, 11 per cent for protein and 33 per cent for iodine value.

The information on the varietal response of linseed to the micronutrients is, however, meagre (Hocking et al., 1989).

Significant variations in linseed cultivars in respect of seed yield as well as growth and yield attributes were reported by several other workers (Anonymous 1984-85, 1985-86, 1986-87, 1987-88 and 1988-89).

Vasilica (1975) summarized four year trials with
10 flax cultivars and concluded that seed yield varied from 0.6 t ha\(^{-1}\) to 0.89 t ha\(^{-1}\). Rowland (1980) obtained significant difference in seed and straw yield of oilseed flax cultivars.

Tomar (1984) reported that the linseed variety R-552 out performed the other cultivars producing the maximum number of capsule plant\(^{-1}\), seeds capsule\(^{-1}\) and straw yield whereas test-weight of seeds, seed yield plant\(^{-1}\) and soil content were significantly higher in cv. R-17. In plant height and dry weight plant\(^{-1}\) cultivar SPS 49-2 proved superior.

Momtaz et al., (1985) and Thompson et al., (1988) also reported significant variation among the oil seed flax cultivars, in yield and yield attributing parameters.

Pathak and Gangwar (1961) reported significant variation in the oil content of different linseed cultivars. Rai et al., (1990) estimated variability, broadsense heritability and genetic advance among 35 promising genotypes of linseed. They recorded significant mean differences among the varieties in moisture content (3.25 to 5.20 %), oil content (38.0 to 45.06 %), protein content (13.55 to
17.86 %) and iodine value (190.25 to 167.68). Similar results were also reported by Rai et al., (1985).

**Role of zinc in plant nutrition**

Zinc is one of the essential plant nutrients and is an important component of several dehydrogenase proteinase and peptidase enzymes (Vallee and Wacker, 1970). According to Price et al., (1972), one of the earliest events in the onset of zinc deficiency would indicate a sharp decrease in the RNA and ribosome contents of the cells.

Thus, zinc appeared to play an important role in carbohydrate, protein, fats and oil metabolism within the plant and in the energy transfer mechanism (Khamparia, 1985).

**Zinc content of soils:**

The average zinc content of the lithosphere is approximately 80 ppm, ranging from 10 to 300 ppm. The critical zinc limits were established at 0.5 ppm both for dithizone and DTPA extractable zinc in black soils of Narmada Valley, M.P. (Anonymous, 1973).
The findings of the work on micronutrients showed that the critical limits of Zn, Cu, Fe and Mn in the soil would be 0.6, 0.2, 4.5 and 20 ppm respectively, while the corresponding critical limits for growth was recorded to be 20, 5, 20-50 and 20 ppm (Anonymous, 1988-89b).

Response of linseed to zinc application:

The widespread occurrence of zinc deficiency in the plants, and low crop yields appeared to be a matter of concern to crop nutritionists.

Flax was observed as one of the highly sensitive crop to zinc deficiency (Viets et al., 1954; Duncan, 1968 and Moraghan, 1978). The deficiency of this nutrient usually occurred in relatively small patches in the fields having linseed crop (Millikan, 1951; Moraghan, 1983).

The literature on response of linseed to micro-nutrients, particularly zinc, appeared to be scanty (Hocking et al., 1989). Cass-Smith and Harvey (1948) reported, from Western Australiia, that application of 11.2 kg ZnSO₄ ha⁻¹ to fiber flax increased yield of fiber by almost 40 per cent. Reports from USSR revealed a few responses of
fiber flax in respect of yield to Zn, B, and Mo either applied singly or included with N, P and K fertilizers (Pieve and Andrianova, 1939; Barsukov and Leonenko, 1982).

Shekhawat et al., (1971) obtained 38.24 and 27.38 per cent more seed yield of linseed due to application of zinc as compared to no supply of zinc at Umedganj and Borkhera, respectively.

Takkar et al., (1989) reported that linseed gave significant response to the applied zinc in terms of seed yield (1.4 q ha\(^{-1}\) higher seed yield under the plots receiving zinc over those deprived of that nutrient).