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S.M.L. RAHMAN, M.M. HOSSAIN, M.M. RAHMAN, M.A.K. MIAN AND T. HOSSAIN

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YIELD CONTRIBUTING CHARACTERS, YIELD AND RUNNER PRODUCTION OF STRAWBERRY AS INFLUENCED BY DIFFERENT PLANTING TIME AND DEFOLIATION

S.M.L. RAHMAN[1], M.M. HOSSAIN[2], M.M. RAHMAN[3], M.A.K. MIAN[4] AND T. HOSSAIN[5]

[1]Citrus Research Station, Bangladesh Agricultural Research Institute, Jaintapur, Sylhet; [2&3]Department of Horticulture; [4]Department of Genetics and Plant Breeding; [5]Department of Crop Botany, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur.

*Corresponding author & address: Dr. Shah Md. Luthfur Rahman, E-mail: luthfr_r@yahoo.com
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ABSTRACT

Rahman SML, Hossain MM, Rahman MM, Mian MAK, Hossain T (2014) Yield contributing characters, yield and runner production of strawberry as influenced by different planting time and defoliation. *Int. J. Sustain. Crop Prod.* 9(2), 22-28.

An experiment was conducted to study the effect of different planting time and defoliation on yield contributing characters, yield and runner production of strawberry at the research field and Laboratory of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur during November 2008 to April 2009. There were three planting dates (P_1= 15 October, P_2= 1 November and P_3= 15 November) and three defoliation (D_1= 25% defoliation, D_2= 50% defoliation and D_3= No defoliation). Remarkable variabilities were recorded among the treatments in respect of number of fruits per plant, weight of fruits per plant, yield per hectare and fruit TSS (%). Individual fruit weight (g), number of fruits per plant, weight of fruits per plant (g) and fruit yield per hectare (t) were found highest (26.67 g, 22.08, 587.96 g and 17.64 t, respectively) in 1st November planting having no defoliation. On the other hand, number of runners per plant, number of plantlets per runner and number of plantlets per plant (8.92, 4.42 and 39.29 respectively) were found highest in P_3D_2 planting (15 Nov planting x 50% defoliation). Fruit TSS% was recorded maximum (11.08) and minimum (9.33) under 15 October planting with 25% defoliation and 15 November planting with 25% defoliation.

Key words: *Fragaria ananassa, Fragaria virginiana, Fragaria chiloensis, runner*

INTRODUCTION

Strawberry (*Fragaria ananassa* Duch.) is a fruit of temperate regions of the world and belongs to the Rosaceae family (Hossain 2009; Rousseau-Gueutin *et al.* 2009). This strawberry known as pineapple strawberry or ananas strawberry was first bred in Brittany, France, in the 1750s via a cross of *Fragaria virginiana* from eastern North America and *Fragaria chiloensis* from Chile (Hossain 2009). The strawberry is, in technical terms, an aggregate accessory fruit, meaning that the fleshy part is derived not from the plant's ovaries but from the receptacle that holds the ovaries. Each apparent "seed" (achene) on the outside of the fruit is actually one of the ovaries of the flower, with a seed inside it. In both culinary and botanical terms, the entire structure is considered as fruit. This fruit is widely appreciated for its characteristic aroma, bright red color, juicy texture, and sweetness. Strawberries are grown throughout Europe, in every state of the United States, as well as in Canada and South America. The wide variation in climates within these regions and the wide adaptation of the strawberry plant permit harvesting and marketing the fruit during greater part of the year. Strawberry has a tremendous scope for cultivation near towns and canning units where the produce can be utilized immediately after harvest. It is more profitable in the shortest possible time as compared to other fruits (Sing 2002). Strawberry is a delicious fruit taken fresh in several ways. It also makes excellent ice cream and jam on account of its pleasant aroma and delicate flavor. It is also nutritious and beneficial to anemic persons. One cup (236 g) of strawberries contains approximately 45 calories (188 kJ) and other nutrients such as water (132 g), protein (0.88 g), fat (0.53 g) carbohydrate (10.10 g), fiber (3.3 g), calcium (20.00 g), iron (0.55 g), vitamin C (82 µg), thiamin (0.03 µg), riboflavin (0.1 µg), vitamin (B-6 0.09 mg), folate (25 µg) and vitamin A (IU 39).

Department of Botany, Rajshahi University is the pioneer of introducing strawberry in Bangladesh. Under the leadership of Dr. Monjur Hossain, Professor of the Department, strawberry research and development has been initiated since 1998. Strawberry has been commercially introduced and started to cultivate recently as a new temperate fruit in Bangladesh. There are two propagation methods for strawberry which are conventionally propagated by rooted runner in the field and *in vitro* propagation in a laboratory using tissue culture technique. The tissue culture technique is considered as one of the most effective methods for obtaining healthy plants (Libek and Kikas, 2003) but there are controversial statements about the yield potential of tissue culture raised plants. There are considerations that tissue culture plants do not have any significant advantages in comparison with the traditional runner plants in respect to the yield potential and fruit quality (Cameron *et al.* 1989).

Tuning of planting time is an important way of achieving higher yield of the crop. Such types of studies had not been done earlier in our country. Rice (1990) observed that late planting of strawberry reduced yield. Strawberry production in Bangladesh will be undoubtedly hampered by lack of enough propagating materials. Propagation in Bangladesh is started mainly by runners. Waithaka (2007) reported that in case of runner production of strawberry, physical manipulation of the parent plants proved a little beneficial in runner production in two ever bearing cultivars. He stated that defoliation of the older leaves promoted runner production in Turft and Tioga varieties. This resulted in an increase of daughter plants for propagation. In view of the above stated facts, the present study was therefore undertaken to study the performance of strawberry under different planting time and to determine the optimum per cent of defoliation for higher runner production.

MATERIALS AND METHODS

Source of planting materials

One accession FA002 of strawberry used in this study was selected from the previous study (Rahman 2007). Six accessions of strawberry *viz.* FA001, FA002, FA003, FA004, FA005 and FA006 were used for that study. The accession FA002 was came out with largest fruit size, maximum fruit TSS% and highest fruit yielding potential. Out of the six accessions, FA002 and FA003 were collected from Rajshahi University and Bangladesh Agricultural University, respectively. Rests of four were collected from different reputed nurseries of the country.

Experimental site and land preparation

The experiment was conducted at the Horticulture Research Farm, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur during the period from November 2008 to April 2009. The experimental site is located at the center of Madhupur Tract (24.09 degree North latitude and 90.26 degree East longitude) at 8.5 m above the sea level and about 40 km north of Dhaka. The land was deep ploughed with tractor followed by harrowing and laddering up to a good tilth. All weeds and stubbles were removed. The plots were prepared with drains which were made around each plot and the excavated soil was used for raising the plots about 10 cm from soil surface. Ridges were made around each plot to restrict the lateral run-off of irrigation water. Well decomposed cow dung and Di Ammonium Phosphate (DAP), Murat of Potash(MP) were applied @ 37 tons, 640 kg and 333 kg per hectare in general (Hossain 2009). Full dose of cow dung and DAP and half of MP were applied at final land preparation and rest of MP in two installments. Immediately after manuring and fertilizing and preparing the field for planting, mulching was done by laying clear plastic polyethylene on moist soil so that heat was trapped under the plastic, raising the soil temperature, killing or debilitating pests. This solarization took about six weeks and after that mulch was removed before planting of strawberry saplings.

Design and layout

The experiment was laid out in Split-plot Design with four replications. The experimental plot was divided into four blocks, representing four replications. Each block was further sub-divided into 03 unit plots. Each unit plot then subdivided into 03 sub-plots. The application of three planting times allotted to three main plots and three level of defoliation was allotted in the sub plots. The plots were raised by 10 cm from the ground level. The unit plot size was 1.75 m x 1.10 m accommodating 10 plants per plot. The unit plots and blocks were separated by 0.6 m and 0.75 m, respectively.

Planting of saplings and intercultural operations

First, second and third transplanting were done on 15 October, 1 November and 15 November 2008, respectively. Saplings were planted with the row and plant spacing of 60.96 cm x 30.48 cm (Hossain 2009) and placed them in the soil in such a way that both the level of soil and of polyethylene pots remain in same level. Water was applied immediately after transplanting. Straw mulch was applied around the plants as a normal practice in order to conserve soil moisture, decreasing weed growth and to provide healthy condition for the plants. After that three flood irrigation were applied at intervals of 15 days.

Plant protection, data collection and statistical analysis

The crop was protected from the attack of leaf roler, spittle bug by applying Sumithion 60 EC @ 1ml/l. *Phytophthora* crown rot was controlled by spraying Ridomil gold @ 2 g/l. Leaf spot was caused by the fungus *Micosphaella fragariae* which was controlled by spraying robral @ 2 g/l (Hossain 2009). The plants were also protected from bacterial wilt by spraying copper oxichloride @ 2 g/l (Uddin *et al.* 2009). Strawberries were harvested by hand picking when it was firm and well-colored and early in the day at an interval of 3 to 4 days. After harvest, fruits were cooled under shade. Five plants were selected t-west directions), days to flower initiation, flower trusses per plant, number of flowers per truss, number of flowers per plant, flower diameter, flower disk diameter, individual fruit weight, fruit length, fruit diameter, number of fruits per plant, weight of fruits per plant, fruit TSS (%) and fruit yield per hectare. The recorded data on different parameters were compiled and statistically analyzed using MSTATC computer program and the treatment means were compared by DMRT (Gomez and Gomez, 1984).

Photograph 1. Showing shy bearing under P_1 (15 October) planting

Photograph 2. Showing profuse bearing under P_2 (1 November) planting

Photograph 3. Showing light bearing under P_3 (15 November) planting

RESULTS AND DISCUSSION

Effect of planting time on the yield, yield contributing characters and qualities of strawberry

Individual fruit weight

Although different planting dates has a non significant effect on individual fruit weight, the largest fruit (25.28 g) was recorded from 01 November planting and the smallest (23.13 g) was in 15 November planting (Table 1).

Number of fruits per plant

A statistically significant variation was found among different planting times on number of fruits per plant (Table 1). The highest number (20.21) was recorded from 1 November planting and the lowest number (15.72) was found from 15 November, which was statistically identical to 15 October planting (Table 1). Number of fruits per plant is an important yield contributing characters which was found best in 1 November planting. According to Hossain (2009), suitable air temperature was prevailing during early November which helped increased number of fruits per plant.

Weight of fruits per plant

The number of fruits per plant was affected by influence of planting dates (Table 1). The highest fruit weight per plant of 512.00 g was recorded in the treatment P_2 (1 November planting) and the lowest of 364.31 g in the P_3 planting (15 November planting). According to Hossain (2009), suitable weather for the production of strawberry prevails during mid November which helped increased weight of fruits/plant.

Table 1. Yield contributing characters, yield and TSS (%) of strawberry under different planting time

Planting time	Individual fruit weight (g)	Number of fruits/plant	Weight of fruits/plant (g)	Yield/ha(t)	TSS%
15 Oct	24.58	17.19b	423.30b	12.70b	10.92a
1 Nov	25.28	20.21a	512.00a	15.36a	10.14b
15 Nov	23.13	15.72b	364.31c	10.91b	9.53c

In a column, means followed by common letters are not significantly different from each other at 5% level of probability by DMRT

Fruit yield

Regarding fruit yield of strawberry, statistically significance difference was found among the planting dates (Table 1). The maximum fruit yield of 15.36 ton per hectare was obtained in the treatment 1 November planting and the minimum of 10.91 ton per hectare in 15 November planting which was statistically identical to 15 October planting. According to Hossain (2009), suitable weather for the production of strawberry prevails during mid November which helped increased fruit yield per hectare.

Total soluble solids

Total soluble solid (TSS%) is one of the most important characters for quality fruits. Statistical variation was found among different planting time on fruit TSS (%) (Table 1). Maximum of 10.92 and minimum of 9.53 TSS (%) were recorded in 15 October planting and 15 November planting, respectively. According to Hossain (2009), suitable weather for the production of strawberry prevails during mid November which helped increased total soluble solid content.

Effect of defoliation on the yield, yield contributing characters and qualities of strawberry

Fruit characteristics of strawberry under three levels of defoliation were found non-significant except weight of fruits per plant (Table 2). However, considerable variations were observed for all the characters studied. Individual fruit weight, weight of fruits per plant, fruit yield per hectare and fruit TSS (%) ranged from 23.16 g to 25.53 g, 17.00 to 18.56, 12.30 t to 14.28 t and 10.03 to 10.31 respectively. On the other hand, a significant variation was found on weight of fruits per plant. Maximum weight of 475.90 g was found in the no defoliated plants while the minimum of 409.91 g was found in 50% defoliated plants.

Table 2. Yield contributing characters, yield and TSS (%) of strawberry under defoliation levels

Levels of defoliation	Individual fruit weight (g)	No. of Fruits/plant	Weight of fruits/plant (g)	Yield/ha (t)	TSS (%)
25% defoliation	24.31	17.00	413.70b	12.39	10.25
50% defoliation.	23.16	17.57	409.91c	12.30	10.31
No defoliation	25.53	18.56	475.90a	14.28	10.03

In a column, means followed by common letters are not significantly different from each other at 5% level of probability by DMRT

Many types of essential foods in plant body are synthesized through leaves highest photosynthate accumulation was occurred in the treatment under highest number of leaves (no defoliation), hence the leaves might be important for fruit growth and development. Table 2 revealed that no defoliation gave maximum results in all the parameters which was might be due to the bearing of profuse leaves that helped increased fruit production.

Interaction effect of planting time and defoliation on yield and yield contributing characters of strawberry

Fruit weight

The interaction effect between planting time and defoliation on fruit weight was found statistically significant (Table 3). The largest fruit (26.67 g) was found in strawberry plants planted in the 1 November having no defoliation which was statistically identical to all interaction except 15 November planting having 25% defoliation or 15 November planting having 50% defoliation. The smallest (21.53 g) fruit was found in the 15 November planting with 50% defoliation, which was statistically identical to the plants of 15 October planting with 50% defoliation, 1 November planting with 50% defoliation and 15 November planting with 25% defoliation.

Table 3. Interaction effect of planting time and leaf defoliation on yield contributing characters, yield and TSS (%) of strawberry

Treat.	Individual fruit weight(g)	No. of fruits/plant	Weight of fruits/plant(g)	Yield/ha(t)	TSS%
P_1D_1	24.76ab	14.67c	363.11g	10.89de	11.08a
P_1D_2	23.87a-c	18.42b	442.10d	13.27b-d	10.67bc
P_1D_3	25.11ab	18.50b	464.54c	13.94bc	11.00ab
P_2D_1	25.10ab	19.33b	485.61b	14.57b	10.33c
P_2D_2	24.08a-c	19.21b	462.49c	13.87bc	10.50c
P_2D_3	26.67a	22.08a	587.96a	17.64a	9.58de
P_3D_1	23.07bc	17.00bc	392.40e	11.72c-e	9.33e
P_3D_2	21.53c	15.08c	325.21h	9.78e	9.75d
P_3D_3	24.80ab	15.08c	375.19f	11.25de	9.50de

In a column, means followed by common letters are not significantly different from each other at 5% level of probability by DMRT

P_1 = 15 October planting, P_2 = 1 November planting, P_3 = 15 November planting
D_1 = 25% Defoliation, D_2 = 50% Defoliation, D_3 = No defoliation (control)

Many types of essential foods in plant body are synthesized through leaves highest photosynthate accumulation was occurred in the treatment under highest number of leaves (no defoliation), hence the leaves might be important for fruit growth and development. Table 2 revealed that no defoliation gave maximum results in all the parameters which was might be due to the bearing of profuse leaves that helped increased fruit production. According to Hossain (2009), suitable weather for the production of strawberry prevails during mid November which helped production of heaviest fruits.

Number of fruits per plant

Number of fruits per plant is an important yield contributing character which was found statistically significant among all the treatment combinations (Table 3). The highest number (22.08) was obtained from the plants of 1 November planting with No defoliation while the lowest number (14.67) was found in plants planted in 15 October having 25% defoliation. Many types of essential foods in plant body are synthesized through leaves highest photosynthate accumulation was occurred in the treatment under highest number of leaves (no defoliation), hence the leaves might be important for fruit growth and development. Table 3 revealed that no defoliation gave maximum results in all the parameters which was might be due to the bearing of profuse leaves that helped increased fruit production. According to Hossain (2009), suitable weather for the production of strawberry prevails during mid November which helped production of maximum number of fruits per plant.

Weight of fruits per plant

Weight of fruit per plant is also one of the important parameters which contributed yield. It was also found statistically significant among all the treatment combinations (Table 3). The maximum weight of fruits per plant (587.96 g) was obtained in the treatment combination of P_2D_3 (1 November planting x No defoliation) and the lowest number (363.11 g) in P_1D_1 (15 October planting x 25% defoliation). Highest photosynthate accumulation was occurred in the treatment under highest number of leaves (no defoliation), hence the leaves might be important for fruit growth and development. Table 3 revealed that no defoliation gave maximum results in all the parameters which was might be due to the bearing of profuse leaves that helped increased fruit production. According to Hossain (2009), suitable weather for the production of strawberry prevails during mid November which helped production of maximum weight of fruits per plant.

Yield per hectare

The highest yield per hectare (17.64 t) was obtained in the treatment combination of P_2D_3 (1 November planting with no defoliation) and the lowest (9.74 t) in P_3D_2 (15 November planting with 50% defoliation) which was statistically identical to the treatment combinations of P_1D_1, P_3D_1 and P_3D_3 (Table 3). Highest photosynthate accumulation was occurred in the treatment under highest number of leaves (no defoliation), hence the leaves might be important for fruit growth and development. Table 3 revealed that no defoliation gave maximum

results in all the parameters which was might be due to the bearing of profuse leaves that helped increased fruit production. According to Hossain (2009), suitable weather for the production of strawberry prevails during mid November which helped production of highest yield per hectare.

Total soluble solids

Total soluble solids is one of the most important characters for quality fruits. Statistically significant variation was found among different treatment combinations regarding fruit TSS (%) (Table 3). Maximum (11.08) TSS (%) was recorded from the treatment combination P_1D_1 (15 October planting with 25% defoliation) and the minimum (9.33) in P_3D_1 (15 November planting with 25% defoliation) (Table 3) which was identical to the treatment combinations of P_2D_3 (9.58) and P_3D_3 (9.50). According to Hossain (2009), suitable weather for the production of strawberry prevails during mid November which helped increased total soluble solid content.

Interaction effect of planting time and defoliation on runner production of strawberry

Number of runners per plant

The highest number of runners per plant (8.92) was obtained in the treatment combination P_3D_2 (15 November planting with 50% defoliation) while the lowest number (5.33) was recorded in the treatment combination of P_1D_3 (15 October planting with no defoliation) (Fig. 1). In this figure there was a negative correlation between number of leaves per plant and production of runners. Essential foods and photosynthates produced in plants were utilized for production of highest number of leaves which ultimately decreased runner production.

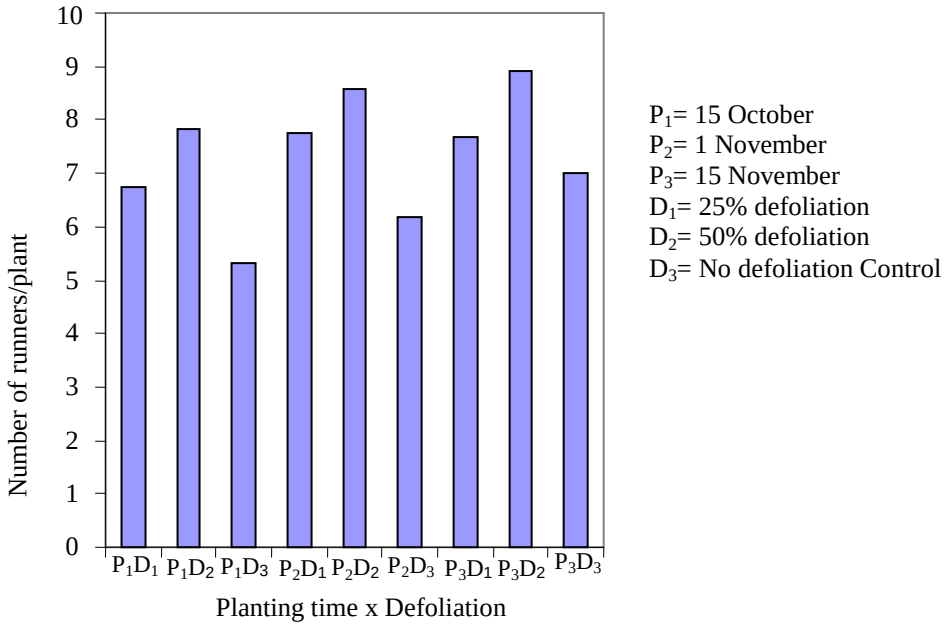

Fig. 1. Interaction effect of planting time and defoliation on the number of runners/plant

Length of runner (cm)

Interaction effect of planting time and defoliation on the length of runner was found significant. Fig. 2 revealed that longest runner was obtained from the treatment combination of P_3D_2 (15 November planting with 50% defoliation) which was identical to P_2D_1 (1 November planting with 25% defoliation), P_2D_2 (1 November planting with 50% defoliation) and P_3D_1 (15 November planting with 25% defoliation) whereas the shortest runner was produced from the treatment combination of P_1D_3 (15 October planting with no defoliation) which was identical to P_1D_1 (15 October planting with 25% defoliation). The longest and shortest runners were 64.04 cm and 34.42 cm respectively.

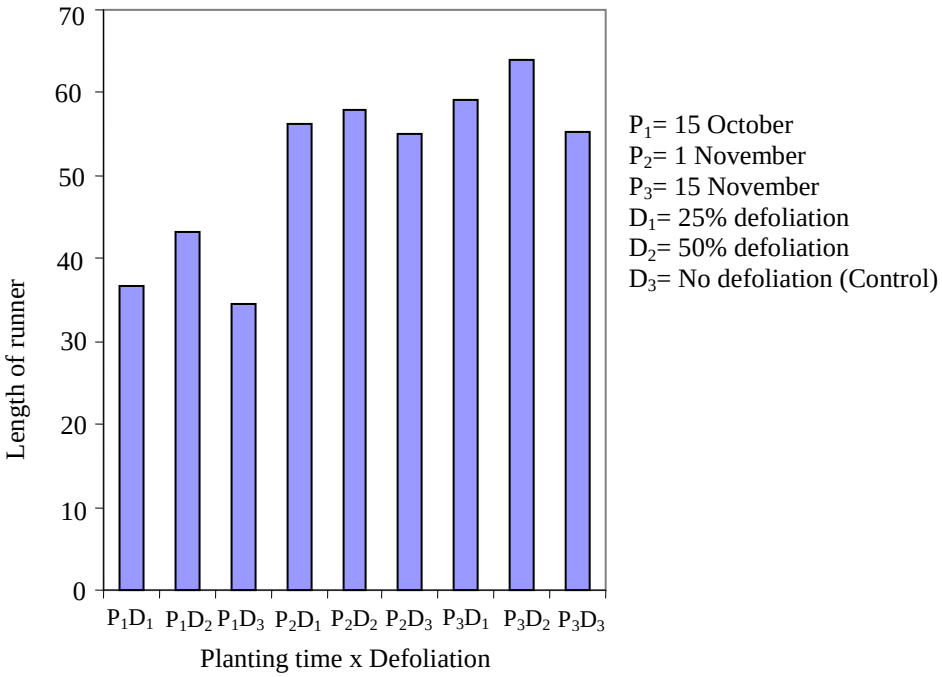

Fig. 2. Interaction effect of planting time and defoliation on the length of runner

No. of plantlets per runner

A statistically significant variation was observed under interaction effects of planting time and defoliation regarding number of plantlets per runner. Highest number of plantlets per runner (4.42) was recorded in the treatment combination of P_3D_2 (15 November planting with 50% defoliation) followed by P_3D_1 (15 November planting with 25% defoliation) and the lowest number (2.50) was found from the treatment combination of P_1D_3 (15 October planting with No defoliation) (Fig. 3).

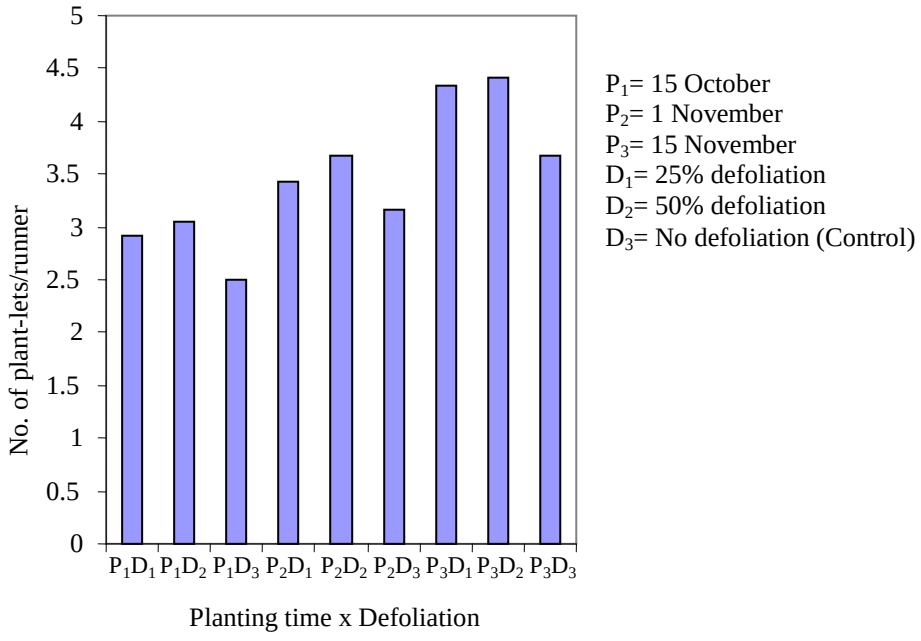

Fig. 3. Interaction effect of planting time and defoliation on the number of plantlets/runner

Number of runners and plantlets production was favored by suitable microclimate with comparatively cold temperature and also with 50% defoliation. It was previously also found that maximum number of leaves decrease runner production whereas minimum number increased In case of plantlets production it may be due to the food which was not utilized for the leaf development enhanced runners as well as plantlets production.

Number of plantlets per plant

The interaction effect of planting time and defoliation had significant effect on number of plantlets/plant. The highest number of plantlets per plant (39.29) was obtained in the treatment combination P_3D_2 (15 November

planting with 50% defoliation) while the lowest number (13.34) was recorded from the treatment combination of P_1D_3 (15 October planting x no defoliation) (Fig. 4).

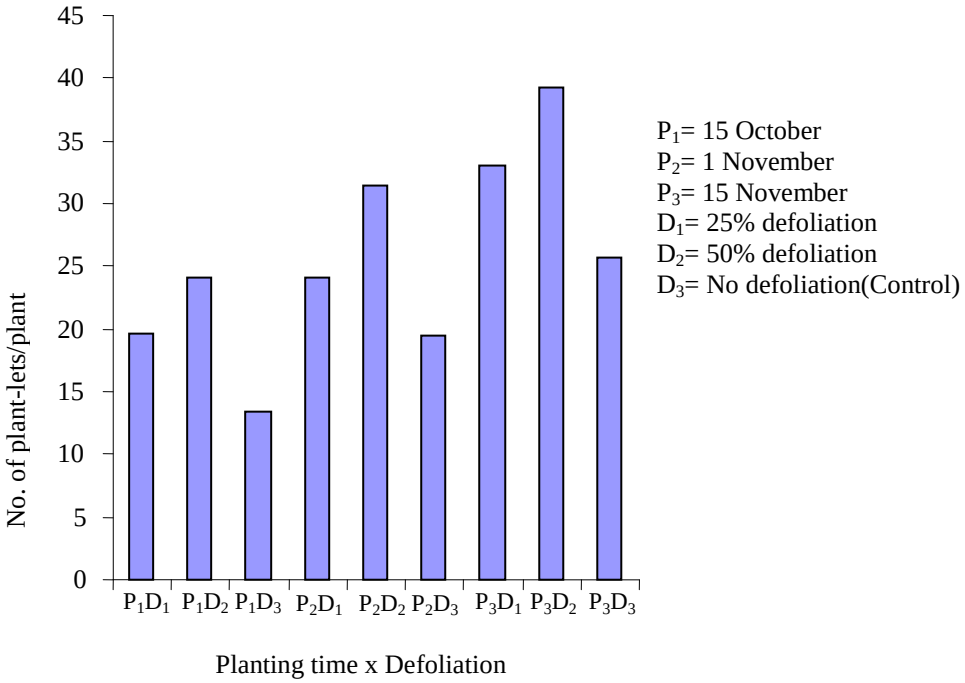

Fig. 4. Interaction effect of planting time and defoliation on the number of plantlets/plant

There was a negative correlation between number of leaves per plant and production of runners. It was found that maximum number of leaves decrease runner production whereas minimum number increased. It may be due to the food which was not utilized for the leaf development enhanced runner production.

CONCLUSION

From the present study, it may be concluded that 01 November planting with no defoliation was the best for yield and quality of strawberry. On the other hand, 15 November planting with 50% defoliation was found best for runner production.

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