CHAPTER – 5

DISCUSSION

The present field study was made for two years during Rabi 2009-10 and 2010-11. The main objective of ascertaining the effect of phosphorus and sulphur fertilization on mustard + chickpea 1:1 row ratio intercropping system under the different soil moisture. An attempt was also made to improve the agro-technique for increasing the productivity of mustard + chickpea. For this purpose, a field study was made with cv. Varuna of mustard and Uday of chickpea in 1:1 row ratio in 36-treatment combinations. The experimental results have been presented in IVth chapter pertaining to plant height at various crop growth stages, number of various types of branches per plant, dry weight per plant at various crop growth stages, number of siliquae per plant, number of seeds per siliquae, 1000-seed weight, seed yield (q ha\(^{-1}\)), biological yield (q ha\(^{-1}\)) and harvest index (%).

Nitrogen, phosphorus and sulphur uptake by grain, straw, oil content in mustard seed, water use efficiency of mustard. Plant height at various crop growth stages, number of different types of branches, number of pods per plant, number of seeds per pod, 1000-seed weight, seed and biological yield (q ha\(^{-1}\)) and harvest index (%). Nitrogen, phosphorus and sulphur uptake by seed and straw, protein content in grain in both the years of chickpea.

Intercropping systems were also evaluated on the basis of crop yield equivalent, gross and net income and cost : benefit ratio. In the present chapter the result and the discussion has been made in the light of the observations and scientific logic according to the objectives to see how for the objective have been fulfilled?

A. MUSTARD

Mustard was grown with chickpea in 1:1 row ratio intercropping. The chickpea was grown to replace of mustard crop in alternat row.

Effect of irrigation

The plant height of mustard from 30 DAS upto the harvesting was significantly influence and with the application of two irrigation was noted maximum from 30 DAS upto the maturity of the crop [cf. Table 4.2]). It is attributed due to the sufficient available of moisture in root zone and increased the availability of plant nutrients as like nitrogen, phosphorus and sulphur to the mustard plant upto the maturity of the mustard.

The results are in conformity with those already reported by Javiya et al. (1989), Singh et al. (2010) and Yadav et al. (2010).
The dry weight per plant of mustard was appreciable increased from 30 DAS upto the maturity of the mustard crop with the application of two irrigation [cf. Table 4.5]. It is increased due the number of leaves per plant increased, number of primary and secondary branches and plant height also increased due to the sufficient availability of moisture and plant nutrients. The same findings also reported by **yadav et al. (2010)**.

The yield attributing traits were significantly increased with increasing frequency of irrigation and with the application of two irrigation the number of primary branches per plant [cf. table 4.3] and secondary branches per plant [cf. Table 4.4], number of siliquae per plant (cf. Table 4.6), number of seeds per siliquae (cf. Table 4.7) and 1000-seed weight (cf. Table 4.8) were significantly increased with the application of two irrigation. The biological and seed yield (q ha\(^{-1}\)) was increased with the application of two irrigation. It is increased due to the number of primary and secondary branches increased with the application of two irrigation. The biological yield was attributed due to the more plant height, more number of primary and secondary branches per plant. The seed yield (q ha\(^{-1}\)) was significantly increased due to the more number of siliquae per plant, more number of seeds per siliquae and higher 1000- grain weight. The same findings also reported by **Yadav et al. (2010)**.

The nitrogen, phosphorus and sulphur uptake by grain and stover was significantly increased due to the application of two irrigation in mustard + chickpea 1:1 row ratio intercropping. It is attributed due to the increased the seed yield (q ha\(^{-1}\)) and stover yield (q ha\(^{-1}\)). The higher yield of any crop more uptake the N, P and S. The same findings also reported by **Yadav et al. (2010)**.

**Effect of phosphorus**

Growth and yield attributes of any crop are basic characters for increasing economic yield of crop. The most of research workers have reported significant response of mustard to different doses of phosphorus application in increasing growth and yield attributes under varied soil and climate conditions.

The plant height of mustard from 30 DAS upto maturity significantly increased with the application of 60 Kg ha\(^{-1}\) phosphorus [cf. Table 4.2] it is attributed due to the increased of phosphorus availability to mustard plant and the mustard plant (root) was absorbed efficient quantity of phosphorus upto the maturity of the crop. The dry matter accumulation per plant of mustard was noted the application of higher dose 60 Kg P\(_2\)O\(_5\) ha\(^{-1}\) was produced significantly more dry matter accumulation [cf. Table 4.5] with the application of 60 Kg P\(_2\)O\(_5\) ha\(^{-1}\). It is attributed due to the increased the plant height, number of primary and secondary branches per plant and number of leaves per plant of mustard.
The results are in conformity with those already reported by Bhan and Singh (1976), Patel et al. (1980), Singh et al. (1991), Prasad et al. (1991), Punia et al. (1993), Khafi et al. (1997), and Yadav et al. (2010).

The yield contributing character of mustard as like number of different type of branches per plant, number of siliquae per plant, number of seeds per siliquae were found significantly superior in the application of 60 Kg ha\(^{-1}\) phosphorus application in mustard + chickpea 1:1 row ratio [cf. Table 4.3, 4.4, 4.6 and 4.7]. It is attributed due to increased the number of primary and secondary branches per plant because, increased the availability of P\(_2\)O\(_5\) to mustard plant. The number of primary and secondary branches per plant increased the number of siliquae per plant increases. The number of seeds per siliquae increases due to the more availability of P\(_2\)O\(_5\) nutrient to mustard plant.

The results are in conformity with those already reported by Singh et al. (1991), Prasad et al. (1991), Punia et al. (1993), Arthamwar et al. (1996), Khafi et al. (1997) and Yadav et al. (2010).

The seed yield and total biological yield (q ha\(^{-1}\)) was significantly increased with the application of 60 Kg ha\(^{-1}\) phosphorus. It is increased due to the plant height of mustard, number of primary and secondary branches per plant, number of siliquae per plant, number of seeds per siliquae and 1000-seed weight significantly increased with the application of 60 Kg ha\(^{-1}\) phosphorus in mustard + chickpea 1:1 row ratio. It is increased due to the more availability of P\(_2\)O\(_5\) to mustard plant. The same results also reported by Chundawat et al. (1975), Chaniara and Damor (1982), Pandey et al. (1979), Patel et al. (1980), Vir and Verma (1981), Mandal and Gaffar (1983), Khan et al. (1986), Singh et al. (1991), Singh et al. (1994) Jaggi and Sharma (1997), Bhari et al. (2000) and Yadav et al. (2010).

The oil content, nitrogen uptake by grain and stover, phosphorus uptake by grain and stover, sulphur uptake by grain and stover were observed significantly increased with the application of 60 Kg P\(_2\)O\(_5\) ha\(^{-1}\). The nitrogen, phosphorus and sulphur uptake appreciable increased in grain and stover yield of mustard with chickpea intercropping. It is attributed due to the seed and stover yield significantly increased in intercropping with chickpea. The same findings also reported by Reddy et al. (1988), Singh et al. (1991), Singh et al. (1994), Trivedi et al. (1995), Arthamwar et al. (1996), Singh and Singh (1997), Singh et al. (1997), Thakur and Chand (1998) etc.

**Effect of sulphur**

Sulphur is the constituent of amino acids (cysteine, cystine and methionine), vitamins and number of co-enzyme. It stimulates the nodules formation in legamineous plants. It favour the soluble organic nitrogen and decrease in quality of insoluble nitrogen. It also encourages the chlorophyll synthesis there by increases negative growth. The effect of sulphur on plant growth are discussed by number of research workers as under.
The plant height of mustard from 30 DAS upto the maturity was significantly increased with the application of 40 Kg sulphur ha$^{-1}$ [cf. Table 4.2]. The dry matter accumulation per plant was significantly increased from 30 DAS upto the maturity of mustard with intercropping chickpea. It is attributed due the application of 40 Kg S ha$^{-1}$ increased the availability of sulphur in root zone of mustard and the mustard plant easily absorbed the sulphur and the plant height appreciable increased upto the maturity of the crop. The dry weight accumulation per plant of mustard was significantly increased from 30 DAS upto the maturity. It is attributed due to the plant height, number of leaves per plant and number of primary, secondary branches per plant increases. The same findings also reported by Dubey and Khan (1993), Khanpara et al. (1993), Rajput et al. (1993), Kharpade et al. (1995), Sumui et al. (1997), Raut et al. (1999) etc.

The number of primary and secondary branches per plant at various crop growth stages of mustard intercropped with chickpea in 1:1 row ratio was significantly increased with the application of 40 Kg sulphur per hectare. [4.3 and 4.4]. It is increased due to the more availability of sulphur with the application of 40 Kg S ha$^{-1}$ due to increased of mustard plant height. Increased the plant height of mustard ultimately increased the number of primary and secondary branches per plant of mustard. The same findings also supported by Khanpara et al. (1993), Sumui et al. (1997).

The number of siliquae per plant of mustard in intercropping with chickpea 1:1 row ratio was recorded significantly highest with the application of 40 Kg S ha$^{-1}$. It is attributed due to the application of 40 Kg S ha$^{-1}$ significantly increased the plant height, number of primary and secondary branches per plant of mustard. The above said growth character was increased significantly with the application of 40 Kg S ha$^{-1}$. The number of siliquae per plant ultimately increased. The same findings also reported by Rathor and Manohar (1989), Kharpade et al. (1995), Deekshitula and subhaiah (1997), Sumui et al. (1997), Singh et al. (1998), Kumar et al. (2002).

The number of seeds per siliquae of mustard in intercropped with chickpea was significantly increased with the application of 40 Kg S ha$^{-1}$. It is attributed due to the 40 Kg S ha$^{-1}$ increased the availability of sulphur to mustard plant and the more availability of sulphur to mustard plant increased chlorophyll content in mustard leaves and the chlorophyll made more food material in the presence of sunlight, CO$_2$ and sufficient moisture. The same findings also reported by Kharpade et al. (1995), Sumui et al. (1997), Kumar et al. (2002).

The 1000-seeds weight of mustard in intercropped with chickpea in 1:1 row ratio was significantly increased with the application of 40 Kg S ha$^{-1}$. It is attributed due to the sufficient availability of sulphur to mustard plant and this availability of sulphur also increased the plant height, number of various types of branches, number of green leaves per
plant, number of siliquae per plant, number of seeds per siliquae and ultimately increased the 1000-seed weight. The same findings also reported by Jain et al. (1996), Singh and Kumar (1996).

The seed yield (q ha\(^{-1}\)) of mustard in intercropping with chickpea in 1:1 row ratio was significantly increased with the application of 40 Kg S ha\(^{-1}\). It is attributed due to the application of 40 Kg S ha\(^{-1}\) was significantly increased the plant height, number of various types of branches per plant, number of siliquae per plant, number of seeds per siliquae and 1000-seed weight increased significantly with the application of 40 Kg S ha\(^{-1}\). The above findings also reported by Rathor and Manohar (1989), Chaudhary et al. (1992), Dubey and Khan (1993), Khanpara et al. (1993), Rajput et al. (1993), Singh et al. (1994), Chakravorthy et al. (1994), Sharma et al. (1994), Dubey et al. (1994), Kharpade et al. (1995), Singh et al. (1998), Raut et al. (1999), Kumar et al. (2002), Mandal et al. (2003), Tripathi et al. (2010), Sarkar et al. (2010), Bultar et al. (2010), Singh et al. (2010), and Lakshman et al. (2010), Mohan and Sharma (1992), Sharma et al. (1992).

The biological yield (q ha\(^{-1}\)) of mustard with intercropped chickpea in 1:1 row ratio was significantly increased with the application of 40 Kg S ha\(^{-1}\). It is attributed due to the application of 40 Kg S ha\(^{-1}\) was significantly increased the mustard plant height, number of various types of branches per plant and number of siliquae per plant. Ultimately the biomass yield of mustard increased ha\(^{-1}\). The same findings also reported by Jain et al. (1996) and Lakshman et al. (2010).

The nitrogen uptake by mustard seed, stover and total nitrogen uptake by mustard plant was significantly increased with the application of 40 Kg S ha\(^{-1}\). It is attributed due to the increased the biomass yield and seed yield (q ha\(^{-1}\)) with the application of 40 Kg S ha\(^{-1}\). The same findings also reported by Saran and Giri (1990), Chaudhary et al. (1992), Dubey and Khan (1993), and Singh et al. (1998).

The phosphorus uptake by the seeds, stover and total phosphorus uptake by mustard plant was observed significantly higher in the application of 40 Kg S ha\(^{-1}\). It is attributed due to the significantly highest yield of biomass and seed yield of mustard. It is attributed due to the application of 40 Kg S ha\(^{-1}\) was significantly increased the biomass yield (q ha\(^{-1}\)), seed yield (q ha\(^{-1}\)) ultimately the phosphorus uptake increased with the application of 40 Kg S ha\(^{-1}\). The same findings also reported by Sharma and Kamath (1991), Chaudhary et al. (1992).

The sulphur uptake by mustard crop with intercropped chickpea in 1:1 row ratio was observed significantly higher with the application of 40 Kg S ha\(^{-1}\). It is attributed due to the significantly highest biological yield (q ha\(^{-1}\)) and seed yield (q ha\(^{-1}\)) of mustard. It is ultimately increased the sulphur uptake by the mustard crop because the total biological yield (q ha\(^{-1}\)) and seed yield (q ha\(^{-1}\)) was obtained significantly highest. The similar results

The oil content in seeds of mustard in intercropped with chickpea was observed significantly highest with the application of 40 Kg S ha$^{-1}$. It is attributed due to the sulphur is the essential elements of amino acids which governed the oil content of mustard seed. It is attributed due to the increased the amino acid in mustard seed and the oil content increased in the seed of mustard. The same findings also reported by Saran and Giri (1990), Dubey and Khan (1993), Rajput *et al.* (1993), Sharma *et al.* (1994), Sumui *et al.* (1997), Singh *et al.* (1998).

The water use efficiency was significantly increased with the application of 40 Kg S ha$^{-1}$. It attributed due to the application of 40 Kg S ha$^{-1}$ was significantly increased the seed yield (q ha$^{-1}$). Ultimately the seed yield increased the water use efficiency increased.

**B. CHICKPEA**

**Effect of irrigation**

The plant height of chickpea was significantly increased with the application of two irrigation in mustard intercropping with chickpea in 1:1 row ratio. It is attributed due to the sufficient moisture available in the root zone of chickpea, in this reason the increased the more availability of N P K and S to the chickpea plant. The same findings also reported by Sher and Singh (2006),

The dry matter accumulation per plant of chickpea was significantly increased in intercropped with mustard with the application of two irrigation. It is attributed due to the plant height of chickpea and number of various types of branches per plant was increased significantly with the application of two irrigation, because the sufficient moisture available in root zone of chickpea which increased the availability of plant nutrients as like nitrogen, phosphorus and sulphur. The same findings also reported by Sher Singh *et al.* (2006), Javiya *et al.* (1989), Singh *et al.* (2010) and Thenua *et al.* (2010).

The days to 50% flowering was significantly delayed with the application of two irrigation in chickpea + mustard intercropping. It is increased due to the sufficient available moisture in root zone of chickpea was prolonged the vegetative growth of chickpea.

The number of nodules per plant in root and their dry weight was significantly increased with the application of two irrigation in chickpea + mustard intercropping. It is attributed due to the root of chickpea prolonged and number of secondary and tertiary roots was more produced in sufficient moisture available in root zone of chickpea. The dry weight of nodules was also significantly in the two time irrigated crop of chickpea. It is attributed due to the number of nodules was significantly increased in root of chickpea.
The time taken to maturity of chickpea with mustard intercropping was significantly delayed maturity with the application of two time irrigation. The maturity delayed because the sufficient moisture available in root zone of chickpea and increased the vegetative phase.

The number of primary and secondary branches per plant of chickpea with intercropped mustard was significantly increased with the application of two irrigation. It is attributed due to the sufficient moisture available in the root zone of chickpea and the nutrient availability increased to plant and this region the vegetative phase increased and the leaves of chickpea manufacture more food material with the presence of chlorophyll. The same findings also reported by Javiya et al. (1989), Singh et al. (2010) and Thenua et al. (2010).

The number of pods per plant of chickpea intercropped with mustard significantly increased with the application of two irrigation. It is attributed due to the sufficient soil moisture was available in root zone and the plant height of chickpea increased and the number of primary and secondary branches per plant increases, ultimately the number of pods per plant increased. The same findings also reported by Javiya et al. (1989), Singh et al. (2010), Thenua et al. (2010) and Praharaj et al. (2010).

Number of seeds per pod of chickpea intercropped with mustard in 1:1 row ratio was significantly increased with the application of two irrigation. It is attributed due the sufficient moisture availability increased the plant nutrients for chickpea plant to long time and the number of seeds per pod appreciable increase in more vegetative period. The same findings also reported by Javiya et al. (1989), Singh et al. (2010) and Thenua et al. (2010).

1000-seed weight of chickpea was significantly increased with the application of two irrigation. It is attributed due to adequate moisture in root zone and the chickpea plant absorbed sufficient nutrient from the soil and long duration of vegetative phase ultimately the photosynthesis process prolonged. The same findings also reported by Singh et al. (2010) and Thenua et al. (2010).

Grain and biological yield (q ha⁻¹) was significantly increased with increasing levels of irrigation and with the application of two irrigation in chickpea + mustard in 1:1 row ratio. It is attributed due to highest plant height, higher number of primary and secondary branches per plant, higher number of pods per plant, more number of seeds per pod and higher 1000-seed weight were recorded ultimately the biological and seed yield (q ha⁻¹) was increased. The same findings also reported by Sher Singh et al. (2006), Javiya et al. (1989), Singh et al. (2010) and Thenua et al. (2010).

The harvest index (%) was significantly increased with the application of two irrigation in chickpea intercropped with mustard in 1:1 row ratio. It is attributed due to the
plant height, number of various types of branches per plant of chickpea ultimately the harvest index increased significantly. The same findings also reported by Singh et al. (2010).

The protein content in grain of chickpea was significantly increased with the application of two irrigation. It is attributed due to availability of proper soil moisture increased the availability of plant nutrients.

Nitrogen uptake by the chickpea was significantly increased with the application of two irrigation. It is attributed due to increased the grain and straw yield (q ha\(^{-1}\)) and ultimately the nitrogen uptake increased.

Phosphorus uptake was significantly increased with the two irrigation applied in chickpea intercropped with mustard. It is attributed due to maximum plant nutrients available in soil moisture levels in chickpea root zone.

Sulphur uptake also significantly increased when the applied two irrigation to chickpea intercropped with mustard. It is attributed due to application of two time irrigation and the chickpea plants properly used sulphur element in proper soil moisture.

Water use efficiency was significantly increased with two irrigation which applied chickpea intercropped with mustard. It is increased the seed yield of chickpea appreciable increased with two irrigation.

**Effect of phosphorus**

Phosphorus is constituent of sugar phosphates, nucleotides, nucleic acid, co-enzymes and phospholipids. The process of anabolism and catabolism of carbohydrates proceed when organic compounds are esterised with phosphoric acid (Reddy and Reddy, 2001). It is closely related to cell division and development. In legumes it enhances the activity of rhizobium and increase the formation of root nodules, thus it helps in fixing of more atmospheric nitrogen (Yawalkar et al. 1977).

The plant height of chickpea intercropped with mustard was significantly increased from 30 DAS upto the maturity of the crop. It is attributed due to the phosphorus increased the cell division and development of the plant. Dry matter accumulation per plant of chickpea was significantly increased from 30 DAS upto the maturity of the crop. It is attributed due to the phosphorus significantly increased the plant height, number of different types of branches per plant, ultimately the dry weight accumulation per plant increased upto maturity. The same findings also reported by Manjhi and Chaudhary (1971), Mishra (1971), Tomar et al. (1990), Tomar and Raghu (1994), Siag (1995), Saraf et al. (1997), Bahadur et al. (2002).

The days taken to 50% flowering by chickpea intercropped with mustard in 1: 1 row ratio was significantly increased with the application of 60 Kg P\(_2\)O\(_5\) ha\(^{-1}\). It is attributed due to the vegetative phase prolonged.
The number of nodules per plant from 30 DAS upto 75 DAS significantly increased with the application of 60 Kg P\textsubscript{2}O\textsubscript{5} ha\textsuperscript{-1}. It is increased due to it enhances the activity of rhizobium and increase the formation of root nodules. The dry weight of nodules per plant of chickpea was significantly increased from 30 DAS upto 75 DAS. It is attributed due to the number of nodules significantly increases. The same findings also reported by Chaudhary et al. (1975), Rewari et al. (1979), Dixit et al. (1983), Singh and Singh (1989), and Tomer et al. (1990).

The days taken to maturity of the chickpea crop was significantly prolonged with the application of 60 Kg P\textsubscript{2}O\textsubscript{5} ha\textsuperscript{-1}. It is increased due to the vegetative phase of chickpea was prolonged.

The number of various types of branches per plant of chickpea intercropped with mustard in 1:1 row ratio was significantly increased with the application of 60 Kg P\textsubscript{2}O\textsubscript{5} ha\textsuperscript{-1}. It is attributed due to more availability of P\textsubscript{2}O\textsubscript{5} for chickpea and increased the height of plant, ultimately the number of primary and secondary branches per plant increases. The same findings also reported by Manjhi and Chaudhary (1971), Mishra (1971), Singh and Singh (1989), Tomar and Raghu (1994), Bahadur et al. (2002).

The number of pods per plant of chickpea was significantly recorded maximum with the application of 60 Kg P\textsubscript{2}O\textsubscript{5} ha\textsuperscript{-1}. It is attributed due to the height of plant and number of primary and secondary branches per plant of chickpea. Ultimately the number of pods per plant increased. The same findings also reported by Manjhi and Chaudhary (1971), Mishra (1971), Mudholkar and Ahlawat (1979), Koinov and Vitkov (1976) Singh and Yadav (1985), Singh and Singh (1989), Tomar et al. (1990), Siag (1995), Saraf et al. (1997), Bahadur et al. (2002).

The seeds per pod of chickpea was significantly increased with the application of 60 Kg P\textsubscript{2}O\textsubscript{5} ha\textsuperscript{-1}. It is attributed due to the phosphorus element was sufficiently used by chickpea plant through root system.

The test weight of chickpea intercropped with mustard in 1:1 row ratio was significantly increased with the application of 60 Kg P\textsubscript{2}O\textsubscript{5} ha\textsuperscript{-1}. It is attributed due to the more availability of P\textsubscript{2}O\textsubscript{5} to chickpea plant and ultimately the grain size increased. The same findings also reported by Manjhi and Chaudhary (1971), Mishra (1971), Koinov and Vitkov (1976), Singh and Yadav (1985), Singh and Singh (1989), Tomar et al. (1990), Siag (1995), Saraf et al. (1997), Saini and Faroda (1998), Bahadur et al. (2002).

The grain and biological yield (q ha\textsuperscript{-1}) of chickpea intercropped with mustard was significantly increased with the application of 60 Kg P\textsubscript{2}O\textsubscript{5} ha\textsuperscript{-1} in 2009-10 increased 1.27 q ha\textsuperscript{-1} and in 2010-11, 1.30 q ha\textsuperscript{-1} over control. It is attributed due to the increased the number of primary and secondary branches per plant, increased number of pods per plant,
number of seeds per pod and 1000-seed weight, the grain and biological yield ultimately increased of chickpea. The same findings also reported by Manjhi and Chaudhary (1971), Chaudhary et al. (1975), Mudholkar and Ahlawat (1979), Dixit et al. (1983), Singh and yadav (1985), Singh and Singh (1989), Tomar et al. (1990), Tomar and Raghu (1994), Siag (1995), Saraf et al. (1997), Singh et al. (1997), Bahadur et al. (2002), Thenua et al. (2010).

The nitrogen, phosphorus and sulphur uptake by chickpea grain, straw and total uptake was significantly increased with the application of 60 Kg P$_2$O$_5$ ha$^{-1}$. It is increased due to the grain and straw yield significantly increased due to the application of 60 Kg P$_2$O$_5$ ha$^{-1}$. The same findings also reported by Dadhich and Moli (1991), Singh et al. (1997) and Thenua et al. (2010).

The water use efficiency of chickpea was significantly maximum with the application of 60 Kg P$_2$O$_5$ ha$^{-1}$. It is increased because the grain yield was recorded significantly highest with the application of 60 Kg P$_2$O$_5$ ha$^{-1}$.

**Effect of sulphur**

Sulphur is the constituent of amino acids (cysteine, cystine and methionine). vitamins and number of co-enzyme. It stimulates the nodules formation in leguminous plants. It favour the soluble organic nitrogen and decrease in quantity of insoluble nitrogen. It also encourages the chlorophyll synthesis there by increase negative growth.

The plant height, dry matter accumulation, number of various types of branches and number of nodules and their dry weight were significantly increased with the application of 40 Kg S ha$^{-1}$. It is attributed due to it increased the chlorophyll in leaves of chickpea. The chlorophyll manufacture the food in the presence of CO$_2$, moisture and sunlight. The same findings also reported by Joseph and Verma (1994), Umesh et al. (1997), Saraf (1988), Rao and Sahu (1991), Shinde and Saraf (1994), Shivkumar (2001), and Sher Singh et al. (2006).

The number of pods per plant, seeds per pod and test weight were significantly increased with the application of 40 Kg S ha$^{-1}$. It is attributed due to the vigorous plant height, number of primary and secondary branches per plant ultimately increased the number of pods per plant, number of seeds per pod and 1000-seed weight. The same findings also reported by Saraf et al. (1997), Singh and Agrawal (1998), Shiv Kumar (2001), and Sher Singh et al. (2006).

The biological and seed yield (q ha$^{-1}$) of chickpea intercropped with mustard was significantly increased with the application of 40 Kg S ha$^{-1}$. It is attributed due to the number of primary and secondary branches per plant, number of pods per plant, number of seeds per pod and 1000-seed weight increased significantly with the application of 40 Kg S ha$^{-1}$ and ultimately the seed yield (q ha$^{-1}$) and biological yield (q ha$^{-1}$) increased.
significantly. The same findings also reported by Tandon (1991), Joseph and Verma (1994), Singh et al. (1994), Singh and Agrawal (1998), Ghosh and Sarkar (2000), Shiv Kumar (2001), Srinivason and Sankaran (2001), Ali et al. (2002), Sher Singh et al. (2004), Chaudhary and Goswami (2005), Singh et al. (2005), Sher Singh et al. (2006), Singh et al. (2010), Thenua et al. (2010), and Praharaj et al. (2010).

The protein content in grain of chickpea was significantly increased with the application of 40 Kg S ha\(^{-1}\). It is increased due to the sulphur was a constant of amino acid which increased the protein content in chickpea grain.

The Nitrogen, phosphorus and sulphur uptake were significantly increased in chickpea grain and straw. It is increased due to the application of 40 Kg S ha\(^{-1}\) significantly increased the chickpea grain and straw yield ultimately the N, P and S uptake increased.

The water use efficiency was significantly increased with the application of 40 Kg S ha\(^{-1}\). It is increased due to the seed yield of chickpea significantly increased. Ultimately the water use efficiency increased.

The phosphorus and sulphur status in the soil significantly increased with the application 60 Kg P\(_2\)O\(_5\) ha\(^{-1}\) and 40 Kg S ha\(^{-1}\). Irrigation schedules did not influence the P and S status is soil after harvesting the experimental crops. It is attributed due to the mustard and chickpea crops take up the applied 60 Kg P\(_2\)O\(_5\) ha\(^{-1}\) and 40 Kg S ha\(^{-1}\) and the residual of P\(_2\)O\(_5\) and sulphur status increased in soil after harvesting the experimental crops.

**C. ECONOMICS**

The mustard + chickpea intercropping in 1:1 row ratio were evaluated in various irrigation schedules, various levels of phosphorus and sulphur. In the present field study know the effect of various irrigation schedules and various levels of phosphorus and sulphur were studied in terms of mustard equivalent yield, cost of cultivation, gross and net income and cost : benefit ratio.

**1. Mustard equivalent yield (q ha\(^{-1}\))**

**Effect of irrigation**

The two irrigation applied in mustard + chickpea in 1:1 row ratio was significantly increased 21.89 q ha\(^{-1}\) and 22.72 q ha\(^{-1}\) over control or 44.04% and 43.40% higher respectively. It is attributed due to the two irrigation increased significantly yield attributes in both crops.

**Effect of phosphorus**

The mustard equivalent yield (q ha\(^{-1}\)) was significantly increased with the application of 60 Kg P\(_2\)O\(_5\)ha\(^{-1}\). It is increased 2.99 q ha\(^{-1}\) in 2009-10 and 3.01 q ha\(^{-1}\) in 2010-11 over control or 15.10% and 14.70% higher over untreated plot with phosphorus
respectively. It is attributed due to the application of 60 Kg $P_2O_5$ ha$^{-1}$ was significantly increased the yield attributing character in both crops mustard and chickpea.

**Effect of sulphur**

The mustard equivalent yield (q ha$^{-1}$) was significantly increased with the application of 40 Kg S ha$^{-1}$ in both crops. It is increased 2.48 q ha$^{-1}$ in 2009-10 and 2.58 q ha$^{-1}$ in 2010-11 or 12.81% and 12.85% over untreated plot with sulphur respectively. It is attributed due to the 40 Kg S ha$^{-1}$ was significantly increased the yield contributing character of both crops.

**2. Cost of cultivation**

The cost of cultivation (Rs ha$^{-1}$) was increased with two irrigation Rs 1495 ha$^{-1}$ over control. It is increased due to the cost of labour and cost of irrigation increased.

The cost of cultivation Rs ha$^{-1}$ was increased with 60 Kg $P_2O_5$ha$^{-1}$ Rs 1025 over control. It is increased due to cost of phosphorus and labour charges increased.

The cost of cultivation Rs 621 increased over control. It is increased due to the cost of sulphur included.

**3. Gross income (Rs ha$^{-1}$)**

**Effect of irrigation**

The gross income (Rs ha$^{-1}$) was significantly increased with two irrigation. It increased Rs 25520 ha$^{-1}$ in 2009-10 or 43.98% and Rs 26126 ha$^{-1}$ or 43.38% in 2010-11 over control respectively. It is attributed due to the mustard equivalent yield (q ha$^{-1}$) increased.

**Effect of phosphorus**

The gross income (Rs ha$^{-1}$) was significantly increased with the application of 60 Kg $P_2O_5$ ha$^{-1}$. It is increased Rs 7900 ha$^{-1}$ in 2009-2010 and Rs 7974 ha$^{-1}$ or 15.06 % and 14.70% respectively over untreated plot with phosphorus. It is attributed due to the mustard equivalent yield (q ha$^{-1}$) increased.

**Effect of sulphur**

The gross income (Rs ha$^{-1}$) was significantly increased with the application of 40 Kg S ha$^{-1}$. It was increased Rs 6563 ha$^{-1}$ in 2009-10 or 12.79% and Rs 6865 in 2010-11 or 12.80 % over untreated plot with sulphur. It is attributed due to the mustard equivalent yield increased with the application of 40 Kg S ha$^{-1}$.

**4. Net income (Rs ha$^{-1}$)**

**Effect of irrigation**

The net income (Rs ha$^{-1}$) was significantly increased with the tried two irrigation in mustard + chickpea intercropping in 1:1 row ratio. It is increased Rs 24025 ha$^{-1}$ or 60.40%
in 2009-10 and Rs 24631 ha\(^{-1}\) or 58.65% in 2010-11 over control. It is attributed due to the application of two irrigation increased the mustard equivalent yield ha\(^{-1}\).

**Effect of phosphorus**

The net income (Rs ha\(^{-1}\)) was significantly increased with the application of 60 Kg P\(_2\)O\(_5\)ha\(^{-1}\). It was increased Rs 6880 ha\(^{-1}\) or 19.91% in 2009-10 and Rs 6949 ha\(^{-1}\) or 19.12% in 2010-11 respectively. It is attributed due to the application of 60 Kg P\(_2\)O\(_5\)ha\(^{-1}\) was significantly increased the mustard equivalent yield in both the years.

**Effect of sulphur**

The net income (Rs ha\(^{-1}\)) was significantly increased with the application of 40 Kg S ha\(^{-1}\). It was increased Rs 5942 ha\(^{-1}\) or 17.69% in 2009-10 and Rs 6236 ha\(^{-1}\) or 17.56% in 2010-11 respectively. It is attributed due to the increased the mustard equivalent yield ha\(^{-1}\).

5. **Cost : Benefit ratio**

**Effect of irrigation**

The benefit : cost ratio was significantly increased with the applied two irrigation in mustard + chickpea intercropping in 1:1 row ratio. It is increased 56.88% in 2009-10 and 55.22% in 2010-11 over untreated plot with irrigation. It is increased due to the net profit per ha was higher and cost of cultivation lowest.

**Effect of phosphorus**

The benefit : cost ratio was significantly higher with the application of 60 Kg P\(_2\)O\(_5\) ha\(^{-1}\). It was significantly higher 14.66% in 2009-10 and 13.93% in 2010-11 respectively. It is attributed due to the net income (Rs ha\(^{-1}\)) was more and cost of cultivation is less.

**Effect of sulphur**

The benefit : cost ratio was significantly higher with the application of 40 Kg S ha\(^{-1}\). It was observed 14.89% in 2009-10 and 14.57% in 2010-11 over untreated plot with sulphur. It is attributed due to the net income (Rs ha\(^{-1}\)) was more and the cost of cultivation is less.

The same findings also reported by Thenua *et al.* (2010), Tripathi *et al.* (2010) etc.