DISCUSSION

Weeds are most often defined as undesirable plants growing where man does not want them, and in the context of agriculture it has generally come to mean any plant other than the crop. Weeds offer a major challenge for the farmers to enhance productivity and for the government to meet food demands of their own nations (rather than supporting other having unfavourable environment for agriculture).

Uninterrupted supply of nutrients, light and moisture during growth period is pivotal to realize full yield potential of a crop. Weeds, being a serious negative factor in crop production for marked losses in crop yields, they may also provide cover or act as hosts for pests and diseases. Weeds may also contaminate the produce, reducing the crop quality, and in extreme cases produce poison. There are also indications that some weeds may exude toxins which adversely affect crop growth. The dwarf varieties of wheat are highly responsive to more number of irrigations and higher amount of fertilization which provide congenial condition for luxuriant growth of weeds. Weeds that grow with crop deplete considerable amount of costly fertilizer nutrients and available soil moisture resulting in reduced crop yield.

Due to preponderance of weeds, yield losses through weed competition in cultivated fields is wide spread and serious problem.
Since last 20 years, isoproturon was intensively used for controlling grassy weeds at farmers' fields. Though 2, 4-D provided excellent control of broad-leaf weeds, it has the problem of developmental deformities in wheat if not applied at proper time. In order to control broad-leaf weeds along with the grasses, application of isoproturon in combination with 2, 4-D may help to control the complex weed flora in wheat (Pandey et al., 2000). Control of weeds with integrated effort of tillage combined with herbicides may check the loss of the vital inputs to a great extent (Pandey et al., 2001). By manipulating plant geometry and plant density through varying row spacing and seed rates along with the weed-management practices, the weed control efficiency of herbicides can be increased appreciably (Johri and Singh, 1991).

The results presented in foregoing chapter are being discussed here as under:

5.1 STUDIES ON WEEDS

Weed flora

Amongst various limiting factors responsible for low yield of wheat, severe infestation of weed with complex flora may be one of them. The experimental crop was infested with Phalaris minor, Cynodon dactylon, Cyperus rotundus. Similar weed flora of wheat crop under normal as well as late sown condition have been reported by a number of scientists working in different agro-climatic zones of the country (Jain et al., 1985; Vaishya et al. 1988; Jain et al. 1990; Shalunke et al. 1990; Maurya, 1991; Pandey et al. 1996; Pandey et al. 1997; Singh, 1996; Singh et al. 1996; Singh and Singh, 1996; Sri;
Katyal et al. 1997; Sharma and Sharma, 1997; Singh et al. 1997; Singh et al. 1998; Singh and Bhan, 1997; Tripathi and Vaishya, 1997; Yaduraju and Ahuja, 1997; Chaubey et al. 1998; Pandey et al. 1998; Dixit and Bhan, 1999; Yadav, 1999; Chopra et al. 1999; Verma et al. 1999; Kolhe and Tripathi, 2000; Bikramaditya, 2000; Pandey et al. 2000; Pandey et al. 2001; Pandey et al., 2005).

5.1.1 METHOD OF SOWING

Cross sowing method significantly reduced the weed density per unit area by 18.79 and 25.28 per cent at 60 DAS, 34.36 and 31.68 per cent at 90 DAS and 44.35 and 65.36 per cent at harvest stage of crop as compared to broadcast sowing method in first and second year, respectively. The canopy cover is of utmost importance for providing smoothing effects to reduce weed population in cross sowing method. Maurya (1991); Tomar et al. (1999) and Yadav (1999) have also reported that cross sowing method of wheat resulted in reduced weed density due to smothering effect on weeds.

Broadcast sowing provided significantly more fresh and dry weight of weeds than cross sowing at 60th, 90th day and harvest stages of crop growth in both the years of study. Cross sowing method of wheat might have benefited the crop by providing large canopy cover as compared to broadcast and line sowing methods. Hence, the canopy cover of wheat might have decreased weed population and its growth. Thus, the decrease in fresh weight of weeds was mainly through shading effect of cross sowing. Similar results have also been
Broadcast sowing method encouraged the weeds to take up significantly more nitrogen from the soil than line and cross sowing methods. This may be attributed to higher density and dry weight of weeds under broadcast sowing method as compared to cross sowing. Maurya (1991), Johri et al. (1992) and Yadav (1999) reported higher nitrogen uptake by weeds under broadcast sowing method as compared to cross and line sowing methods.

5.1.2 SEED RATE

The use of 100 kg seed rate being at par with 125 kg seed rate at 60th, 90th day and at harvest stages during both the years registered significantly the higher weed density per unit area as compared to 150 kg seed rate at 60th, 90th day and at harvest stages of crop growth during both the years of investigation. This may be because of the fact that the number of crop plants per unit area under 150 kg seed rate was more which did not allow the weeds to emerge more in number. Sriprakash (1996), Yaduraju and Ahuja (1997) and Yadav (1999) have also reported smothering effect on weed growth and reduced weed emergence and establishment under higher seed rates.

The use of 125 and 150 kg seed ha⁻¹ has been found promising to reduce the weed fresh and dry weight per unit area as compared to 100 kg seed rate at different stages of this observation during both the years of study. This may be attributed to lower number of weeds per
unit area under 150 kg seed rate. This was also probably because of the suppression effect of higher seed rate on growth of individual weeds. This results corroborated with the findings of Panwar (1989); Shripkrakash (1996); Yaduraju and Ahuja (1997) and Yadav (1999).

The weeds found in the crop raised with 100 kg seed rate removed significantly more nitrogen from the soil than 125 and 150 kg seed rates. This may be attributed to higher number and weight of weeds under 100 kg seed rate than higher seed rate of 150 kg ha\textsuperscript{-1}. Similar results have also been reported by Johri \textit{et al.} (1992) and Yadav (1999).

\textbf{5.1.3 WEED MANAGEMENT PRACTICES}

Application of isoproturon @ 1.0 kg ha\textsuperscript{-1} + 2, 4-D Na salt @ 0.5 kg ha\textsuperscript{-1} (tank mix) as post emergence has been found most promising to reduce the weed density per unit area at all the stages during both the years. This might be due to synergistic effect of mixture of both the herbicides. Use of isoproturon either alone or as mixture with 2, 4-D Na salt to minimize the weed density has also been reported by Dutta \textit{et al.} (1989); Maurya (1991); Saini and Angiras (1991); Singh and Malik (1993); Singh and Singh (1996); Shripkrakash (1996); Pandey \textit{et al.} (2000) and Pandey \textit{et al.} (2001).

Application of isoproturon @ 1.0 kg and 2, 4-D Na salt @ 0.5 kg ha\textsuperscript{-1} (tank mix) has been found most effective as compared to rest of the treatments to reduce the fresh as well as dry weight of weeds at 60\textsuperscript{th}, 90\textsuperscript{th} day and harvest stages of crop growth during both the years. This was mainly due to reduced weed population under these
treatments. The findings are in line with those of Dutta et al. (1989); Maurya (1991); Singh and Malik (1993); Shripakash (1996); Sinha et al. (1999) and Kolhe et al. (2000).

All the weed control practices minimized the removal of nitrogen by weeds as compared to unweeded check which exhausted maximum amount of nitrogen from the soil during both the years. This may be attributed to lower weed density, weed fresh and dry weight under the effect of herbicidal treated plots. Similar findings have also been reported by Singh et al. (1988); Maurya (1991); Yadav (1999) and Pandey et al. (2001).

5.1.4 INTERACTION EFFECT

The post-em. application of tank mix isoproturon and 2, 4-D Na salt (1.0+0.5 kg ha⁻¹) under line and cross sowing methods reduced weed density as well as weed fresh and dry weight as compared to broadcast method of sowing at 60th, 90th day and harvest stages of crop in both the years. This may be probably due to the fact that cross sowing method and application of herbicides provided congenial conditions for better growth and development of crops which might have resulted in reduced weed density and weed dry weight per unit area. Similar findings were also reported by Maurya (1991), Singh and Singh (1996) and Yadav (1999).

5.2 STUDIES ON CROP

5.2.1 METHOD OF SOWING

Initial plant population was not influenced significantly by the different methods of sowing. However, the highest number of plants
m$^{-2}$ was noted under the effect of cross sowing method which was closely at par with line sowing. This may be attributed to better germination of seeds placed at proper depth in furrows in case of cross and line sowing methods. Maurya (1991) and Yadav (1999) have also reported the similar results.

Different methods of sowing did not cause significant variations in the values related to plant height and number of tillers and functional leaves plant$^{-1}$ recorded at various growth stages of crop during both the years. However, numerically, cross sowing method recorded taller plants, more number of tillers and functional leaves planr$^{-1}$ followed by line and broadcast sowing methods at all the growth stages of crop. The findings are in conformity with those of Maurya (1991), Singh and Singh (1996) and Yadav (1999).

The leaf area index under the effect of cross sowing method was significantly higher than that obtained with broadcast sowing method. This might be attributed to increased number of functional leaves plant$^{-1}$ and initial plant population per unit area in cross sowing method. The superiority of cross sowing over broadcast has also been reported by Singh et al. (1988); Maurya (1991) and Pandey and Kumar (2005).

Different methods of sowing did not show their significant effects on fresh and dry matter of crop at all the stages as well as days taken to 50% heading and maturity during both the years. But, numerically, more fresh and dry matter accumulation was recorded under cross sowing where plants availed more space and sunlight for
their better growth and development which might have enhanced in fresh and dry matter accumulation in plant.

Different yield contributing characters such as length of spike, weight of grains spike$^{-1}$, number of spikelets and grains spike$^{-1}$ and 1000-grains weight were not influenced significantly due to varying methods of sowing. However, cross sowing produced numerically better values of these attributes than broadcast and line sowing methods.

Cross sowing method provided significantly higher grain yield than those of line and broadcast sowing methods in both the years. Cross sowing being identical to line sowing produced significantly higher straw yield than broadcast sowing method in both the years. This may be due to the fact that yield is the cumulative effect of different growth and yield contributing characters and almost all the growth and yield contributing characters were better under cross-sowing method due to better availability of congenial atmosphere which ultimately resulted in enhanced grain and straw yields. Higher grain and straw yields under cross sowing method has also been reported by Angiras and Sharma (1993), Jadhav and Nalamwar (1993), Singh and Singh (1996), Tomar et al. (1999), Yadav (1999) and Kolhe et al. (2000).

Cross sowing method recorded higher values of harvest index followed by line sowing. This was probably due to the fact that proportional increase in grains was more than straw yield under cross
sowing method. Similar results have also been reported by Maurya (1991) and Yadav (1999).

5.2.2 EFFECT OF SEED RATE

A seed rate of 150 kg ha\(^{-1}\) being at par with 125 kg ha\(^{-1}\) recorded significantly more number of initial plants per unit area than 100 kg seed rate in both the years of study which may be due to higher plant stand under higher seed rates. Similar results have also been reported by Singh et al. (1999) and Yadav (1999).

The varying seed rates did not affect appreciably the plant height and number of functional leaves plant\(^{-1}\) recorded at various crop growth stages in both the years. Number of tillers plant\(^{-1}\) recorded at 90th day and harvest stages of crop was affected significantly by varying seed rates. Seed rate of 100 kg ha\(^{-1}\) being at par with 125 kg ha\(^{-1}\) recorded significantly more number of tillers plant\(^{-1}\) than 150 kg ha\(^{-1}\) in both the years. This may be attributed to better horizontal growth of the plants under lower seed rate. Similar results have also been reported by Pawar et al. (1989), Mahajan et al. (1991) and Yadav (1999).

A seed rate of 100 kg ha\(^{-1}\) being at par with 125 kg ha\(^{-1}\) recorded significantly less leaf area index than 150 kg ha\(^{-1}\) at 60\(^{th}\) and 90\(^{th}\) day stages in both the years. This was probably due to optimum plant population per unit area which provided better opportunity to the crop plants for their effective growth and development which have resulted in increase in size of leaf vis-a-vis leaf area index.
The plant fresh and dry matter were significant only at 30 DAS stage of crop growth during both the years. However, higher values of fresh and dry weight were recorded with 150 kg seed ha\(^{-1}\) followed by 125 and 100 kg seed ha\(^{-1}\) at all the stages during both the years. It might be due to higher source capacity and efficient light interception and utilization provided under higher seed rates which might have resulted in higher dry matter production of the crop.

The varying seed rates did not cause significant variation in days required to 50% heading and maturity in both the years of investigation.

Yield contributing characters such as length of spike, weight of grains spike, number of spikelets spike\(^{-1}\), number of grains spike\(^{-1}\) were not influenced significantly by the varying seed rates in both the years. However, 125 kg seed rate produced significantly heavier grains than those of 150 and 100 kg ha\(^{-1}\). This may be probably due to lesser competitions among the plants for different growth factors under optimum seed rate (125 kg ha\(^{-1}\)) than lower and higher seed rates (100 and 150 kg ha\(^{-1}\)) which might have resulted in better growth and development of yield contributing characters. Singh et al. (1999) and Yadav (1999) have also reported similar results.

Significantly the highest grain and straw yields as well as harvest index were recorded with 125 kg seed ha\(^{-1}\) which was at par with 100 kg seed ha\(^{-1}\) as compared to 150 kg seed rate in both the years. This may be probably because of the fact that higher values of yield contributing characters under optimum seed rates (100 and 125
kg ha\(^{-1}\)) which have positive correlation with grain yield. The findings are in line with those of Pawar et al. (1988).

### 5.2.3 EFFECT OF WEED MANAGEMENT PRACTICES

The initial plant population per unit area was not influenced by the different weed management practices.

Plant height and number of tillers plant\(^{-1}\) were influenced significantly by the different weed management practices at almost all the stages of crop growth. The highest plant height was recorded under weed free treatment followed by tank mix application of isoproturon and 2,4-D Na salt. Whereas post-em. application of isoproturon @ 1.0 kg ha\(^{-1}\) either alone or as mixture with 2, 4-D Na salt @ 0.5 kg ha\(^{-1}\) being comparable with weed free treatment recorded significantly more number of tillers plant\(^{-1}\) than unweeded check at 60\(^{th}\), 90\(^{th}\) day and harvest stages of crop growth. This may be attributed less crop weed-competition for different growth factors due to reduced density and dry matter of weeds which provide better opportunity to the crop to utilize moisture and nutrients in better way for its proper growth and development resulting in to more height and number of tillers plant\(^{-1}\). The results reported by Maurya (1991) and Dixit and Bhan (1997) are also in the line of above findings.

Number of functional leaves plant\(^{-1}\) were not influenced significantly by the different weed management practices at all the stages, probably due to identical character of variety. Maurya (1991) and Dixit and Bhan (1997) also reported similar findings.
Weed free treatment recorded significantly higher values of LAI than both the herbicidal treatments and weedy check at both the stages in both the years but was at par with tank mix application of isoproturon and 2, 4-D Na salt (1.0 +0.5 kg ha$^{-1}$) at 60$^{th}$ and 90$^{th}$ day stage in both the years. Next best treatments to weed free were the herbicidal treatments i.e. use of isoproturon @ 1.0 kg ha$^{-1}$ alone as well as in mixture with 2, 4-D Na salt @ 0.5 kg ha$^{-1}$. This may be ascribed to more number of functional leaves plant$^{-1}$. Higher values of LAI in herbicide treated crop has also been reported by Singh et al. (1988) and Maurya (1991).

Different weed management practices showed their pronounced effects on plant fresh and dry matter during both the years. Use of herbicides (Isoproturon and 2, 4-D Na salt) either alone or as mixture and weed free treatment being identical among themselves provided significantly higher values of fresh and dry matter than weedy check. This was probably due to reduced weed density which provided better growth and development of crop by reducing crop weed competition. The findings are in line with those of Johri and Singh (1991) and Thakur et al. (1998).

Weed free and post-emergence application of isoproturon @ 1.0 kg ha$^{-1}$ either alone or in mixture with 2, 4-D Na salt @ 0.5 kg ha$^{-1}$ recorded significantly higher values of weight of grains spike$^{-1}$, number of spikelets spike$^{-1}$, number of grains spike$^{-1}$ and 1000 grain weight than weedy check. This may be due to better control of weeds which resulted in reduced crop weed competition which provide
better opportunity for the development of all the yield contributing characters. Positive effects of weed control practices on different yield contributing characters of wheat crop have also been reported by Singh et al. (1987); Thakur and Singh (1987); Angiras and Sharma (1991); Maurya, (1991); Shriprakash (1996); Thakur et al. (1988); Kolhe and Tripathi, (2000) and Pandey et al. (2005).

Weed free treatment recorded significantly higher grain and straw yields than the herbicide alone and weedy check. The next best treatment to weed free was post-em. application of tank mix isoproturon and 2, 4-D Na salt (1.0 + 0.5 kg ha⁻¹) which was significantly better than the use of isoproturon alone @ 1.0 kg ha⁻¹ as post-em. and weedy check. This was mainly due to significantly higher number of effective tillers and spikes per unit area as well as other yield contributing characters which have high positive correlation with grain and straw yield. The poor weed density and weed dry growth noted under well managed plots resulted minimum crop weed competition and resulted in better expression and yield components vis-a-vis higher grain and straw yields. Enhanced grain and straw yields of wheat tank mix application of isoproturon and 2, 4-D Na salt (0.75 + 0.5 kg ha⁻¹) as post emergence as compared to weedy treatment has also been reported by Malik et al. (1988); Singh and Singh (1996); Shriprakash (1996); Dixit and Bhan (1997), Pandey et al. (1997) and Pandey et al. (2000). Dixit and Bhan (1997)

The highest values of harvest index was associated with weed free treatment followed by tank mix application of isoproturon and 2,
4-D Na salt (1.0 + 0.5 kg ha\(^{-1}\)) and then isoproturon alone @ 1.0 kg ha\(^{-1}\) while the lowest was recorded by weedy check probably due to better partition of photosynthates towards sink.

**5.2.4 Interaction Effects**

The combined effects of method of sowing and seed rate were not visible on growth, yields and yield contributing characters of crop in both the years of field experimentation. Yadav (1999) has also found similar trend in his experiment.

The combined effects of method of sowing and weed management practices were also not visible on growth, yields and yield contributing characters of crop in both the years of field experimentation. Yadav (1999) has also found similar trend in his experiment.

The combined effects of seed rate and weed management practices were also not visible on growth, yields and yield contributing characters of crop in both the years of field experimentation. Yadav (1999) has also found similar trend in his experiment.

**5.3 Economics**

Cross sowing method in conjunction with 100 kg seed ha\(^{-1}\) and tank mix application of isoproturon @ 1.0 kg ha\(^{-1}\) + 2, 4-D Na salt @ 0.50 kg ha\(^{-1}\) as post-emergence gave the highest net income of Rs. 19875.88, net return rupee\(^{-1}\) investment of Rs. 1.42.