Planting time and mulching influenced vegetative and reproductive traits in strawberry (*Fragaria* × *ananassa* Duch.) in India

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Abstract — **Introduction**. Planting time is considered as one of the most important factors for successful strawberry cultivation. Traditionally, under north-Indian plains, strawberry is planted after the second week of October, which results in the availability of fruits for a month or so. With the use of plasticulture techniques, the planting time can be enhanced, which facilitates early and higher production, and enhances availability of the fruit for a longer period. Mulching is the most important cultural practice in strawberry, which influences plant growth, fruit yield and quality. Hence, studies were conducted to determine the influence of planting time and mulching on growth, flowering and fruiting behaviour, yield and quality of strawberry in northern plains of India. **Materials and methods**. Studies were conducted on 'Chandler' strawberry with three planting times (mid-September, mid-October and mid-November) as the main effect and three mulching materials (black polyethylene, clear polyethylene and paddy straw) as the sub-main effect in a split-plot design with three replications. Standard procedures were adopted for making observations on plant growth parameters, flowering and fruiting behaviour, yield and quality parameters under different treatment combinations. **Results and discussion**. Mid-September planting favoured vigorous growth, enhanced flowering and fruiting, which resulted in the production of the largest fruits and highest yield of the best quality. Among the three different mulch materials, plants mulched with black polyethylene had the best growth, fruit weight, yield and quality compared with those mulched with clear polyethylene or paddy straw mulch. The [planting time × mulching] interaction was also found to be significant for all measured parameters. **Conclusion**. Our study revealed that, in northern plains of India, to get an early and high yield of the best quality under a micro-irrigation system, Chandler strawberry could be planted in mid-September if mulched with black polyethylene.

India / *Fragaria ananassa* / mulches / straw mulches / polyethylene / planting date / growth / yield increases / fruits / quality

La date de plantation et le paillage influencent certains caractères végétatifs et reproductifs du fraisier (*Fragaria* × *ananassa* Duch.) en Inde.

Résumé — **Introduction**. La date de plantation est considérée comme l'un des facteurs les plus importants pour réussir une culture de fraisiers. Traditionnellement, dans les plaines du nord de l'Inde, le fraisier est planté après la deuxième semaine d'octobre, ce qui permet de disposer des fruits pendant environ un mois. En utilisant des techniques de plasticulture, l'époque de plantation peut être élargie, ce qui induit une production précoce et améliorée, et augmente la disponibilité du fruit pendant une plus grande période. Pour le fraisier, le paillage est la pratique culturale la plus importante ; il influence la croissance des plantes, le rendement et la qualité du fruit. Des études ont donc été entreprises pour déterminer l'influence de la date de plantation et du paillage sur la croissance, la floraison et la fructification, ainsi que sur le rendement et la qualité de la fraise en plaines du nord de l'Inde. **Matériel et méthodes**. Des études ont été entreprises avec le fraisier 'Chandler' planté à trois dates différentes (mi-septembre, mi-octobre et mi-novembre) comme effet principal et sur trois type de paillage (polyéthylène noir, polyéthylène clair et paille de riz) en tant qu'effet secondaire dans un dispositif expérimental de split plot avec trois réplications. Des procédures standard ont été adoptées pour mesurer les paramètres de croissance des plantes, leurs comportements de floraison et de fructification, ainsi que certains paramètres de rendement et de qualité en fonction des différentes combinaisons de traitements. **Résultats et discussion**. La plantation de la mi-septembre a favorisé une croissance vigoureuse ; elle a augmenté la floraison et la fructification, ce qui a conduit aux fruits les plus gros et aux rendements les plus élevés avec des fraises de meilleure qualité. Parmi les trois types de paillages, les plants sur polyéthylène noir ont présenté la meilleure croissance et les meilleurs poids de fruits, rendement et qualité comparés à ceux cultivés sur polyéthylène clair ou sur paille de riz. L'interaction [date de plantation × type de paillage] a été significative pour tous les paramètres mesurés. **Conclusion**. Notre étude a indiqué que, en plaines du nord de l'Inde, sous un système de micro-irrigation, le fraisier Chandler pouvait être planté à la mi-septembre pour peu qu'il soit paillé avec du polyéthylène noir, apte à induire un rendement précoce et élevé et à produire des fruits de très bonne qualité.

Inde / *Fragaria ananassa* / mulch / paillis / polyéthylène / date de plantation / croissance / augmentation de rendement / fruits / qualité

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1. Introduction

Strawberry (*Fragaria* × *ananassa* Duch.) is one of the most fascinating fruits in the world, which is a rich source of vitamins and minerals and has a fabulous flavour and tantalising aroma. Although it is a major fruit of temperate regions, with the advent of day-neutral cultivars, it grows profitably well in tropical and sub-tropical regions. In India, it was introduced in the early sixties but all efforts made to popularise it had setbacks, for several reasons [1]. However, in recent years, several day-neutral varieties have been introduced and agro-techniques have been standardised at various research stations. Hence, stawberry has now become the most favoured fruit crop among the growers, especially near towns and cities because of its remunerative prices and higher profitability, which has resulted in a phenomenal increase in its area and production [1].

Planting time is considered as one of the most important factors for successful cultivation of strawberry. Several reports in the literature indicate that strawberry can be planted at several times of the year, depending on variety, location and climate [2]. However, under north-Indian conditions, it is usually planted in the second fortnight of October with the traditional method. As a result, availability of fruit is restricted to one and a half months only, which reduces the profit of farmers considerably. In contrast, farmers of many advanced countries are taking huge yields and making profits by early planting and enhancing the availability of fruit by staggered planting and with the use of plasticulture techniques [3, 4]. However, such agro-techniques have not yet been standardised under Indian conditions.

Furthermore, strawberry is a low surface creeping herb and, hence, mulching plays a very important role in soil moisture conservation, weed control and regulation of soil-hydrothermal regimes, besides keeping the delicate fruit neat and clean [4–7]. In addition, mulching also improves plant growth, berry weight, fruit yield and quality in strawberry [8–10]. For mulching, different materials such as black polyethylene, clear plastic, coloured plastics, hay, wheat straw, paddy straw, pine needles, etc. are used in different parts of the world, but black polyethylene is the most favoured [1, 3, 4]. Considering these facts, systematic studies were conducted in 'Chandler' strawberry, which is the most famous and widely cultivated variety of strawberry in different regions of India [11] to standardise the appropriate planting time and mulching material for early yield of better quality fruits, which would help the farmer to get the maximum possible and early return on his investment.

2. Materials and methods

The studies were conducted during 2000–2002 at the research farm of the Central Institute of Post-Harvest Engineering and Technology, Abohar (lat. 30° 09' N, long. 74° 13' E, 185.6 m above sea level), Punjab, India. The mean temperature during the experimental period (2 years) at the experimental site was (26.8, 24.4, 19.6, 14.6, 10.6, 15.1, 19.7 and 23.2) °C during September (15th onward), October, November, December, January, February, March and April (up to 14th April), respectively.

The experiment was laid out in a split-plot design, with three dates of planting as the main effect, and three mulching materials as the sub-main effect, with three replications. The soil of the experimental farm was sandy-loam, with a pH of 8.5, which was low in organic carbon (0.42%), medium in available phosphorus and high in potash. The soil was thoroughly ploughed and raised beds of 25-cm height and 1-m width were prepared, with a distance between them of 50 cm.

Healthy and disease-free runners of 'Chandler' strawberry were planted at a spacing of (25 × 25) cm on three dates, viz, mid-September, mid-October and mid-November. Irrigation was provided with a micro-sprinkler system during the early stage of plant establishment, which was replaced by a drip system after 20 days of planting. Two rows of laterals were spread in each plot with drippers (4 $L \cdot h^{-1}$) at a spacing of 50 cm. Mulching treatments consisted of black polyethylene film (50 µm), clear

Table I.
Effect of planting time and mulching on growth characters of Chandler strawberry in India.

Treatment	Crown height (cm)				Plant spread (cm)				Leaf area (cm^2)			
	Black polyethylene	Clear polyethylene	Paddy straw	Mean	Black polyethylene	Clear polyethylene	Paddy straw	Mean	Black polyethylene	Clear polyethylene	Paddy straw	Mean
Planting time												
Mid-September	11.2	10.9	9.7	10.6	24.1	21.3	19.4	21.6	87.9	81.2	79.8	82.9
Mid-October	10.7	9.6	9.1	9.8	22.0	19.1	18.2	19.8	79.3	72.1	69.6	73.7
Mid-November	8.9	8.1	7.7	8.2	19.4	16.2	16.8	17.5	71.6	65.4	67.3	68.1
Mean	10.3	9.5	8.8	9.5	21.8	18.9	18.1	19.6	79.6	72.9	72.2	74.9
Critical difference at $P \leq 0.05$												
Type of mulch		0.53				0.72				4.82		
Planting time		0.74				1.12				7.53		
Planting time × mulching		0.42				0.81				5.23		

polyethylene film (50 µm) and paddy (*Oryza sativa* L.) straw (10 cm thickness). Mulches were applied 1 month after planting the runners. Polyethylene mulches (black and clear) were spread manually in such a way that the plants came out of the films and the drip system remained below the polyethylene films. Each treatment combination consisted of 96 plants per plot with a size of (600 × 100) cm, replicated thrice. However, in each plot, 24 plants were selected randomly for making observations of different parameters. All necessary cultural practices and plant protection measures were followed uniformly for all the plots and treatments during the entire experimentation period.

Observations on crown height, plant spread and leaf area; days taken to flowering and fruiting; and fruit weight and yield per plant were recorded in 24 randomly selected plants from each treatment combination replicated thrice. Standard procedures were adopted for recording data on different quality parameters such as total soluble solids (TSS in %), titratable acidity (TA in %) and ascorbic acid (mg·100 g^{-1} fresh weight) [12].

For quality parameters, 25 randomly selected fruits were taken from each treatment combination, replicated thrice. As all parameters studied during both the years have the same trend and as yearly variations were not significant, hence 2 years' data of different parameters were pooled and analysed, following a split-plot design [13].

3. Results

3.1. Plant growth parameters

Plant growth parameters, such as crown height, plant spread and leaf area of Chandler strawberry were significantly influenced by planting time, mulching and their interaction (*table I*). Irrespective of mulching, crown height (10.6 cm), plant spread (21.6 cm) and leaf area (82.9 cm^2) of the plants were significantly higher in mid-September planting than plants of other plantings (mid-October and mid-November). Similarly, crown height (10.3 cm), plant spread (21.8 cm) and leaf area (79.6 cm^2) were significantly higher in plants mulched with black polyethylene than in those mulched either with clear polyethylene or paddy straw. However, no significant difference existed in all growth parameters when either clear polyethylene or paddy straw was used as mulch. Further, the interactive effect [planting time × mulching] showed that crown height (11.2 cm), plant spread

Table II.
Effect of planting time and mulching on flowering and fruiting behaviour of Chandler strawberry in India.

Treatment	Days taken to flowering				Days taken to fruiting			
	Black polyethylene	Clear polyethylene	Paddy straw	Mean	Black polyethylene	Clear polyethylene	Paddy straw	Mean
Planting time								
Mid-September	73.7	76.0	82.3	77.3	31.3	33.7	34.0	33.0
Mid-October	78.0	81.7	85.3	81.7	29.3	31.3	34.7	31.8
Mid-November	89.0	92.6	95.7	92.4	27.0	28.3	32.2	29.2
Mean	80.2	83.4	87.8	83.8	29.2	31.1	33.7	31.3
Critical difference at $P \leq 0.05$								
Type of mulch		5.71				1.16		
Planting time		7.26				1.81		
Planting time × mulching		6.23				1.43		

(24.1 cm) and leaf area (87.9 cm^2) were highest in plants of mid-September planting, when mulched with black polyethylene and lowest in plants of mid-November planting, when mulched with paddy straw (*table I*). All the measured growth parameters were progressively lower with successive plantings (mid-October or mid-November) and/or when either black/clear polyethylene or paddy straw was used as mulch.

3.2. Days to flowering and fruiting

Planting time, mulching and the [planting time × mulching] interaction had a significant influence on the flowering and fruiting behaviour of Chandler strawberry (*table II*).

Irrespective of mulching, plants took only 77.3 days to flower when planting was done in mid-September and as many as 92.4 days when planting was done in mid-November. Similarly, plants mulched with black polyethylene took less days to flower (80.2 days) than those mulched either with clear polyethylene (83.4 days) or paddy straw (87.8 days). Further, the interactive effect of [planting time × mulching] was much more significant as plants took only 73.7 days to flower, when planted in mid-September and mulched with black polyethylene, whereas those planted in mid-November and mulched with paddy straw took as long as 95.7 days (*table II*). In contrast, plants of mid-September planting took more days (33.0 days) for fruiting than those planted on later dates (mid-October or mid-November). However, plants mulched with black polyethylene fruited earlier (29.2 days) than those mulched either with clear polyethylene (31.1 days) or paddy straw (33.7 days). Further, the synergistic effect of [planting time × mulching] on fruiting was significant as plants took only 31.3 days to fruit when planted in mid-September and mulched with black polyethylene than those planted either in mid-October or mid-November and mulched either with black/clear polyethylene or paddy straw (*table II*).

3.3. Fruit weight and yield

Planting time, mulching and their interaction also significantly influenced fruit weight and yield of Chandler strawberry (*table III*). Irrespective of mulching, larger fruit (13.0 g) were harvested from plants of mid-September planting than from those planted either in mid-October (11.4 g) or mid-November (10.5 g). Plants of mid-September planting also produced significantly higher fruit yield (174.4 $g \cdot plant^{-1}$) compared with those of mid-October (149.3 $g \cdot plant^{-1}$) and of mid-November (133.9 $g \cdot plant^{-1}$) plantings. Irrespective of planting time, mulching also significantly influenced the fruit weight and

Table III.
Fruit weight and yield of Chandler strawberry as influenced by planting time and mulching in India.

Treatment	Fruit weight (g)				Fruit yield (g·plant^{-1})			
	Black polyethylene	Clear polyethylene	Paddy straw	Mean	Black polyethylene	Clear polyethylene	Paddy straw	Mean
Planting time								
Mid-September	13.7	12.8	12.4	13.0	191.3	175.1	156.8	174.4
Mid-October	12.5	10.9	10.7	11.4	172.9	130.8	144.1	149.3
Mid-November	11.6	9.7	10.1	10.5	153.0	110.5	138.2	133.9
Mean	12.6	11.1	11.0	11.6	172.4	138.8	146.4	152.5
Critical difference at $P \leq 0.05$								
Type of mulch		0.71				8.72		
Planting time		1.02				15.11		
Planting time × mulching		0.85				8.55		

yield per plant (*table III*). Fruits were comparatively larger (12.6 g) in plants mulched with black polyethylene than in those harvested from plants mulched either with paddy straw (11.1 g) or with clear polyethylene (11.0 g). Similarly, fruit yield per plant was significantly higher in plants mulched with black polyethylene (172.4 g·plant^{-1}), which was (24.2 and 17.8)% higher as compared with fruit yield of plants mulched with clear polyethylene and paddy straw, respectively. The [planting time × mulching] interaction for fruit weight and yield was highly significant, as fruit harvested from plants of mid-September planting were largest (13.7 g) when mulched with black polyethylene and produced maximum yield (191.3 g·plant^{-1}), whereas fruit harvested from plants of mid-November planting and mulched with clear polyethylene produced the smallest fruit (9.7 g) and the lowest yield (110.5 g·plant^{-1}) (*table III*).

3.4. Fruit quality parameters

Planting time, mulching and the [planting time × mulching] interaction influenced the quality parameters of Chandler strawberry significantly (*table IV*). Total soluble solids (9.23%), titratable acidity (1.22%) and ascorbic acid (44.1 mg·100 g^{-1} fresh weight) were comparatively higher in fruit harvested from plants of mid-September planting than in those harvested from plants of successive plantings (*table IV*). Similarly, fruits obtained from plants which were mulched with black polyethylene had better TSS (9.20%), lower titratable acidity (1.09%) and better ascorbic acid (42.7 mg·100 g^{-1} fresh weight) than fruits obtained from plants mulched either with clear polyethylene or with paddy straw. The interactive effect of [planting time × mulching] for all quality parameters was also significant as fruit harvested from plants of mid-September planting and mulched with black polyethylene had maximum TSS (9.41%) and ascorbic acid (46.4 mg·100 g^{-1} fresh weight) and the lower titratable acidity (1.17%), whereas those harvested from mid-November plantings and mulched with clear polyethylene had the lowest TSS (8.79%), titratable acidity (1.14%) and ascorbic acid (36.4 mg·100 g^{-1} fresh weight) (*table IV*).

4. Discussion

4.1. Plant growth parameters

Our studies indicated that plant growth parameters such as plant spread, crown height and leaf area of Chandler strawberry were significantly influenced by planting time,

Table IV.
Fruit quality of Chandler strawberry as influenced by planting time and mulching in India.

Treatment	Total soluble solids (%)				Titratable acidity (%)				Ascorbic acid content (mg·100 g^{-1} fresh weight)			
	Black polyethylene	Clear polyethylene	Paddy straw	Mean	Black polyethylene	Clear polyethylene	Paddy straw	Mean	Black polyethylene	Clear polyethylene	Paddy straw	Mean
Planting time												
Mid-September	9.41	9.26	9.03	9.23	1.17	1.22	1.26	1.22	46.4	44.1	41.8	44.1
Mid-October	9.24	8.95	8.85	9.01	1.11	1.08	1.20	1.16	42.4	40.1	39.7	40.7
Mid-November	8.96	8.79	8.81	8.85	0.98	1.14	1.14	1.09	39.4	36.4	37.1	37.6
Mean	9.20	9.00	8.90	9.03	1.09	1.18	1.20	1.16	42.7	40.2	39.5	40.8
Critical difference at $P \leq 0.05$												
Type of mulch		0.11				0.03				1.61		
Planting time		0.20				0.07				2.30		
Planting time × mulching		0.14				0.05				1.52		

mulching and their interaction (*table I*). Individually, plants of mid–September planting had better growth than other plantings, perhaps because the microclimate was most favourable for the growth and development of plants. Thus, the availability of comparatively lower temperatures for plants of mid-October and mid-November plantings might not have favoured appropriate growth in plants. Although there is no report in the literature to support these observations, however, some workers have observed better growth of strawberry runners if they are planted after the second week of October under north Indian conditions, because the temperature in these areas is usually higher up to the first fortnight of October, which is not conducive for proper establishment, growth and development of the runners. The available literature indicates that earlier studies on strawberry in India were conducted without the use of a micro-irrigation system. Furthermore, the earlier authors have also suggested that strawberry could be planted at any time of the year, if assured irrigation facilities are available in a particular area [1, 2]. Thus, our results are contradictory to earlier reports perhaps because our studies were conducted in micro-irrigated strawberry, in which the microclimate is regulated by a continuous supply of water, which helped the runners with their proper establishment, further growth and development. Plants mulched with black polyethylene had better growth than those mulched either with clear polyethylene or with paddy straw (*table I*). This may be attributed to better soil hydrothermal regimes and suppression of weeds in plants mulched with black polyethylene than other mulches [6, 7, 10]. Many researchers have also reported better growth of strawberry plants when mulched with black polyethylene than with other mulches [8, 10, 14]. The interaction [planting time × mulching] had a significant influence on plant growth, with maximum crown height, plant spread and leaf area in plants of mid-September planting, and when mulched with black polyethylene than with other combinations. It may be attributed to the synergistic and interactive influence of early planting and black polyethylene mulch on the creation of a comparatively favourable environment (microclimate) and better moisture conservation, suppression of weed growth, etc., which might have resulted in comparatively better growth of plants than other combinations.

4.2. Days to flowering and fruiting

Planting time and mulching, individually and in combination, significantly advanced

the flowering and fruiting in Chandler strawberry (*table II*). Mid-September planting resulted in early flowering and fruiting (77.3 and 33.0 days, respectively) compared with other plantings, probably because, during the first week of December (when flowering commenced), the day temperature was comparatively favourable for the better growth and development of the plants, which might have advanced both flowering and fruiting. Moreover, plants of mid-September planting have sufficient time for proper growth up to mid-December, which might also have advanced the flowering and fruiting (personal observations). Plants of successive plantings had poor growth and received low temperatures (after 15th December, when flowering commenced), which delayed the flowering and fruiting. Further, different mulching materials affected the flowering and fruiting in Chandler strawberry, mainly because of different soil hydrothermal regimes. Better moisture conservation and higher soil temperature with the use of black polyethylene mulch than with other mulches have also been reported by Abbott and Gough [5], Hassan *et al.* [9], Singh *et al.* [10] and Pollard *et al.* [15]. The interactive effect of planting time and mulching had a positive and significant influence on the advancement of flowering and fruiting in Chandler strawberry, as mid-September planting coupled with black polyethylene mulch further enhanced the flowering and fruiting, mainly because of the combined and beneficial effect of early planting and black mulch on the better growth of the plants, which might have cumulatively enhanced the flowering and fruiting significantly.

4.3. Fruit weight and yield

Individual berry weight and fruit yield per plant were significantly influenced by planting time, mulching and their combination (*table III*). Higher fruit weight and yield per plant observed in plants of mid-September planting, compared with plants of other plantings (mid-October and mid-November), may primarily be because of the better growth of the plants, which advanced flowering and fruiting, resulting in the better growth of berries and higher yield. Our experience while working with strawberry reveals that plants which were planted earlier (mid-September) got sufficient time for adequate growth, which further resulted in early flowering and fruiting, better berry weight and, consequently, the highest yield. In contrast, plants of mid-October or mid-November plantings had less time for attainment of adequate vegetative growth before the onset of winter, which resulted in lesser plant and fruit growth and comparatively the lowest yield. Moreover, the fruiting period of plants of mid-September planting was for about 2.5 months (mid-January to the end of March), compared with only 1.5 months (March to mid-April) (personal observations) in later plantings, primarily because with the onset of spring, the temperature rose, which resulted in small fruit and low yield. Thus, all these factors cumulatively might have resulted in higher fruit weight and yield per plant in mid-September planting than in other plantings. Plants under black polyethylene mulch produced larger fruit and had higher yield per plant, because of better plant growth owing to the favourable hydrothermal regime of the soil and a completely weed-free environment [8, 10, 17]. Nevertheless, plants under clear polyethylene mulch also had better plant growth, but berry weight and fruit yield per plant were less than those of plants mulched with paddy straw. Our observations in this regard reveal that weeds were not as completely suppressed by clear polyethylene mulch as by black polyethylene or paddy straw; hence plants under clear polyethylene mulch might have produced smaller fruit with low yield per plant. Obminskaya and Teuvazhukov [16] have also reported that emergence of weeds is quite common with clear plastic films, which hinders the plant growth and fruit yield per plant adversely. The interactive effect of planting time and mulching on fruit weight and yield per plant were highly significant as plants of mid-September planting, when mulched with black polyethylene, produced the largest fruit and highest yield per plant. It may be attributed to the synergistic influence of early planting and black polyethylene mulch on the better growth and development of the plants, better hydrothermal regimes and a weed-free environment. Hassen *et al.* [9], Badiyala

and Agrrawal [14] and Lamarre *et al.* [17] have also reported increase in strawberry yield, following mulching with black polyethylene.

4.4. Fruit quality parameters

Planting time, mulching and their interaction significantly influenced the fruit quality parameters of Chandler strawberry (*table IV*). The better quality of fruits from the early planting (mid-September) may be associated with the prolonged harvesting period (mid-January to March). Moreover, due to the onset of spring, the fruit development was very fast in plants of later plantings, which might have resulted in accumulation of less sugars or other quality compounds than in fruits of mid-September planting, which got sufficient time. Hassan *et al.* [9] have reported that increased temperature has a negative effect on fruit quality parameters in strawberry. Mulching had a significant influence on the quality of the strawberry fruit. Fruit harvested from plants mulched with black polyethylene had higher TSS and ascorbic acid, and lower titratable acidity than those harvested from plants mulched either with clear polyethylene mulch or with paddy straw (*table IV*). It may be attributed to the creation of a better microclimate and a weed-free environment by black mulch polyethylene in fields, which led to higher TSS and ascorbic acid and lower titratable acidity in fruits [6, 8, 9]. The interactive effect of the [planting time × mulching] interaction on fruit quality was observed, as fruit harvested from plants of mid-September planting and mulched with black polyethylene had the highest TSS, ascorbic acid content and lowest titratable acidity compared with those harvested from plants of other plantings, and when mulched either with clear polyethylene or with paddy straw (*table IV*). It may be attributed to the cumulative and synergistic effective of early planting and black polyethylene mulching, due to which plants have better growth, early flowering and fruiting, and fruit received extra time for growth and development, and accumulation of quality traits in the fruit.

5. Conclusions

Our studies indicated that Chandler strawberry could be planted in mid-September under sub-tropical semi-arid zones of India with micro-irrigation facilities. Mid-September plantings coupled with black polyethylene mulch favoured early flowering and fruiting in strawberry with high yield of quality fruits. However, to extend the period of availability of fruits for a longer time in the market, planting could also be done in mid-October, if mulched with black polyethylene.

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La fecha de plantación y la lubricación del suelo con materia orgánica influyen sobre algunos caracteres vegetativos y reproductivos de la fresa (*Fragaria* × *ananassa* Duch.) en India.

Resumen — Introducción. La fecha de plantación se considera como uno de los factores más importantes para conseguir un cultivo de fresas. Tradicionalmente, en las llanuras del norte de India, la fresa se planta después de la segunda semana de octubre, lo que permite disponer de las frutas durante cerca de un mes. Al utilizar técnicas de plasticultura, el tiempo de plantación puede ampliarse, lo que conlleva una producción precoz y mejorada, y aumenta la disponibilidad de la fruta durante un mayor período. Para la fresa, la lubricación del suelo con materia orgánica es la práctica cultural más importante; influye sobre el crecimiento de las plantas, el rendimiento y la calidad de la fruta. A continuación se emprendieron algunos estudios para determinar la influencia de la fecha de plantación y la influencia de la lubricación del suelo con materia orgánica sobre el crecimiento, la floración y la fructificación, así como sobre el rendimiento y la calidad de la fresa en las llanuras del norte de la India. **Material y métodos**. Se emprendieron algunos estudios con la fresa 'Chandler' plantada en tres fechas diferentes (mediados de septiembre, mediados de octubre y mediados de noviembre) como efecto principal y con tres tipos de lubricación del suelo con materia orgánica (polietileno negro, polietileno claro y paja de arroz) como efecto secundario, y esto en un diseño experimental por parcelas subdivididas (split plot) con tres repeticiones. Se adoptaron algunos procedimientos generales para medir los parámetros de crecimiento de las plantas, sus comportamientos de floración y fructificación, así como algunos parámetros de rendimiento y calidad en función de las distintas combinaciones de tratamientos. **Resultados y discusión**. La plantación de mediados de septiembre dio lugar a un crecimiento vigoroso; aumentó la floración y la fructificación, lo que conllevó a frutas más grandes y a rendimientos más elevados con fresas de mejor calidad. Entre los tres tipos de lubricación del suelo con materia orgánica, las plantas sobre polietileno negro presentaron el mejor crecimiento y el peso de la fruta más elevado, así como un rendimiento y una calidad comparados a aquellos cultivados sobre polietileno claro o sobre paja de arroz. La interacción [fecha de plantación × tipo de lubricación del suelo con materia orgánica] fue significante para todos los parámetros medidos. **Conclusión**. Nuestro estudio indicó que, en llanuras del norte de la India, bajo un sistema de micro-riego, la fresa Chandler podría establecerse a mediados de septiembre por poco que estuviese cubierto de polietileno negro, apto a inducir un elevado rendimiento precoz y a producir frutas de muy buena calidad.

India / *Fragaria ananassa* / material de cobertura / cobertura con paja / polietileno / fecha de plantación / crecimiento / aumento del rendimiento / frutas / calidad