INTRODUCTION
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Mustard (*Brassica juncea* L. Czern & Coss.) is an important oilseed crop of the tropical and sub-tropical regions of the world (Weiss, 1983). It is grown mainly for seeds, which contain fat that provide 2.5 times calories than carbohydrates and form an important human diet. Besides use of mustard seeds in diet, the vegetative parts, like leaf has also been in use since age-old times for condiment and spices. In Northern India mustard leaves are used as vegetable. Considering the crops grown in India, oilseeds are only next to food grain crops and hold a sizeable share of 13% of the country's gross cropped area and contribute 5% of its gross domestic production and 10% of the value of all agricultural products. The per capita consumption of edible oils in India has raised from 4.5kg to 9.5kg in the last 15 years, which is still below the world's average of 17.6kg and also below the value of 14kg oil and fats per capita per annum, the standards prescribed by Indian Council of Medicinal Research, New Delhi.

*Brassica* accounts for approximately 10% of the total world oilseed production (Downey and Rimmer, 1993). In the Indian sub-continent oilseed crop *Brassica juncea* is the dominant species grown (Prakash, 1980). It is one of the most popular edible oilseeds of the
central, eastern and northern parts of India (Prasad and Ehsanullah, 1988). The area of its cultivation and production has only increased marginally during the last 15 years (Shukla et al., 2000). Of the several factors tested, input of chemical fertilizers, particularly nitrogen (N) has proven successful in increasing plant biomass and productivity.

Fertilization of agricultural system is an essential factor for maintaining or increasing crop production. For increased crop productivity the use of N fertilizer has increased on large scale, particularly in developing countries to meet the increasing demand of continuous increasing population. A close correlation has been reported between crop yields and annual N application rates (Sinclair and Horie, 1989). Application of N to soil compensates for N lost by crop removal, leaching and gaseous N loss and also maintains soil conditions productive for agriculture (Tabachow et al., 2001). On a global scale terrestrial plans assimilate an estimated 1.4 gigatons of N annually; approximately 90-95% of the total N is assimilated from mineral N and remaining from symbiotic dinitrogen fixation (Paul and Clark, 1988).

In many cropping systems, N frequently limits crop yield and additional N inputs are required to optimize productivity and profitability (Rice et al., 1995). The N uptake in the seeds is taken as an indicator of N sufficiency (Goos et al., 1982) because most of the N accumulated during vegetative growth is translocated to the seeds
Nitrogen supply has been reported to affect growth of plants greatly in terms not only of amount of biomass produced but the size and proportion of organs and their structure (Pearman et al., 1977; Sinclair and Horie, 1989; Greenwood et al., 1991; Lemaire et al., 1992). These are the essential features of plant development and crop production and depend greatly on N supply (Lawlor et al., 2001). N supply also alters the rates of cell division and cell expansion in growing leaves (Gastal and Lemaire, 2002). Mustard plants respond markedly to N application. Nitrogen requirement in Brassica is much greater and increased when sown after a cereal crop whose straw or stubble is ploughed under (Allen and Morgan, 1972; Downey et al., 1974). Higher rates of N fertilizer are usually supplied to oilseed rape in order to obtain maximum seed yield (Barraclough, 1989; Holmes, 1980; Porter, 1993; Yusuf and Bullock, 1993). However, only 50% of the applied fertilizer N is recovered in the seeds (Augustinussen, 1987; Holmes, 1980; Smith et al., 1989; Taylor et al., 1991) due to the significant losses of N to the environment (Schjoerring et al., 1995). A significant amount of applied N to crops is leached to ground water and remains unavailable to crop because of gaseous N losses from soil through denitrification, volatilization and erosion. Thus, it is important to develop judicious practices for N fertilizer to ensure its efficacious use for economic and environmental reasons.
In any crop improvement and management programme increased N use is a major target. The technologies that influence N use include the judicious N input and timing of application of N fertilizer (Rice et al., 1995). Simultaneously, efficient use of N for high crop productivity is influenced by the leaf photosynthetic capacity and assimilation of photosynthates, which is correlated with uptake, translocation and assimilation of N. The photosynthetic capacity can be enhanced by reducing the competition between assimilating organs (leaves) of a plant together with judicious application of N. Reducing the competition between assimilatory leaves can be viewed as to allow functional and efficient leaves to grow and removal of shaded and senescing leaves, which largely depend on the photosynthetic efficiency of the younger leaves. It was hypothesized that removal of shaded leaves might provide an opportunity for the younger leaves to grow faster with enhanced photosynthetic efficiency, use N more efficiently for photosynthate and seed formation. This hypothesis was tested in mustard because of its special relevance in the crop.

Mustard (Brassica juncea) plant is characterized by large and broad oblong-shaped leaves on the lower layers of the plant. Such leaves do not receive sufficient light and remain below light photosynthetic compensation point. They contribute to the development of supra-optimal leaf area indices with accompanying self shading and by other
leaves within the plant axis. They are poorly illuminated, therefore, are less efficient in photosynthate production. Later, at maturity, these leaves are shed. Their cost of maintenance exceeds the rate of production in terms of nutrients and water, and also they abscise at maturity. It has been reported that large number of leaves can affect the interception of photosynthetically active radiation (Ballare et al., 1989; Grewal and Kolar, 1990; Krishnamoorthy, 1993; Kruger et al., 1998; Khan et al., 2002a). Defoliation has been reported to bring about changes in numerous metabolic processes including activities of enzymes and mobilization of C and N compounds (Ourry et al., 1996; Bruening and Egli, 2000). This is a worthwhile fact that plant within a given environment depends more on a compromise within the C and N interactions in order to optimize the use of available resources.

Any strategy that could lead to the rapid loss of such leaves would prove advantageous for assimilate balance and overall performance of the plant. The regrowth ability of a plant after defoliation (removal) is predominantly dependent upon the size of the reserves of C and N (Ourry et al., 1988; Goulas et al., 2002). Moreover, acquisition of N is closely connected with photosynthesis (Lawlor, 2002), therefore, these two phenomenon may be influenced by defoliation.

The work of defoliation in mustard and its impact on growth, physiology and yield was started at Aligarh by N. A. Khan and associates
The reported research in the thesis is an extension of the research background with which they started work in 1998 and published as Khan et al. (2002a). This work reported that defoliation of 50% leaves on lower layers of mustard plants at 40d after sowing (DAS) enhanced photosynthetic capacity of leaves and biomass production. However, the study did not compare the appropriate stages of defoliation and the performance of crop under N regimes given after defoliation. To test the hypothesis mentioned earlier and to carry on the research work undertaken by Khan and associates, the following objectives were set:

1. To compare the effect of defoliation of 50% leaves on lower layers of plant axis at 40DAS (pre-flowering) or 60DAS (post-flowering) for maximal growth, photosynthetic and biochemical characteristics, N assimilation, ethylene biosynthesis and productivity of crop.

2. To study the effect of defoliation of 50% leaves on lowers layers of plant axis at a growth stage (40 or 60DAS) found suitable and treated with varying levels of basal N on growth, photosynthetic and biochemical characteristics, N assimilation, ethylene biosynthesis and productivity of crop.

3. To study the effect of defoliation of 50% leaves on lower layers of plant axis at the growth stage found suitable and N given to soil as a single basal dose or in split applications.