REVIEW OF LITERATURE

Literature pertaining to affect of agronomic practices like spacing and fertilization on the growth, morphological characters, yield and quality of *Toria*, is reviewed in this section. Due to paucity of literature on *Toria*, the work done on other oil seed crops has also been included in the review.

1. Effect of Nitrogen:

Oilseed crops respond well to nitrogen fertilization. The application of nitrogenous fertilizers results in better vigour of plant and ultimately it affects the final grain yield. Maini et al., (1959) reported an increase in yield by about 35 percent with the application of 67 Kg Nitrogen per hectare in the case of *Toria*. He worked out 27 Kg N/ha as optimum dose of nitrogen. Dalal et al., (1962) also obtained an increase of 20 percent in yield with 67 Kg and 11 percent with 33.6 Kg nitrogen per hectare. An increase of 247 Kg and 407 Kg in the yield of *Toria* with the application of 33 Kg and 67 Kg nitrogen respectively was observed by Maini et al., (1965) and that of 275 Kg per hectare by the application of 33 Kg nitrogen by Anonymous (1966). Wankhede (1970) found the application of 40 Kg nitrogen per hectare as beneficial dose for increasing
grain yield of Toria, where as at higher level the trend was reverse. Singh *et al.* (1971) obtained 845 and 963 Kg grains of Toria with the application of 70 and 140 Kg N/ha respectively along with a basal dressing of P K. However, with a basal dressing of P K only, they obtained 592 Kg of grain yield. Lahiri *et al.* (1971) reported that in mustard crop the soil application of 60 Kg N/ha before sowing and 40 Kg N/ha (as Urea) by foliar sprays at 40 days after sowing gave average seed yields of 10.83 Q/ha, compared with 10.76 Q/ha on plots given pre-sowing soil application of 120 Kg N/ha and 6.10 Q/ha on those given no nitrogen.

Bhan (1975) observed in his experiment that application of 80 Kg N/ha increased yields from 3.60 Q/ha without N to 10.52 Q/ha. Nitrogen placed at 4 cm. below the seed increased yields by 36 percent over N applied broadcast. Singh *et al.* (1970) found that application of 120 Kg N/ha tended to give higher yields than did 120 Kg N + 30 Kg P_2O_5 + 30 Kg K_2O/ha. Singh *et al.* (1972) observed that 101 Kg N/ha gave 51.6 and 10.5 percent more yield over the control and 74 Kg N/ha respectively where as application of 74 Kg N/ha gave only 36.4 percent more yield over the control. Stabbetor (1973) found at Norway that the seed
yield increased consistently with Nitrogen to the highest rate from 47 Kg N/ha to 186 Kg N/ha in the rape and turnip rape. Suraj Bhan et al., (1974) reported seed yield of 9.30 Q/ha without N, 12.70 Q/ha with 40 Kg N/ha and 15.10 Q/ha with 60 Kg N/ha, 11.70 Q/ha without P, 12.60 Q/ha with 20 Kg P2O5/ha and 13.30 Q/ha with 40 Kg P2O5/ha. Vullioud (1970) found from his research done at Switzerland that the optimum nitrogen requirement was 120-130 Kg N/ha for winter oilseed rape. The crop required 140 Kg N/ha for producing 30 Quintal seeds/ha. Halpa (1971) concluded at U.K. on oilseed rape that 150 Kg N/ha gave significant higher seed yield than 100 and 200 Kg N/ha. Vullioud (1974) observed at Switzerland on winter rape that increase in the rate of applied N from 110-120 Kg to 190-210 Kg/ha did not affect seed yields. Pangle et al., (1970) found in linseed that increasing levels of N enhanced the test weight and grain yield per hectare and also the same results were found with the increasing levels of P.

Sahu et al., (1975) concluded from his experiment on mustard at Bhubaneshwar that the balanced fertilization with 50 Kg N, 25 Kg P2O5 and 25 Kg K2O gave the highest seed yield of 1957 Kg/ha as against a yield of 825 Kg/ha under no fertilizer treatment. On the basis of response curves, it was
found that for maximisation of yield a dose of 66 Kg N, 
25 Kg P₂O₅ and 25 Kg K₂O per ha could be recommended.
Singh et al., (1970) observed that application of 120 Kg 
N/ha tended to give higher yields of raya than did 120 Kg 
N + 30 Kg P₂O₅ + 30 Kg K₂O/ha. Singh et al., (1971) also 
found that application of 50 Kg N + 25 Kg P₂O₅ or 100 Kg 
N + 25 Kg P₂O₅/ha gave yields of Brown Barson as 12.50 
and 12.20 q/ha respectively as compared with 8.90 q/ha 
on plots given no fertilizer. Singh et al., (1972) observed 
that 49 Kg N + 20 Kg P₂O₅/ha gave the maximum yield, follo-
wed by 20 Kg N + 20 Kg P₂O₅/ha. Skelton et al., (1969) 
reported that if rape is grown for fodder then 120-140 Kg 
N/ha at sowing is recommended, plus 50-60 Kg N/ha later 
when the crop is row filled or after the first cut. Patil 
et al.,(1976) reported that the economic optimum dose of 
N was 52.3 Kg/ha at an estimated yield of 20.2 q/ha of 
Toria. Dhindsa et al., (1973) observed a reduction in yield 
of Toria if nitrogen dose is increased from 50 to 100 Kg/ha.
Kinra et al., (1972) found in Rai that the nitrogen appli-
cation increased the yield significantly upto a level of 
100 Kg N/ha, beyond this the yield declined. Bhan et al., 
(1975) reported that application of nitrogen increased 
yield significantly.
Arora et al., (1970) observed that in *D. juncea*, nitrogen application increased grain yield, protein content in seeds and the allyliso-thiocyante (ATC) value but decreased the oil content and its Iodine value. Gupta et al., (1970) reported that a dose of 80 Kg N + 60 Kg P₂O₅/ha was considered as optimum for *Toría* crop for its grain and stover yield, oil and protein content. Phosphorus alone tended to increase the phosphorus and oil content in seeds. A low negative correlation was observed between oil and protein content. However, allylisothiocyanate content did not show any definite trend due to K P K fertilizers.

Dargen and Maini (1970) reported that there was progressive and significant increase in the seed yield of *Toría* over control with the increased dose of nitrogen upto 100 Kg/ha. However, optimum dose was worked out to be 50 Kg N/ha. The beneficial effect of nitrogen application on number of branches and capsules per plant has also been reported by many workers. Maini et al., (1964) found that the application of 40 Kg N/ha increased the number of branches and capsules per plant. Thind et al., (1973) obtained maximum oil yield with an application of 50 Kg N/ha. Higher doses of nitrogen decreased oil yield and other chemical constituents of grain. Similar results were
reported by Gupta et al., (1972), Stabbetoro (1973) while working on rape and turnip rape who recorded highest yield at the highest phosphorus rate (32 Kg/ha). The effects of K on seed yield were small and unpredictable. Crude fat content decreased with increasing N rate while crude protein content of the seed increased. Contents of P and K showed little change in response to increasing N, P and K. Vullioud (1970) reported in winter oilseed rape that N uptake was highest between the resumption of growth, in spring and flowering. The oil content of the seed was negatively correlated with the protein content and was decreased by increase in applied N. The optimum time of application was 33% of the total in autumn and 67% in spring. There was no advantage in splitting the spring dressing of N as it had no effect on seed density or oil composition. Wankhede et al., (1970) reported that 40 Kg N + 20 Kg P₂O₅/ha has significantly increased the number of branches, capsules per plant and grain yield. The height of the plant continued to increase with higher levels of fertilizer, but the oil content of the seed was reduced with fertilizer application. Wankhede et al., (1970) have reported that seed and oil yields were increased if the crop is applied with 40 Kg N + 20 Kg P₂O₅. Singh et al., (1971) observed
from his experiment that seed oil decreased due to more fertilizer. Hoag et al., (1963) found that the application of fertilizer significantly increased the growth of safflower and increased plant height, number of heads per plant and yield per hectare. There was a significant negative correlation between oil content and seed weight and a highly significant positive correlation between oil, iodine value and seed weight. Zubrski et al., (1974) have found that nitrogen fertilizer increased seed yield, head size and oil yield in Sunflower. Sahu et al., (1975) observed in mustard that balanced fertilization consisting of 50 Kg N, 25 Kg P₂O₅ and 25 Kg K₂O gave the highest seed yield of 1957 Kg/ha as against yield of 325 Kg/ha under control. Pande et al., (1970) observed that increasing levels of N enhanced the height, branches, capsules and seed yield per plant, grain and straw yield per hectare. Increasing levels of P influenced the height, capsules, seed and straw yield per plant, test weight and yield per hectare in linseed.

Vullioud (1974) found that increased in the rate of applied N from 110-120 Kg to 190-210 Kg/ha did not affect seed yields but increased the number of branches, pods per plant and per m², and decreased the number of seeds per pod. Allen et al., (1972) observed in oilseed rape that
controls grain and oil yields. Maini et al., (1964) have reported that wider spacing reduced grain yield of Toria. The oil content of grain was also higher in 30 cm. row-spaced crop as compared to that of 45 cm. row-spacing. Singh et al., (1972) reported that the spacing of 30 cm x 7.5 cm gave the maximum and that of 60 cm x 7.5 cm the minimum seed and oil yield of Toria. Dhindia et al., (1973) also observed that closer row-spacing (30 cm) proved better over wider spacing (45 cm) as regards yield and quality of Toria. In case of Brown Sargon Singh et al., (1971) reported that 30 cm spacing yielded significantly more than row-spacing of 60 cm. In a trial conducted on Raya at Hisar during 1972-73 closer row-spacing was better than wider (Anonymous, 1973). Wankheda et al., (1970) reported that the number of capsules per plant increased with decrease in plant density of Toria. Plant population of 166 thousand plants/ha was optimum and gave the highest grain yield. The number of branches and capsules per plant were more with 111 thousand plants per ha, but the height per plant did not show any difference among the three plant populations tried. The oil content of the seed with 166 and 111 thousand plants per ha was slightly better than with 333 thousand plants/ha. Hoag et al., (1963) obtained greater yield of Safflower crop sown at 15 or 53 cm
row-spacing than the yield from 91 cm row-spaced crop. Safflower in 15 cm row-spaced crop had significantly higher oil content and a lower iodine value than safflower grown in 53 or 91 cm spaced rows.

Skaland et al., (1969) drew the following conclusion from his experiments. (1) If rape is to be harvested or grazed 60-70 days after sowing, a narrow row-spacings of 40 cm can be used, 60 cm row-spacings should be used where weeds are a problem or where the crop has to stand for a longer period. (ii) A seed rate of 5-7 Kg/ha is recommended with 60 cm spacing, 6-8 Kg with 40 cm and 10-20 Kg with a 13 cm spacing. Singh et al., (1971) on the other hand obtained equal yield in Mustard crop grown either in rows 45 or 90 cm apart. Kinra et al., (1972) observed a significant increase in yield with a plant density of 2.2 lakhs/ha over the minimum plant density of 1.43 lakhs/ha. The yield of the crop decreased significantly when the plant population was raised to 4.44 lakhs/ha. Ohlsson (1971) found that summer turnip rape was sown at 12 cm, 24 cm and 48 cm apart and given inter-row cultivation to the widest spaced sown crop only. Oil yields were 610, 583 and 503 Kg/ha. Larsen et al., (1971) reported seed oil content of 40.4 percent at close and 40.0 percent at wide spacing, with corresponding
protein contents of 21.5 and 22.0 percent in the seed. The seed weight was unaffected by row-spacing in winter rape. Kondra (1975) reported in rape seed that the narrowest row-spacing gave the highest yields (30.8-27.4 Q seed/ha). He also found that row-spacings have no effect on oil content and no appreciable effect on the protein content of the seed was noted.

Huhn et al., (1975) on the other hand found no effect of plant density on competition between individual plants in the plant stand on winter oilseed rape, seed yield and its components like plant height and the number of seed per pod. However, seed yields and number of pods and seed per plant were very sensitive to plant density and competition. 1000-seed weight was not affected by plant density but was very sensitive to competition, while the reverse applies to numbers of primary, secondary and tertiary branches per plant. Bhau et al., (1975) observed that B. juncea cultivars sown at spacings of 20x10, 20x15 and 30x10 cm gave similar average seeds yields of 22.40 - 23.40 Q/ha, which were significantly higher than those at spacing of 20x20 cm and 40x10 cm (17.10-19.70 Q/ha). Vullioud (1974) found that seed yields of winter rape grown under favourable conditions were highest at row-spacings of
significantly higher seed yield of Toria variety ITSA than T-27 but was at par with variety TH-1.

Singhvi et al., (1973) found that high incidence of L. erysimi (Aphid) decreased yields of seed by 65.3% and oil by 66.9% in Toria CV. ITSA and by 27.5 and 31.5% in Raya RL 18. Thurling (1974) found in rape seed a decrease in yield with successive delays in sowing accompanied by a marked reduction in the number of pods per plant, but little change in the seed weight per pod. In B. campestris, the number of pods per plant decreased with delay in sowing, but the seed weight per pod increased, particularly between the 1st and 2nd sowings. The seed yield was significantly correlated with the numbers of pods per plant, pod-bearing branches and pods per branch in B. napus and with the number of seed per pod and 1000-seed weight in B. campestris. Singh et al., (1972) found that the interaction of date of sowing and varieties of Raya was also significant. The crop sown on October 10, gave 11.4, 53.3 and 122.3% more seed yield than the crop sown on Oct. 10, Nov., 10 and Nov. 25 respectively. Mustard varieties RG-1, RG-3, RL-9 and RL-18 were not significantly different from one another. However, RG-3 gave 11.2, 9.1 and 8.8 percent more yield than RG-1, RL-9 and RL-18 respectively.
Pathak et al., (1962) found that ITSA gave on an average 14-26 percent higher yields (of seed) than other strains except W B 106, which followed next in order. Because of its early maturity, it generally escape damage caused by aphides and frost and is quite suitable for growing as the only winter crop before sugarcane. Toria Abobar, which is a late maturing type, evolved in Punjab, has been found suitable for the plains of U.P. under irrigation. Hardoi and Mainpuri strains have given an average of 10-12% greater yields, than early strains from Bengal and are superior to Toria, CVs, Beas and T-9 which are also high yielding.

Singh et al., (1974) found that Toria CV. ITSA when sown in September and harvested at 5 days intervals between 95 and 120 days after sowings, the seed yields increased from 6.3 to 14.8 Q/ha in 1970-71 and 3.0 to 7.0 Q/ha in 1971-72 as the crop matured, while oil content increased from 37.3 to 44.9 and 37.0 to 39.5% respectively. Agarwal et al., (1973) found in Toria varieties that oil yield was positively correlated with seed yield, number of siliqua per plant and seed oil content. The last two characters accounted for the greatest variability in oil yield. Dhinda et al., (1974) analysed thirty strains of
and found that total oil production was maximum in P300-62, which was 16% more than that of RL-18 (standard variety). The varieties RS-1, BRR-62, H-1, C1str-43, KB-2 and No. 31 had higher protein content than RL-18. The oil content was found to be negatively correlated with protein content.

4. Effect of Interaction between Variety, Nitrogen and Plant Population:

Singh et al., (1972) observed that a spacing of 30 x 7.5 cm. gave the maximum yield with 49 Kg N + 20 Kg P2O5/ha. This dose of fertilizer gave a net profit of Rs.139.35/ha and the higher dose consisting of 80 Kg N + 20 Kg P2O5/ha gave a loss of Rs.12.05/ha when compared with the control. Bhan et al., (1975) found maximum yield with narrow spacing in conjunction with 120 Kg N + 60 Kg P2O5 + 60 Kg K2O/ha. Singh et al., (1971) found in brown sauerkraut that 30 cm spacing with 50 Kg N + 25 Kg P2O5 gave more yield. Skaland et al., (1969) recommended a seed rate of 5-7 Kg/ha for fodder rape varieties with 60 cm spacing, 6-8 Kg with 40 cm. and 10-20 Kg with a 13 cm spacing. Wankhede et al., (1970) reported that in tola a plant population of 166 thousand plants/ha was optimum and obtained the highest grain yield with 40 Kg N + 20 Kg P2O5.
Dhindsa et al., (1973) in their experiment, on Toria CV. HSA sown on 18 or 25 August and 1, 8 or 15 September in rows 30 or 45 cm apart applied with 25 Kg P2O5/ha and 50 or 100 Kg N/ha, the oil, seed yields and protein increased with delay in sowing to 15 September. Kinra et al., (1972) found in Indian mustard that interaction between nitrogen and spacing was significant. The application of 100 Kg N/ha over close spacing 5 cm between plants with in rows gave the highest yield. Economics of nitrogen fertilization was also calculated and a highest return of Rs.3.63 was recorded at 50 Kg N/ha for per rupee invested on N fertilization. The lowest return of Rs.3.03 was, however, worked out for 150 Kg N/ha application for per rupee spent on fertilization. Saini et al., (1974) observed a non-significant interaction between spacing and fertilizer in spreading groundnut varieties. Vullioud (1974) found in winter rape that seed yields was highest at sowing rate of 18-20 cm. Increase in the rate of applied N from 110-120 Kg to 190-210 Kg/ha did not affect seed yields. Similarly nitrogen did not interact with seeding rate. Kubriski et al., (1974) reported that in Sunflower N and plant density have a relatively large effect on seed yield and a smaller effect on oil concen-
tration and seed size.

Wankhede et al., (1970) observed in Toria CV. Rbobar that yields of seed and oil were highest with 16,6000 plants/ha given a fertilizer dose of 40 Kg N + 20 Kg P2O5/ha. Pande et al., (1970) found in linseed that seed yield increased with increasing levels of N and P. Singh et al., (1971) found that in mustard an application of P K with out N had little effect on yield. They further observed that the yields obtained with 45 and 90 cm. row spacings were at par with each other.

Allen et al., (1971) conducted a trial on oilseed rape (Brassica napus Var. oleifera Subvar. annus) CV. Zellerengold and Crisus sown in rows 15.2 or 45.7 cm apart and applied with 0, 106.5 or 211.0 Kg N/ha. Plants were sampled at 1 week intervals for 15 weeks beginning with 14 May and data were collected for total plant and pod dry weights, LAI and Crop growth rate (CGR). Development of the crop occurred in four more or less distinct phases according to the pattern of dry weight production. There was an initial period lasting 6 or 7 weeks depending on N treatment, during which CGR, reached and remained at a relatively high level. LAI reached a peak in the 4th or 5th week and declined thereafter Nitrogen promoted growth.
and increased both LAI and CGR. The 2nd phase lasted about 2 weeks during which there was a marked reduction in CGR and it was concluded that gain in weight from photosynthesis by senescing leaves was balanced by weight loss from respiration. In phase 3 (1-2 weeks) CGR increased to a level much higher than that in phase I, despite the lower LAI, and there was a marked increase in size and weight of pods. During the final period of 5 weeks ending at full pod maturity, plant weight decreased owing to loss of pods and seeds from obsession and bird damage. It was concluded that new and actively photosynthesizing tissue of the pods was responsible for the DM increase in phase 2. Increasing the rate of applied N increased the number of pods per plant. It was concluded that leaves have little direct influence on the growth of pods.

Singh et al., (1974) found in 36 strains of B. campestris Var. Sarson that seed yield was positively correlated with number of pods and branches per plant and height. Partial correlations between yield and pod number and between yield and branch number when keeping the height constant, and between yield and branch number when keeping the pod number constant were positive and significant. Multiple correlation between yield as a dependent variable
and number of pods and branches per plant as independent variables was highly significant and positive. Cross (1964) found in *Brassica napus* and *B. campestris* that significant negative correlation was obtained between seed yield and sowing date, yield was highest when seeded on May 8 and declined as seeding was delayed. Earlier seeding resulted in frost damage. Delay in seeding resulted in later maturity, reduction in plant height and time required for vegetative and reproductive development.

5. Rotation:

As mentioned earlier *Toria* is a short duration crop, therefore, to have good income, wheat can easily follow this crop in rotation. In the following paragraphs an attempt has been made to review literature on the effect of one crop on the performance of succeeding crop in rotation, because no specific work on *Toria* wheat rotation has been done. Lal et al., (1972) tested 4 crop rotation in U.P. involving 3 crops per year. Bajra for grain or fodder, wheat-cowpeas for fodder gave the highest net profit, followed by Bajra-wheat-moong in rotation. Bockmann (1976) reported that yields of spring and winter wheat were lower when grown after wheat, barley or rye crops than after fallow, oats, legumes or oil seeds and root crops. Yield
reductions in wheat were mainly the results of decreases in 1000-grain weight and the number of ears per m².

Bairathi et al., (1974) found that wheat grown after the incorporation of root residues of Guar (*Cyanopsis psoralodes*) Moong (*Phaseolus aureus*) or Cowpea (*Vigna catjang*) into the soil and given 60 Kg N + 40 Kg P₂O₅ + 20 Kg K₂O/ha gave higher yields of grains of high protein content and took up more N and P than when grown with NPK after fallow. Incorporation of residues of *Cyanopsis psoralodes* and *Vigna catjang* also significantly increased yields over those obtained after fallow without NPK.

6. **Residual Effect of Nitrogen on Wheat after a Preceeding Crop**:

It is very essential to know about residual effect of nitrogen on late sown wheat after *Toria*, because *Toria* is a higher feeder of Nitrogen and wheat also, lies in the same line. Therefore, an agronomist must find out the best dose of Nitrogen, plant population and variety of *Toria* for good production of wheat after *Toria*.

Menarova et al., (1975) found that P in combination with N and NK applied to peas on leached chernozem soil significantly increased grain yields of wheat after it
respectively and in monoculture 13.6 q/ha. The optimum rate of N for high grain yield was 63 Kg/ha after clover, 80 Kg/ha after maize and 107 Kg/ha in monoculture. Ahmad et al., (1970) reported that grain yield of Japan Dwarf and straw yields of both CVs i.e., Dirh and Japan dwarf were increased with increasing rates of N to preceding crop of Maize.

Kolev, D (1969) observed that 130 Kg N + 130 Kg P2O5/ha applied to Cotton increased the average yield of winter wheat following it.