REVIEW OF LITERATURE

The pertinent literature in relevance to the present investigations with respect to cultivation of strawberry under protected and field conditions has been briefly reviewed and given under appropriate headings.

2.1 Time of Planting

2.1.1 Effect of time of planting on growth characteristics

Hughes (1965) advised that for early runner production the cold stored runners should be planted in June to July. Rosati (1971) conducted an experiment by planting large and medium sized cold stored runners of cv. Souvenir de Charles Machiroux strawberry between June 22 to Aug 21 and found that the number of crown buds, leaves and total yield decreased as the planting date was delayed. Cox (1976) recorded the considerable number of runners in the autumn after planting the cold stored plants in Jan to Feb, but not by the freshly lifted runners in cv. Torrey. Obayashi (1977) while studying runner production in strawberry reported that mother plants of cv. Hokawase when planted in early Dec without removal of flower produced more than 200 runners. Danek (1984) reported that early planting in summer (early Aug) had the greatest positive effect on the number of runner in the following summer. Schmitz and Lenz (1989) planted freshly harvested and cold stored runners from May 16 to Sept 7 and found decreased number of runners, dry weight and leaf number as the planting date was delayed. Chandler et al. (1991) grown short day cvs. Dover and Pajaro and day neutral cv. Selva on raised beds from runner tips and planted on Aug 25, Sept 22 and Oct 22, the number of runners were greatest with the planting in Aug and decreased with later planting dates.

Turemis and Kaska (1995) planted cold stored runners of strawberry cvs. Cruz, Tufts, Vista, Pocahontas and Aliso on six dates between Oct and May. They reported that all the cultivars except Cruz produced large number of runner plants. The highest number of runners were produced following planting in Oct than Nov and Dec under Atlanta conditions.

2.1.2 Fruit yield
According to Vik (1966) the fruit yield were highest with the earliest planting date (July 1), becoming less with later planting at the latest date (Aug 10). Hughes (1967) reported that when small or large runners of cv. Cambridge Favourite and Cambridge Rival were planted in Aug or Sept, the planting time had greatest effect on the yields. Early planting (Aug) markedly increased the yield as compared to Sept planting. Kroon (1967) observed that cvs. Redgauntlet and Cambridge Vigour yielded 16 tones acre\(^{-1}\) from a mid-May planting and one tones acre\(^{-1}\) from mid Sept planting while Redgaunlet planted on same dates yielded 19 and 2 tones acre\(^{-1}\) respectively. According to Thosrud (1972) when planting of strawberry was done on different dates in spring and autumn seasons, there was a little loss in yield resulting from latest planting time (Oct 15) and spring (June 11). Stancevic (1974) studied the effect of planting date on various strawberry cvs. and noted that the delayed planting after Nov 15 reduced the fruit yield while early planting raised the production of fancy first grade fruits. Noto (1977) while studying yield and course of ripening in strawberry planted on successive dates in summer and autumn in south Italy reported that in the first year early yield decreased as planting delayed from May to Sept whereas in the second year early and total yield were lowered and affected by planting dates. Stancevic (1977) planted strawberry cv. Senga Precosana at 10 days intervals from Aug 15 to Nov 15. He noticed that yields decreased gradually from an annual mean of 7342 kg ha\(^{-1}\) over a 3 year cropping period for the 1\(^{st}\) planting date to 3879 kg ha\(^{-1}\) for the last date. Risser and Vaillen (1980) planted cold stored strawberry runners of cvs. Gariguette and Favette on July 19, July 27, Aug 2, Aug 10 and Aug 22 and noted that the yields from the July planting dates were lower in both the cultivars. Fiedler and Weier (1983), while working in West Germany with 5 strawberry cvs. Fratina, Fracunda, Senga Sengana, Gorella and Redgauntlet planted in early April, late May, late July, or late Oct found that early planting was significantly better in respect of yield and mean fruit weight in the first cropping year in all the cultivars than later planting.

The cold stored plants of cvs. Brighton, Fern and Selva were planted by Faedi et al. (1988) on April 17, May 13 and Jan 7. Cultivar Fern yielded more fruits while Selva gave the largest fruits. According to Takahashi and Takai (1988), the yield of strawberries per unit area was highest with Sept planted plants followed by Oct and Nov. Badiyala and Bhutani (1990) reported that the berry yield of Tioga was significantly higher from the plants planted on Sept 30 and the yield decreased under Himachal Pradesh conditions. Chandler et al. (1991) grown short–day cvs. Dover and Pajaro and day neutral cv. Selva on raised beds with planting date of Aug 25,
Sept 22 and Oct 22. They did not find any influence of planting dates on an average fruit weight but yield was affected significantly. Cultivars Pajaro and Selva, recorded highest yield from Oct and Aug planting respectively. Human (1993) showed that yields of cvs. Selekt, Rolinda, Tioga and Parfaite were significantly reduced with the later planting dates in two seasons when planting was done on raised beds from March 1 to 25 and April 17 to 4. Marotaborrego et al. (1993) planted the cold stored plants and recorded greater early and total marketable yields of Chandler, Doughlas and Selva strawberries in summer than autumn planting.

Lopez-Galarza et al. (1994) obtained the highest marketable yield of Chandler with the earlier planting date i.e. Oct 14 than Oct 28 under the conditions of Valencia. Caruso and D'Anna (1995) reported that fruit yield of strawberry cv. Chandler declined as the planting was delayed beyond Aug 16 as a result few flower and fruit number per plant\(^{-1}\), when planting was performed on July 27, Aug 16, Sept 5 or Sept 25 under Silicon conditions. Tripathi (1997) planted strawberry cv. Chandler on three timings i.e. Aug 10, Aug 25 and Sept 10 under Himachal Pradesh conditions and reported that the maximum yield was obtained from Aug 25 planting followed by Aug 10 whereas, minimum yield was obtained in Sept 10 planting which was also found statistically significant.

### 2.1.3 Fruit weight

Zemlaric and Koron (1996) planted strawberry cvs. Marmolada and Sella on July 25 or Aug 2, 9 or 16 and found that fruit weight of cvs. Marmolada was greatest (317.9g) when planted on July 25 and lowest (240.7 g) for Aug 16 under Slovenia conditions. Risser and Vaillen (1980) observed a slight increase in fruit size in strawberry plants with later planting dates Aug 10, and Aug 22. Human (1993) planted the Parfaite, Salecta, Rolenda and Tioga cvs. on March 1, 15 and 25 in first cropping season and March 17, 21 and April 4 in second cropping on raised beds, the planting on 3\(^{rd}\) date (in both the years) reduced the size of fruit in all the cultivars studied during experimentation.

### 2.1.4 Fruit quality

Op’t Hoog (1967) found the best quality fruits of Senga Sengana, Elista, Redgauntlet, IVT 6032 and Gorella cultivars of strawberry when planted during summer (mid Aug). However, Wienberd and Seidel (1972) obtained the higher early yields and lightly better quality fruits with
the winter planted crop rather than planted in Aug, Sept and Dec under Spain conditions. Schmitz and Lenz (1989) reported that when freshly harvested and cold stored runners of strawberry cvs. Elvira, Tenira, Korona and Bogota were planted on 4 dates in 1982 and 6 dates in 1986 between May 16 to Sept 27, the mid May and mid June planting produced the yields as high as those of freshly harvested runners planted from mid July onwards, however, the fruit quality of the cold stored plants was somewhat inferior than the freshly harvested plants.

### 2.2 Protected Conditions

The research work carried out on the production of strawberry crop under protected conditions is almost negligible in Punjab as well as in India. Some useful work has however been carried out in horticulturally advanced countries to promote strawberry production under protected conditions.

Riser (1963) conducted a trial of six strawberry cultivars grown under protection of frames and found cv. Surprise des Halles the best in yield and earliness but the fruits of Glasa and Senga Precosa cultivar were better in appearance and quality. John and Dana (1966) in their trial on growth and fruiting in strawberry studied the effect on fruiting in newly planted strawberry plants under green house and field conditions with three cross cvs. i.e. Dunlop, Sparkle and Catspill. In the green house observations on leaf area, number of leaves, flowering, fruiting and plant weight were recorded and in the field data on non-fruiting plants were taken. The most rapid and the greatest growth was found to occur on the oldest plants of cv. Sparkle. According to Lalatta et al. (1974) the use of plastic green houses for forcing helped in prolonging fruit retention with increase in fruit yield and quality and protection against adverse climatic conditions in almost all the cultivars of strawberry. Ivanov (1976) demonstrated that Belrubi and Chandler when planted under green house conditions yielded high. Takai and Seyama (1978) effectively reduced the winter temperature by keeping the plants in a cold green house clad with 2 layers of plastic throughout the winter. Lutz and Konard (1981) studied the microclimate of protected strawberry fields and reported the lesser temperature fluctuation and uniform water distribution by covering the crop with Agryl-P-17- Abdeckvlies which resulted the better plant growth, fresh green foliage, earlier flowering and lesser frost damage of the crop then perforated plastic covering or control. Cultural system using covers like perforated plastic poly films, extruded meshes and spun bound textiles to modify growing conditions for high
value field grown horticultural crops like strawberry are being developed in Europe, Japan, Italy, and north America with a goal of inducing early maturity and improving production efficiency through extending the season by retaining heat during period of decreasing ambient temperature (Wells and Loy, 1985).

Sologalov and Sedykh (1987) observed the intensification of plant growth in a number of strawberry cultivars under temporary covering with the plastic mulch. Pollard and Cundari (1988) recorded significantly greater accumulation of degree days (base10°C) in soil and air in covered plots than in non covered. The covering with slitted polyethylene affected the fruit production apparently in winter and/or spring rather than in the autumn. Bringhust and Voth (1989) recorded high yield in strawberry cvs. Belrubi and Chandler under green house conditions. Gast et al. (1989) reported that the higher mean temperature under row covers of plastic film, extruded meshes and spun bound textiles in autumn and spring combined with longer period of exposure to light with early mulch removal in spring enhanced development of fruit buds and yield components in strawberry cv. Douglas. The strawberry plants planted in May were given treatments of row cover, row cover+ mulch, no row cover and no row cover+ mulch and it was found that row cover treatments increased number of primary, secondary and tertiary flowers along with marketable production in each year (Pollard et al., 1989). Gast and Pollard (1989) concluded that the use of row covers in autumn sustained carbohydrate metabolism longer and that using in spring with early removal of mulch advanced the spring flush of accelerated carbohydrate metabolism in Earliglow strawberry plants. In another study they found that the higher mean temperature under row covers in spring and autumn and the longer period of exposure to light permitted by earlier removal of mulch tended to increase both vegetative growth and yield potential of short day cv. Earliglow. Rossi et al. (1989) stated that the tunnels had diverse effects on the yields of the two tested cvs. Brighton and Fern out of which Brighton was more affected than Fern but both tunnel-grown cultivars showed increased yields in comparison to open- field cultivation. Sharma and Singh (1990) recorded significantly increased yield in plastic covered strawberry cv. Pusa Early Dwarf in the first year.

Gast and Pollard (1991) observed the increase in the yield of Earliglow strawberry fruits under row covering with extruded polypropylene–polyamide mesh or spun bounded polypropylene but not in the number of flowers plant⁻¹, suggesting that the yield increase was
primarily due to an increase in the development of tertiary berries in trusses. Austin (1991) recorded highest marketable yields in cv. Sparkle of strawberry by covering the plants with plastic film over hoops during the autumn, winter and spring. Application of plastic cover and barley straw in different cultivars of strawberry (viz. Bounty, Hecker and Totem) provided best protection in winters with below-normal temperatures resulting in the highest fruit yield (Turner et al., 1992; Moore et al., 1992) Lui et al. (1992) found strawberry forcing cultivation profitable under double film green houses. Highest yield and financial return increased up to 17 and 27 percent respectively taken in Belrubi strawberry plants with perforated plastic film (Verlinden, 1992). Kongsrud (1994) reported that the black plastic mulching increased vegetative growth but reduced berry size and yield in strawberry cv. Chandler. According to Probasco (1994) field trials were carried out to investigate profitability of strawberry cv. Chandler under polyester row cover and found that early fruit yields from newly planted beds covered with black plastic were higher than those of 2 year old beds and the use of a polyester row cover during the winter increased the total marketable yield. Caruso (1996) planted strawberry cvs. Tudla and Chandler in late Aug or late Sept in poly tunnels and found that fruits reached marked ripeness at the beginning of April in each year and on an average cv. Tudla was more precocious in fruiting than cv. Chandler.

According to Aflatuni (1997) the effects of a non woven cover and three soil mulches (mypex film, plastic film and white on black plastic film) on yield of strawberry cvs. Chandler, Milcin Milsie and Oso Grande to row covers were studied on plants transplanted in Oct. Row covers reduced fruit yield and number in all cvs. primarily by reducing fruit number. The shading effect of row covers offset the effect of the slight rise in soil temperature (1-2°C) it caused (Rubeiz, 1997). Lisiecka and Pudelski (1997) reported that strawberry runners planted in containers in an unheated tunnels in middle of April become multi crown plants and gave a high yield in May-June. Two experiments were carried out in Atibaia, SP, Brazil one in a protected environment and other in an open field to evaluate the cv. Campinas IAC-2712, under different irrigation levels and soil mulches (black and clear polyethylene) and it was found that the clear plastic mulch favoured the vegetative growth, evaluated through plant height, leaf area as well as by total marketable fruit yield and its components (mean number and weight of fruits per plant). In the open field cultivation, no effect of treatments due to rainfall were observed. Protected cultivation also protected plants from harsh weather and for a better control of diseases (Passos,
Antuono et al. (2000) studied the effect of planting strawberry under open field conditions and protected conditions with a plastic tunnel set over field and reported that the fruits from open field were characterized by better mechanical properties and colour parameters showed a tendency to deviate from the more accepted light red standards. Fruits from the protected conditions looked good although they were low in sugar and acidity and had poor mechanical properties.

Nestby et al. (1997) conducted a trial by covering strawberry plants with single layer polyethylene glycol with or without brown paper lamination in Oct and the covers were removed in April. The covered plants had less browning of the crown tissue and higher yield than uncovered plants. Straw covered plants yield 42.5 per cent more than the uncovered plants. Cu-Xiao (2000) conducted an experiment in China with strawberry cvs. planted in a film covered greenhouse with a simplified heating system. Planting took place in early mid-Sept and the film was put over the greenhouse in mid-late Oct and Dec and it was observed that the yields reached 2120kg/667m. Awani et al. (2001) cultivated strawberry cv. Chandler under green house which resulted in maximum yield and runners plant$^{-1}$.

Kasperbauer (2000) compared the black plastic mulch and red plastic mulch in field experiments at a research center and on a commercial farm and observed that the yield per plant and size of strawberries were greater over the red than over the black plastic at both the locations. A replicated experiment was conducted by Fletcher et al. (2002) in 8 small experimental greenhouses covered with different photoselective films characterized by a range of red/far-red ratio and PAR transmissions to study their effects on the growth, yield and quality of the strawberry cv. Elsanta. Marketable yield per plant was 51 per cent greater under the film with the highest transmission (control) compared with the lower light transmission films. Data was recorded on leaf growth, crop yield, crop quality and occurrence of tip burn. Recommended RH levels during growth and harvesting are 65-70 per cent during the day and 75-80 per cent during the night. Strawberry plants cv. Commander were grown with different polyethylene bed mulches in 2000 and 2001 to determine the effects on plant growth and yield and it was noticed that plants on clear full bed (CFB) mulch had greater growth than those on clear center- strip mulch (CS) or yellow-on- black full-bed mulch with no effect of mulch on yield or fruit weight (Larson et al., 2006). Pires et al. (2006) reported that the plants of strawberry cv. Campinas grown under
protection with clear plastic mulch favoured increased vegetative growth evaluated through plant height, leaf area, fruit yield than the plants under the black mulch. Jennings and Brennan (2008) stated that polytunnels is a key element in production, improving yield, quality and extending the season from the traditional six weeks to more than six months.

Caracciolo et al. (2009) planted four cultivars of strawberry plants viz. Camarosa, Candonga, Tudla, Naiad and a selection, MT 99.163.22 (MT 91.143.5 X Chandler) on Sept 25 and Oct 10 and stated that early season and total yield were greatest for plug plants established in late Sept as plants were able to achieve adequate growth before the cold winter season. Studies were conducted by Singh et al. (2009) to standardize the package of practices of strawberry cultivation with modern techniques under northern Indian plains and it was found that the use of plastic tunnels during night enhances fruiting and flowering by two weeks and fruit yield by 27 per cent. Population of 90,000 to 1,00,000 plants/ha has proved to be optimum for harvesting fruit yield of 18-20 t/ha in north Indian plains. A trial with cvs. Chandler and Camarosa planted on black polyethylene covered beds under walk-in tunnels was conducted in the 2004-2005 nursery season using drip irrigation. Daughter plants of both Chandler and Camarosa were sent to fruiting fields in Famailla and Bell Vista on April 1, these were classified by crown diameter ($\geq$ 10 mm and $\leq$ 10 mm). Yields ranged from 527 to 865 g per plant. Four types of stolons per mother plant were detected according to their chronological order of appearance: I, II, III and IV. The quantity of each stolon type per mother plant was 1.97 (I), 2.68 (II), 3.89 (III) and 3.13 (IV). The number of daughter plants per each stolon type was 6.8 (I), 4.6 (II), 2.2 (III) and 1.0 (IV). This was considered a very promising research line for getting transplants with high early fruit production potential for sub-tropical regions of South America (Miserendino et al., 2009).

### 2.3 Effect of Gibberellic acid

Growth regulators play an important role in the physiological functions of plants. The gibberellins help in increasing the elongation of stems and leaves in higher plants. They also affect flowering, germination of seeds and breaking of dormancy / rest period. The literature on the effect of GA$_3$ on fruit crops is reviewed under relevant headings.

#### 2.3.1 Runner production

Verzilov and Mikhteleva (1963) studied the effect of GA$_3$ on growth and productivity of
five cultivars of ever bearing strawberries and reported that of the five cultivars, two cultivars showed an increased growth and runner production in both the crops with 50-75 ppm of GA$_3$ application. Exogenous application of gibberellins has been reported to promote runner production in different strawberry cultivars (Moore and Scott, 1965; Blat and Crouse, 1970; Kender et al., 1971). Zuluoaga et al. (1967) in Mexico obtained 2-4 runners per plant in cv. Florida 90 with GA$_3$ 75-100 ppm. Lee (1971) recorded improved runner production in strawberry with GA$_3$ 50 ppm application. Bruce (1974) reported that application of GA$_3$ 50 ppm in strawberry cv. Olympus after 10 to 30 days of planting significantly increased the number of runners/plant.

Schimmelpfeng (1971) conducted studies on the possibilities of using GA$_3$ to increase and accelerate the production of strawberry runners and reported that cultivar Senga Sengana produced more runners with autumn application of GA$_3$ at 50-75 ppm and again with spring application of GA$_3$ 100 ppm. Singh (1979) stated that GA$_3$ 100 ppm produced significantly more number of runners in strawberry cv. Cavalier while GA$_3$ 50 ppm produced the lesser number in cv. Jeolikota respectively. Noto (1980) observed that the application of GA$_3$ 20 ppm in strawberry cv. Senuoi increased the runner production with the increase in the number of plantlets runner$^{-1}$. Zatyko et al. (1980) reported that strawberry cvs. Gorella and Hakras Romata produced more runners with AgNo$_3$+GA$_3$ treatment, GA$_3$ alone stimulated only shoot elongation in both the cultivars.

Singh and Phogat (1983) stated that GA$_3$ (25, 50, 75 ppm) sprayed on strawberry cv. Majestic before flowering, significantly increased the runner production, during both the experimentation years the maximum increase was noticed with the GA$_3$ 25 ppm application. Reid (1983) observed an inconsistent increase in runner production with the help of gibberellins. Choma and Himerlick (1984) observed that application of GA$_3$ 50 ppm produced significantly more runners in day neutral and everbearing strawberry plants. Research on the influence of growth regulators on the growth of strawberry revealed that GA$_3$ promotes runner development and inactive auxillary buds responded to GA$_3$ for runner formation (Chome et al., 1984; Braun et al., 1985). Kahangi et al. (1992) observed that chilling in combination with GA$_3$ 50 ppm produced significantly more runners per plant in strawberry cvs. Nyoho, Meriaka-16 and Hokouase.
Pankov (1992) found that application of GA$_3$ (0.008 per cent) applied in the first week of September in strawberry cvs. Yasna and Senga Sengana registered 22 per cent increase in number of runners/plant. Dale et al. (1996) studied the performance of Selva cultivar of strawberry and observed that foliar application of GA$_3$ increased runner production under greenhouse conditions. Pipattanawong et al. (1996) reported that application of GA$_3$ 50 ppm resulted in a 2 to 3 fold increase in the number of runners in Miyoshi whereas GA$_3$ or GA$_3$ + BA led to an increase up to 4 to 8 times in Enrai and Summer Berry day neutral strawberries. Sangwook et al. (1996) found that cold storage of plants for 600-800 hour +GA$_3$ treatment promoted the development of runners in strawberry cv. Sambheri.

Turemis and Kaska (1997) investigated that when GA$_3$ at 30 or 50 ppm was applied to strawberry cvs. Cruz, Vista, Tufts, Pochontas and Aliso after 30 or 60 days of planting maximum increase in the number of runners per m$^2$ and stem diameter was obtained with GA$_3$ 100 ppm, the runner production in cv. Cruz, which is usually low, was greatly improved by the same GA$_3$ treatment. Pocahontas also responded well to the GA$_3$ treatments.

Duarate and Hermosa (1998) sprayed strawberry cv. Chandler with 50 ppm GA$_3$ two months after planting, some of the plants were sprayed once while the others sprayed for second time after 15 days with the same concentration of GA, in both, half of the plants had their floral buds removed as soon as they appeared and the other half were left intact. Evaluation was made after 2 months and it was observed that the treatment comprising of two GA$_3$ sprays plus bud removal registered the best results with 9.3 crown shoots and 10.2 runners per plant respectively. It was followed by the treatment combination of one application with bud removal and then by the other spray without flower bud removal while the control plant produced only 4.2 crown shoots and no runners. Exogenous application of gibberellins has been reported to promote runner production in different strawberry cultivars (Asrey et al., 2003, Khokhar et al., 2004). According to Archbold (2009) application of 100 ppm GA$_3$ at first bloom increased runner production in strawberry cv. Honeoye.

2.3.2 Growth Characters

Improvement in the vegetative growth of strawberry plants was reported with the spray of GA$_3$ 75 ppm by Leshem and Koller (1966). Singh and Kaul (1967) studied the effect of GA$_3$ in
Nov and Jan on the growth of strawberry plants and reported that height and spread of plants, leaf area and petiole length were mainly increased by increased length of parenchyma cells. Celestre (1970) studied the effect of GA$_3$ on the vegetative growth of strawberry plants and found that application of GA$_3$ at 20 ppm in Oct did not effect vegetative growth but when applied in Jan, it stimulated the growth. Celestre and Pierandrei (1971) showed an improvement in the vegetative growth with GA$_3$ 20 ppm on three strawberry cvs. surprise des Halles, Gorella and Pocahontas.

Solovei (1972) conducted studies on the effect of GA$_3$ on the development of vegetative organs in the strawberry and obtained increased number of leaves with GA$_3$ 25–50 ppm. The studies of Agafonov and Solovei (1975) on the effect of growth regulators on growth and productivity of strawberry revealed an increased internodal length, petiole length and leaf area with GA$_3$ application. Tafazali and Shaybany (1978) found that Gem strawberry plants treated with GA$_3$ 50 or 100 pm resulted in maximum vegetative growth as compared to ethephon (50 or 100 ppm) treated plants. Singh and Phogat (1983) recorded higher number of runners and green leaves with GA$_3$ 25-50 ppm whereas, GA$_3$ 75 ppm had no effect on runner production in strawberry cv. Majestic. Maximum leaf area in Senga Sengana cultivar was obtained with GA$_3$ 50 ppm (Dwivedi, 1987).

Wang (1989) observed that growth of plants was increased with GA$_3$ 100 ppm concentration. Anwar et al. (1990) noted maximum plant height and leaf number/plant with the application of GA$_3$ 100 ppm in strawberry cv. Muree. Fouad et al. (1990) reported that GA$_3$ produced more vigorous plants than control. Miranda et al. (1990) recorded that there is no significant difference in plant morphology characteristics as a result of different growth regulator treatments (GA$_3$, NAA, Ergostin or Atenix) except in the case of GA$_3$ where more vertical growth was noted in cv. Sequeia. The plant height (31.0 cm), number of leaves per 20 plant (39.7) and number of suckers per 20 plants (98.7) were the highest with GA$_3$ 100 ppm application in cv. Muree of strawberry (Mohammad et al., 1990).

Tehranifer et al. (1997) stated that foliar spray of GA$_3$ (0, 50, 150 and 450 ppm) to strawberry plants resulted in increased vegetative growth. The effect of GA$_3$ (25, 50, 100 ppm) in cvs. Senga Sengana and Missionary resulted in maximum increase in leaf number and area (Dwivedi et al., 1999). It has been reported that application of GA$_3$ was effective in increasing
photosynthetic rate and stomatal conductance in strawberry plants (Du-Yao, 2000). Maximum plant height, leaf number and total biomass production in strawberry cv. Chandler was obtained with the application of GA$_3$ 100 ppm (Rana, 2001). The effect of GA$_3$ (0, 50, 200 ppm) was studied on strawberry cvs. Camarosa, Laguna and Sea Scape and it was found that GA$_3$ application increased petiole length and leaf area of the plants in most of treatments (Paroussi et al., 2002). Improvement in the vegetative growth of strawberry plants was reported with the spray of GA$_3$ 75 ppm (Khokhar et al., 2004).

Studies were conducted by Sharma and Singh (2009) with the aim to observe the effect of GA$_3$ on strawberry, GA$_3$ (75 ppm) was applied to the plants either during mid-Nov (at fruit bud differentiation), or mid-Feb (initiation of flowering) or at both times. In all following treatment combinations were tried: (1) water spray only (2) GA$_3$ (75 ppm) during Nov, (3) GA$_3$ (75 ppm) during Feb, (4) GA$_3$ (75 ppm) both during Nov and Feb. Fruits under control were sprayed with tap water only. Results indicated that GA$_3$ (75 ppm) spray either during November or February or both has increased the leaf petiole, leaf area and leaf number significantly. Camacaro et al. (2009) evaluated the effect of application of exogenous gibberellic acid on the vegetative growth of strawberry cv. Chandler and stated that the highest leaf number and crown number were obtained in plants treated wit 20 mg/l$^{-1}$ of gibberellic acid throughout the period of evaluation.

### 2.3.4 Flowering and fruit set

Leshem and Koller (1966) conducted studies on the role of GA$_3$ in strawberry and reported that exogenous gibberellin application hastened fruiting by anticipating the endogenous gibberellin which is normally formed at a somewhat later stage of plant development. Soczek (1966) studied the effect of GA$_3$ on flowering, fruiting and growth of strawberry and found that GA$_3$ application in glasshouse advanced flowering. The studies of Singh and Kaul (1967) on the effect of GA$_3$ on growth and fruiting of strawberry revealed delayed flowering with the application of GA$_3$. Turner and Lagaude (1970) conducted field experiments in various Mediterranean climates with different levels of GA$_3$ application on strawberries and reported improvement and earliness in flowering in all the cvs. i.e. Pocahontas, Gorella and Henanni Grande.

Pathak and Singh (1971) conducted investigations with Pusa Early Dwarf and Katrain
Sweet cultivars of strawberry on the effect of GA$_3$, growth retardants and cloching and found hastened flowering by 7-17 days in both the cultivars. Celestre and Pierandrei (1972) reported hastened flowering with which they noted advancement in ripening of cv. Pocahontas with GA$_3$. Honda et al. (1972) reported that the application of GA$_3$, a month before the appearance of flower buds, hastened the flowering in strawberry, whereas, GA$_3$ applied at flower opening hastened fruit maturation. Tavadze and Mazanashivili (1972) observed enhanced flowering in the early stages of development in GA$_3$ sprayed plants of strawberry.

Mikhteleva (1975) observed that GA$_3$ 50 ppm applied twice in spring increased the number of inflorescence, stimulated branching and fruit formation. Kalie et al. (1980) concluded that GA$_3$ 100 ppm stimulated flower production in the plants of strawberry cv. Beggale. It was observed that application of GA$_3$ 25 or 50 ppm in strawberry induced earliness in flowering without affecting fruit size and yield (Moroto et al., 1983).

Lopez et al. (1989) recorded advanced flowering with the application of GA$_3$ 28 or 80 ppm as compared to control in Pajaro and Douglas cultivars of strawberry. Tehranifar et al. (1997) stated the least flower and fruit abnormalities and the highest fruit set with GA$_3$ (50 ppm) in strawberry cv. Chandler. The foliar application of GA$_3$ (30 or 60 mg) applied three months after planting improved weight, size and colour of the fruits in strawberry cv. Chandler (Montero et al., 1998). The effect of GA$_3$ was evaluated on flowering of strawberry cvs. Oso Grande and Seascape at Brazil and it was concluded that GA$_3$ at 40 mg/l$^{-1}$ in two applications (45 and 65 days after transplanting date) presented better results in cv. Seascape than cv. Oso Grande (Filho et al., 2004). Studies were conducted by Sharma and Singh (2009) with the aim to observe the effect of GA$_3$ on strawberry, GA$_3$ (75 ppm) was applied to the plants either during mid-Nov (at fruit bud differentiation), or mid-Feb (initiation of flowering) or at both times. In all following treatment combinations were tried: (1) water spray only (2) GA$_3$ (75 ppm) during Nov, (3) GA$_3$ (75 ppm) during Feb, (4) GA$_3$ (75 ppm) both during Nov and Feb. Fruits under control were sprayed with tap water only. Results indicated that GA$_3$ (75 ppm) spray either during Nov or Feb or both has decreased the fruit size and increased the fruit number but there was no remarkable effect on quality parameters.

The research work carried out by Shabasi et al. (2009) indicated that GA$_3$ 10 ppm increased the number of flowers and total yield in all the strawberry plants. Perez de Camacaro et
al. (2009) evaluated the effect of application of exogenous gibberellic acid on the flowering of strawberry cv. Chandler and stated that the largest number of inflorescences and flowers were obtained in plants treated with 20 mg/l of gibberellic acid throughout the period of evaluation.

2.3.4 Yield

Verzilov and Mikhteleva (1963) studied the effect of GA$_3$ on the growth and production of five cultivars of everbearing strawberries and reported that two cultivars showed increased growth and production in both the crops with GA$_3$ application at 50-75 ppm. Brightwel (1964) conducted studies on yield of Dixieland cultivar of strawberry in Georgia as influenced by date of setting plants and stated that strawberry runners planted in late Sept or early Oct gave highest yield than those planted later. Mikhteleva (1966) working on GA$_3$ and fruit productivity obtained an increase in the yield with GA$_3$ 50 ppm when applied 2-3 times at 5-7 days interval after the formation of flower-buds. Turner and Lagaude (1970) conducted field experiments on strawberries in various Mediterranean climates with different levels of GA$_3$ and obtained increased yields. Castro et al. (1976) reported that GA$_3$ at 10 ppm concentration increased fruit yield but GA$_3$ at 50 ppm showed marked decrease in yield of strawberry fruits.

Stoyanov and Velchev (1977) sprayed GA$_3$ at the rate of 25 and 50 ppm with K salt solution as pre treatment on strawberry plants. They recorded increase in fruit weight and yield as compared to unsprayed plants. Fonda et al. (1979) conducted trial on Fresno cv. of strawberry with GA$_3$ (50 and 100 ppm) applied once or twice (Dec 15 alone or Dec 15 and repeated on Jan 15) and observed that GA$_3$ treatment decreased total yield. Zakharova (1979) reported an increase of 30 per cent in fruit yield following the foliar sprays of GA$_3$ as compared to control. Kalie et al. (1980) found that GA$_3$ 100 ppm concentration resulted in heavier fruiting in the strawberry plants. Lucchesi and Minami (1980) observed that GA$_3$ (30 ppm) give the higher yield (26.5 t/ha) when sprayed three times at weekly intervals after three weeks of planting on strawberry cvs. Compinas and Monte Algera. Singh and Phogat (1983) observed that among various concentrations of GA$_3$ 75 ppm was the most effective in increasing strawberry fruit yield to the extent of 43.3 to 55.5 q/ha. A single application of GA$_3$ 40 ppm to the plants growing in plastic tunnels, significantly increased early yields of Pajaro strawberry fruits during first month of harvesting without affecting total yield or fruit size (Marota et al., 1986). Lopez et al. (1989)
concluded that neither yield nor fruit size was affected by winter applied GA₃ at 20-80 ppm in cvs. Pajaro and Douglas growing under low tunnels. Anwar et al. (1990) noted the maximum yield with GA₃ 100 ppm in strawberry cv. Muree. Mirinda et al. (1990) observed the effect of growth regulators on morphological characteristics and productivity of strawberry cv. Sequeia and found that no appreciable effects were noted on fruit length, diameter and yield following the application of GA₃, NAA and Ergostin at the rate of 10 ppm each. Mohammad et al. (1990) reported that the longest productivity period (21 days) highest weight (6.7 gm) per fruit and total yield (242.7 gm/plant) when sprayed with 50 ppm GA₃.

Sharma and Singh (1990) applied GA₃ 75 ppm as foliar spray on plastic covered strawberry and found higher yield in cv. Pusa Early Dwarf than control. Pankov (1992) reported that GA₃ had no effect on fruit yield in cvs. Yasna and Senga Sengana. In the trials carried out on strawberry cv. Australia, the plants were sprayed with 25, 50 or 75 ppm GA₃ at 35 and 51 days after planting. Average yields ranged from 34.3 gm/plant with 50 ppm to 103 gm plant⁻¹ with 25 ppm GA₃ application (Bhautkar, 1994). Camargo et al. (1995) noted that GA₃ treatments resulted in maximum yield with a consequent increase in the production of carbohydrates. Dale et al. (1996) concluded from a field experiment that daughter plants derived from plants sprayed with growth regulators (GA₃ or BA) showed an increase in yield up to 10 per cent over daughter plants which were derived from unsprayed ones.

Rana (2001) recorded maximum number of fruits and fruit yield in strawberry cv. Chandler with the application of GA₃ 100 ppm. Ozguven (2002) also found an increased yield of strawberry cv. Camarosa with the application of GA₃ (5, 10, or 20 ppm) before flowering. Paroussi et al. (2002) investigated the effect of GA₃ on the yield of three strawberry cvs. Camarosa, Laguna and Seascape under unheated greenhouse conditions. The plants were sprayed once with GA₃ (0, 50, 200 mg l⁻¹) and it was found that lower concentration (50 mg l⁻¹) of GA₃ did not affect the total marketable yield, whereas 200 mg l⁻¹ increased the percentage of aborted flowers plus malformed fruits, resulting in decreased total marketable yield.
2.3.5 Fruit quality

The strawberry is generally considered as non-climacteric fruit and hence does not show an appreciable increase in synthesis of ethylene during ripening. Thus the growth regulators are considered imminent as they influence the ripening and maturity indices of the fruits. The quality of fruits constituted the fruit length, width, weight, TSS, acidity, TSS /acid ratio, total sugars, reducing sugars, non reducing sugars and ascorbic acid during the research investigations.

The application of GA$_3$ 75 ppm alone or in combination with Urea did not show any effect on the total soluble solids however, improvement in fruit acidity and vitamin C was noted, but decrease in fruit volume, weight and size at peak harvesting periods was recorded (Singh and Kaul, 1967). Likewise, fruit quality parameters were also enhanced with the spray of GA$_3$ (Tavadze and Mazanashvilli, 1972). Mikhteleva and Petrovska (1974) reported that Komosimolka and Krasavitsa strawberry cultivars sprayed with GA$_3$ 50 ppm in spring, had higher levels of reducing sugars, amino acids and ascorbic acid and low contents of starch and fats. Pathak and Singh (1976) conducted studies on the effect of GA$_3$ and photoperiod on yield and fruit quality and recorded a significant reduction in berry length and breadth under GA$_3$ treatment in Pusa Early Dwarf strawberry. Singh and Singh (1978) recorded decrease in fruit size and increase in the fruit TSS and acid content with GA$_3$ 75 ppm.

Singh and Phogat (1983) found that GA$_3$ (25, 50 and 75 ppm) significantly increased the fruit weight in cv. Majestic and maximum weight was recorded in GA$_3$ 75 ppm treatment, it did not effect the TSS of the fruits but total sugars were higher when plants were treated with GA$_3$ (50 and 75 ppm) and fruit acidity was also increased with GA$_3$. Mohammad et al. (1990) reported longest productivity period (21 days) and registered the highest fruit weight (6.7 gm) in strawberry fruits when sprayed with GA$_3$ 50 ppm. Mirinda et al. (1990) observed the effect of growth regulators on morphological characteristics and productivity of strawberry cv. Sequia and found no appreciable effects on fruit length and diameter following the application of GA$_3$, NAA and Ergostin at the rate of 10 ppm each. Ozguven and Kaska (1990) observed variation with the action of GA$_3$ when sprayed on Aliso, Pocahontas and Tioga cultivars of strawberry at the end of Nov, Jan or April. All the treatments enhanced the quality (TSS) of fruits over control. Bhautkar (1994) conducted a field experiment on strawberry cv. Australia and found that plants when sprayed with varied concentrations of GA$_3$, ascorbic acid or NAA at 35 and 51 days after
planting significantly increased the TSS level of the fruits. Camargo et al. (1995) harvested the crops 33 times between July 14 and Nov 4 and recorded the number and weight of the fruits and found that treatment of GA$_3$ increased the number and weight of fruits in the 4th and 5th harvests and they also observed a consequent increase in the production of carbohydrates.

Kumar et al. (1996) sprayed GA$_3$ (50, 25,12.5 ppm) on strawberry cv. Tioga and reported that GA$_3$ 12.5 ppm resulted in the highest fruit length, breadth and weight followed by GA$_3$ 50 ppm and GA$_3$ 25 ppm respectively. Martinez et al. (1996) observed a significant delay in colour development of strawberry cv. Selva fruits when treated with GA$_3$. Three applications of GA$_3$ (12.5, 25 and 50 ppm) on Aliso, Pocahontas and Tioga strawberries in Nov, Jan and April evidently enhanced total soluble solids of fruits (Ozdemir and Kaska, 1997). Montero et al. (1998) reported that the foliar application of GA$_3$ (30 or 60 mg /l ) to strawberry cv. Chandler improved colour, weight and size of the fruits. Ozguven (2000) stated that higher fruit weight, TSS and acidity was recorded with the foliar application of GA$_3$ 200 ppm in strawberry cv. Camarosa. Rana (2001) obtained maximum TSS and total sugar content in the fruits with the application of GA$_3$ 100 ppm in strawberry cv. Chandler. Ozguven et al. (2002) evaluated the effectiveness of GA$_3$ (0, 5, 10 and 20 ppm) when applied exogenously during the 2nd and 4th week in Jan on the plants of Camarosa. Tests confirmed the efficiency of the experimental treatments to cause early flowering and improved fruit quality while the fruit soluble solids and acidity was not diminished. From this study, it was concluded that GA$_3$ 10 ppm was the best treatment.

2.4 Varietal Performance

Generally, none of single cultivar of strawberry has been reported to grown worldwide or even nationwide, its two main types are recognized based on environment factors i.e. short day which require photoperiods under 14 hr and temperatures under 60°F for floral initiation, ever bearing which fruit throughout the growing season provided temperature limits should not exceed, in its further division long day in which lengthening days promote more or less continuous flowering throughout the summer, provided the temperatures does not exceed ; day neutral where photoperiods has no effect on flowering. Strawberries are perennial, stoloniferous herbs, means they spread via stolons or runners, which produce daughter plants at every other node.
Its flowers are white, borne on dichasial cyme, the centre most terminal flower opens first and is largest, producing the largest fruit where as subordinate flowers are smaller, have fewer pistils and produce smaller fruits, most of its cultivars are self fruitful therefore do not need cross pollination for fruit set. It is an accessory fruit, since the edible portion is non ovarian in origin, it is largely swollen receptacle tissue. The true fruits that contain the seeds of strawberry are achenes, these are numerous tiny, ellipsoid specks that cover the fruit surface. Areas on the fruit surface devoid of functional achenes do not grow causing irregularly shaped fruits, ultimate fruit size and shapes are heavily dependent on achene set and pollination (Rieger, 2006). Recent increase in strawberry production of the world is largely due to the availability of objective specific cultivars (Sharma and Yamdagni, 2000).

Kays (1960) made studies on performance of some strawberry cultivars in Oklahoma and reported that. Blackmore was the most desirable cultivar due to the excellent quality of the berries for fresh market. Lover (1969) compared the performance of nine strawberry cvs. and found the cvs. Klaradyn, Cambridge, Rearguard and Festival (at Henderson Research Station, Mozeae) as the high yielding cultivars. Sistrunk and Moore (1971) while studying strawberry quality reported that fruits of cvs. Earlibelle, Md U.S. 34131, Ark 5018 and Md U.S. 2713 were of bright intense red in colour with better quality while those of Blackmore and Sunrise were paler in colour and with poor quality fruits. Phogat et al. (1972) tried some cvs. of strawberry at Jeolikote in district Nainital (U.P.) and obtained more TSS, vitamin C in cv. Cavalier than those of tested cvs. Albritton, Premier, Red coat, Hybrid-2, Local Jeolikote and Rearguard. Janick and Hayden (1973) carried out studies on strawberry cultivars and reported that the cvs. Apollo, Atlas, Guardian and Red Chief were the best suited under Indian conditions. Athwal (1976) studied the performance of strawberry under Punjab conditions and reported that cvs. J.F.2, Katrain Sweet, Benglora and Stek Master showed flowering by the end of January while cvs. C.L.40, Elista, Senga Sengana and Pusa Early Dwarf produced flowers in the first week of February. Performance of strawberry under Allahabad conditions was studied by Sharma et al. (1977) who reported that cv. Albritton did not produce any flower but cv. Chauhatia-40 produced the flowers under the same agro- climatic conditions but did not set fruits.

Sharma et al. (1980) conducted experiment on performance of some strawberry cvs. in mid hill region of north India and reported that cv. Tioga produced the best quality fruits.
Bocktaela et al. (1980) carried out a varietal trial on strawberry and obtained the highest yield from cvs. Redgauntlet, Olympia and Prins Karel but highest yield/plant was obtained from cvs. Olympia, Gorrela and Redgauntlet. Mason and Rath (1980) studied some yield components in East of Scotland strawberry plantation and reported that yield of fruit/ha was found positively correlated with the number of crowns/ha, berry weight and weight of fruits were negatively correlated with the number of emerged crowns. Sharma and Badiyala (1980) conducted experiment on the performance of some strawberry cvs. in the mid hill region of north India and obtained the highest yield in cv. Tioga followed by cv. Blackmore while the lowest yield was registered in cv. Senga Sengana. Shukla et al. (1980) studied the performance of strawberry in the hills of U.P. and indicated that cvs. Albritton, Robinson, Jem and Shasta were the most promising for commercial scale. Singh (1982) demonstrated that out of 14 cultivars of strawberry tried under Punjab conditions six cvs. Torrey, Blackmore, Katrain Sweet, Senga Sengana, Pusa Early Dwarf and Florida-90 have shown good performance with respect to plant survival, runner production and yield/plant parameters.

Badiyala and Joolka (1983) observed that quality in terms of size, TSS, acidity and TSS/acid ratio of strawberry fruits was better in cv. Tioga under the mid-hill zone of Himachal Pradesh. Beniwal et al. (1989) tried ten cultivars of strawberry namely Blackmore, Catskill, Elista, Fairfax, Florida-90, Howard-17, Robinson, Shesta, Tioga and Torrey. Data reveal that cv. Howard-17 exhibited highest per cent survival, Elista highest plant height, Blackmore maximum number of leaves, highest fruit set, fruit retention and Tioga maximum leaf area. The highest number of runners were observed in cvs. Elista, Fairfax, Tioga and Torrey. The cvs. Florida-90, Tioga, Shasta, Howard-17 and Blackmore seems to stand promising for general cultivation under Hisar conditions. According to Kaska et al. (1997) the growth and productivity of some new strawberry cvs. for Turkey were studied under walk in polytunnels at Adana, the experimental cvs. H-I (day neutral), Red Chief, Lester, Honeoye, Addie, Elsanta, Chandler, Selva (day neutral) and Tufts were used, the highest yield (83.64 g/plant) was obtained from H-1 and from the Frigo plants while cv. Chandler gave the highest yield (79.19 g/plant) and cv. Selva recorded the lowest yield, the cvs. H-1, Selva, Tufts and Elsanta appeared to be vigorous and Chandler, Addie, Red Chief, Lester and Honeoye were lesser vigorous in comparison to the others. Umesh (1998) evaluated 15 strawberry cultivars out of which cvs. Chandler and Selva
proved to be promising under mid hill conditions of H.P. in terms of fruit yield and quality. Sharma and Yamdagni (2000) who explained the characters of different strawberry cultivars mentioned that the fruit of cv. Chandler was of exceptionally high desert quality with outstanding colour, flavour and texture, the fruits of cv. Fern are large medium, conical and solid internally with firm flesh and excellent flavour and suitable for processing, the cv. Tioga has too short harvest season, and is deficient in fruit size particularly with the advancement in the season somewhat difficult to pick for the fresh market because the fruit tends to cap easily and comes off without calyx, it was considered suitable for processing but not for fresh market (Bringhurst and Voth, 1989).

Dinesh (2000) studied the performance of various strawberry cvs. and concluded that out of strawberry cvs. Belrubi, Torrey, Selva, Catskill, Gorella, Shasta, Blackmore cvs. Belrubi, Blackmore, Shasta, Tioga and Selva can be used as potential donors for strawberry improvement. Funaro (2000) evaluated 13 varieties of strawberry, cultivated in Calabria in the Lamezia region for the production of commercially suitable fruits with respect to fruit weight, length of the fruit and ripening period and results indicated that the fruit production of cvs. Camarosa, Carlsbad, Clea and Tudla was the best with an average yield around 700 – 800 g/plant whereas, Tudla and Camarosa emerged over the other cvs. for the production of high quality fruits in terms of shape, colour and flavour. Over all, Tudla and Camarosa were the most reliable cvs. both in open field and protected tunnel cultivation. Chadha (2001) reported that all the cultivated varieties of strawberry are octaploid, according to him number of cultivars have been evaluated from time to time, the fruits of cv. Chandler are of exceptionally high desert quality tolerant to viruses, large in size with firm skin and excellent flavour. Tioga is an early maturing cultivar. Its fruits are very large with good desert and processing qualities, the fruits of cv. Selva are large, conic to blocky in shape with good desert quality, Fern another day neutral cultivar, early ripening, over bearing with large to medium sized fruit, conical, solid, internally skin red, flesh red, excellent flavour suitable for fresh market.

Hassan et al. (2001) evaluated different strawberry cultivars under Haryana conditions and demonstrated that the fruits of cv. Chandler registered the maximum yield and TSS contents. According to Ilgin et al. (2002) the Frigo plants of day neutral cvs. of Selva, Seascape and Fern were planted in August 1999. The fruit size, TSS, ease of calyx removal, flesh colour and
firmness, fruit colour and flavour were determined. In the viability and germination tests, Selva has given the best results. Sharma et al. (2002) found Gorella, Chandler and Belrubi to be high yielding out of 8 strawberry cvs. viz. Addi, Belrubi, Brighton, Chandler, Confitura, Fern, Gorella and Selva tested under R.S. Pura conditions of Jammu district.

The yield performance of anther-cultured strains of strawberry cvs Capitola, Chandler and Camarosa was determined in a field experiment. Anther culture derived plants from cv. Camarosa recorded higher yield, TSS, total acidity, TSS:acid ratio and ascorbic acid content (Okasha, 2003). According to Sharma and Sharma (2004) cv. Chandler was chosen as the highly acceptable present day cultivar of northern plains of India, its fruits have exceptionally high desert quality with outstanding colour, flavour and texture, the cv. Fern bears large conical shaped fruits with firm pulp and excellent flavour, the cv. Selva performed well under the conditions of north Indian plains and considered a ray of hope for the growers, the cv. Tioga is a short harvest season variety and its fruit size decreases with advancement of season.

Bhatt et al. (2005) cultivated six strawberry cvs. Gorella, Belrubi, Blackmore, Chandler, Shasta and Katrain Sweet under sub-tropical conditions of Jammu region out of which Gorella found to be the most promising cultivar followed by Belrubi and Chandler for commercial cultivation. Singh and Asrey (2006) conducted a field experiment to study the performance of strawberry cvs. Chandler, Gorella and Fern, the cv. Chandler was found to be the best with maximum TSS (8.43 %), ascorbic acid (48.8 mg /100 ml) and highest yield (21.3 t/ha), whereas cv. Gorella recorded maximum early yield (44.1g/ plant), the fruit quality was the best in all the cultivars in March because the acidity was the highest (1.29 %) in Feb and in April ascorbic acid content was lowest (38.2 mg/100 ml). Out of strawberry cvs. Fern, Tioga, Chandler and Sea Scape Chandler performed the best in terms of fruit yield and quality under Lucknow conditions (Ram et al., 2008). Strawberry cvs. Honeoye and Elsanta were grown for early and late harvest and a significant variation in vitamin C was observed. Plant type and growing time did not influence the content of vitamin C. Analysis of variance showed significant differences in dry matter content of fruit only between the cultivars. Sharma and Thakur (2008) evaluated 15 strawberry cvs. for yield, fruit and quality characters, the results revealed that cv. Chandler exhibited maximum fruit length (3.49 cm), breadth (3.14 cm), berry weight (9.62 g), yield per plot (1.18 g) and total sugars (6.81 %). Pajaro exhibited higher TSS (12.17 B) and TSS/ acid
ratio (14.02\(^0\) B). Acidity was found highest in Catskill while sugar/acid ratio was found highest in Selva, in mid hills of Himachal Pradesh Chandler and Selva stand promising in respect to yield and fruit quality. Fruit and plant characters of strawberry cultivars were studied at Shimla, the fruits of cv. Chandler were of conical shape with 16.01 g fruit weight, 36.11 x 28.87 mm in size, 8.01\(^0\) brix TSS and 240.30 g yield/plant, the fruits of cv. Fern also of conical shape with 9.08 g fruit weight, 29.52 x 21.85 mm size, 9.50\(^0\) brix TSS and 154.98 g yield/plant, the fruits of cv. Blackmore of flattened round shape, 5.05 g fruit weight, 24.44 x 17.30 mm size, 11.02\(^0\) brix, TSS and 91.05 g yield/plant, the fruits of cv. Selva were of conical shape with 18.51 g fruit weight, 38.45 x 26.85 mm size, 8.50\(^0\) brix TSS, 186.48 g yield/plant. The fruits of cv. Tioga were of conical shape with 4.02 g fruit weight, 21.21 x 16.97 mm size, 10.50\(^0\) brix TSS, 72.88 g yield per plant (Anon, 2008).