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Effect of different planting times and mulching materials on flower quality and yield of China aster cultivars

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Abstract
The investigations entitled 'Effect of different planting times and mulching materials on flower quality and yield of China aster cultivars' were carried out at the experimental farm of Department of Floriculture and Landscape Architecture, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during 2015-2016. The experiment was laid out in a Randomized Block Design (factorial) consisting of 48 treatment combinations of four planting dates *viz*., D_1- mid of March, D_2 -mid of April, D_3-mid of May and D_4- mid of June and two cultivars namely V_1- Kamini and Poornima-V_2 with six mulching materials *i.e.*
M_0-without mulch, M_1- Black plastic mulch (100 µ), M_2-Silver plastic mulch (100 µ), M_3-Transparent plastic mulch (100 µ), M_4- Pine needle (1 inch) and M_5-Grass (1 inch layer). Among different planting times, D_1 i.e. mid March planting obtained best results for plant height (107.70 cm), plant spread (55.54 cm), number of flowers per plant (72.54), flower yield per plant (198.70 g). However, number of days taken for flower bud formation (108.24 days), 50 per cent flowering (124.46 days), flower diameter (5.47 cm), duration of flowering (55.90 days), fresh flower weight (301.67 g), were recorded to be best in mid of June. Among the cultivars, cv. 'Poornima' gave best results for plant height (89.34 cm), Plant spread (47.99 cm), flower diameter (4.77 cm), flowering duration(51.83 days) and fresh weight of 100 flower (291.64 g) whereas minimum number of days taken for flower bud formation (99.04 days), 50 per cent flowering (118.25 days) and were recorded in cv. 'Kamini'. However, cv. 'Kamini' recorded the maximum number of flowers (57.16), flower yield per plant (158.62 g).Silver plastic obtained best results for plant height (84.48 cm), plant spread (48.39 cm), number of flowers per plant (47.89), flowering duration (51.53 days), flower diameter (4.73 cm), fresh weight (291.67 g), flower yield per plant (134.73 g) and minimum days taken for flower bud formation (115.91 days) and 50 per cent flowering (136.60 days).

Keywords: cultivars, mulch materials, planting times, flowers, China aster

Introduction
China aster [*Callistephus chinensis* (L.) Nees.] belongs to the family 'Asteraceae' and is a native of China. The blooms are used as cut flower, loose flower, bedding plant, for flower decoration, bouquets, garlands and also in landscape gardening to provide mass aesthetic effect. In India, China aster is grown on a large scale in Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra and West Bengal. Productivity and quality of flowers and seed crop can be improved by using high yielding cultivars and improved horticultural practices like date of planting and mulching. Mulching prevents rapid evaporation from the soil surface and reduces rapid drying thereby conserving soil moisture. It also suppresses weed infestation successfully and is also used as a mean of successful crop production mainly in place where irrigation facilities are scanty. It is important to produce flowers in different ways through which maximum benefits can be obtained from the limited available resources such as water which is main limited factor now days. Hence, the present investigation was designed to determine the effect of various mulches and planting dates on quality of China aster with objective to identify suitable mulch material for China aster and to find out the appropriate planting date for China aster under mid hill condition of Himachal Pradesh.

Materials and Methods
The present investigation was carried out at the research farm of the Department of Floriculture and Landscape Architecture, Dr. Y.S. Parmar, University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during 2015 and 2016. The experimental field was prepared by ploughing the soil thoroughly up to a depth of 30-35 cm. Well rotten farm yard manure (FYM) was added @ 5 kg per meter square before transplanting of seedlings and

mixed thoroughly in the soil. Then, the raised beds of required size 1 m x 1 m x 30 cm (L x B x H) were prepared and levelled properly. The healthy, disease free and stocky seedlings of uniform size and vigour at 5-6 leaf stage were selected and transplanted during evening time. The seedlings of two cultivars of China aster namely, 'Kamini' (V_1) and 'Poornima' (V_2) were planted in raised beds with spacing of 30 x 25 cm (Row x Plant) to accommodate 12 plants/m^2 with six mulching materials (M_0) without mulch, (M_1) Black plastic mulch (100 µ), (M_2) Silver plastic mulch (100 µ), (M_3) Transparent plastic mulch (100 µ), (M_3) Transparent plastic mulch (100 µ), (M_4) Pine needle (100 µ) and (M_5) Grass (1 inch layer) and four planting dates viz., mid of March (D_1), mid of April (D_2), mid of May (D_3) and mid of June(D_4). Experiment was laid out in Randomized Block Design (factorial). The observations to recorded plant height (cm), plant spread (cm), number of days taken for flower bud formation (days), number of days taken for 50 % flowering (days), number of flowers per plant, flower duration (days), flower diameter (cm), fresh weight of 100 flowers (g), flower yield per plant (g) and flower yield per plot (g) were recorded.

Results and Discussion

Plant height

The plant height (Table 1) has been influenced significantly by the planting dates, mulching and cultivars of China aster alone and in combination. The height of aster plants was more in earlier planting dates than the later plantings and decreased with the corresponding delay in planting time in all the cultivars. The tallest plants (107.70 cm) were produced when planting was accomplished on mid March which may be ascribed to the fact that these plants could get sufficient time for putting up more vegetative growth. They grew comparatively much longer than the later planted crops. These results are in close agreement with the earlier findings of Mishra (1997) [14-15] and Kumar and Kaur (2000) [11].

The plants of cv. 'Poornima' attained more height (89.34 cm) than cv. 'Kamini', may be due to the superiority of cv. 'Poornima' over other cultivar. Similar results have also been reported earlier by Kumar (2005) [13] and Dilta *et al* (2007) [6].

The interactive effects of planting dates and varieties revealed maximum plant height (122.63 cm) in the treatment combination D_1 x V_2 i.e. planting of cv. 'Poornima' on mid March which may be due to the reason that mid March planted crop got maximum time to put up sufficient vegetative growth which was further catalyzed by the superior genotype of Poornima. In the interaction planting time × mulch materials, tallest plants (110.31 cm) were observed when planting was done in mid March with silver mulch ($D_1 \times M_2$). Interaction effects of cultivars and mulch materials (V × M) showed a non significant effect on plant height. Pooled data of Table 2 revealed that V × D × M interactions significantly affected the plant height. Taller plants (124.52 cm) were recorded in cv. 'Poornima' planted in mid March planted with silver plastic mulching ($V_2 \times D_1 \times M_2$).

Plant spread (cm)

An inquisition pooled data (Table 1) revealed that largest spread of plants (48.39 cm) was recorded with silver plastic mulch (M_2). The plants attained wider spread with the application of silver polythene mulch and may be due to the fact that silver colour polythene has more capacity to regulate soil temperature as compared to other mulch materials. In addition to this, no weed infestation was seen under silver polythene mulch treatment. Chawla (2008) [4] reported maximum plant spread in African marigold when plants were mulched with black polythene mulch. Largest spreads of plants (55.54 cm) were registered in mid March planting (D_1) was recorded in mid June planting (D_4). Between the cultivars, larger spreads of plants (47.09 cm) were recorded in cv. 'Poornima' (V_2). The difference in plant spread is a genotype trait as it is governed by the genetical makeup. Similar variations in plant spread per plant among varieties were also observed in China aster by Rao and Negi (1990). The interaction, varieties × planting dates also revealed maximum plant spread (58.21 cm) in the interaction $D_1 \times V_2$ i.e. when 'Poornima' was planted on mid March and found to be significantly higher than all other interactions. In the interaction planting time × mulch materials, largest spread of plants (58.30 cm) were registered when planting was done in mid March with silver mulch ($D_1 \times M_2$). Largest spread of plants (61.17 cm) were recorded in cv. 'Poornima' with mid March planting and silver plastic mulching ($V_2 \times D_1 \times M_2$). The plant spread has been influenced significantly by the planting dates and varieties of China aster alone and in combination. The spread of aster plants was more in earlier planting dates than the later plantings and decreased with the corresponding delay in planting time in both cultivars. The plants with more spread were produced when planting was accomplished on mid of March which may be ascribed to the fact that these plants could get sufficient time for putting up more vegetative growth. So, they attained comparatively wider plant spread than the later planted crops. These results are in close agreement with the findings of Mishra (1997) [14-15] who reported that early planted crop resulted in more plant spread in marigold under Samastipur conditions of Bihar.

Number of days taken for flower bud formation (days)

A perusal of pooled data (Table 1) revealed those minimum days taken for flower bud formation (115.91 days) was recorded with silver plastic mulch (M_2). Whereas, maximum (119.53 days) were observed without mulch (M_0). Transmittance, reflectance, photo synthetically Active Radiation and absorbance were black and silver mulches. The soil moisture content was higher under plastic mulches than bare soil. The use of mulches significantly decreases days for flower bud formation. Minimum days taken for flower bud formation (108.24 days) was registered in mid June planting (D_4) and maximum (127.05 days) was recorded in mid March planting (D_1). Between the cultivars, minimum numbers of days taken for flower bud formation (98.78 days) were recorded in cv. 'Kamini' (V_1) and significantly maximum than cv. 'Poornima' (V_2) i.e. (136.37 days). The days taken for first flower bud formation have been greatly influenced by the planting dates and cultivars of China aster alone and in combination. The maximum days taken for flower bud formation were observed in earlier planting dates than the later plantings and decreased with the corresponding delay in planting time in both cultivars. The maximum time was taken when planting was accomplished on mid March which may be ascribed to the fact that these plants could get sufficient time for putting up more vegetative growth. So, they took comparatively more time than the later planted crop. These results are in close agreement with the earlier findings of Gowda (1990) [8] who reported maximum days taken for flower bud formation in earlier plantings under Banglore conditions.

Number of days taken for 50 per cent flowering (days)

An inquisition pooled data Table 3 revealed that minimum

days taken for 50 per cent (136.60 days) was recorded with silver plastic mulch (M_2). Mulching used in crop production are helpful in controlling weed population, reducing the impact of falling rain drops and reducing soil erosion, besides regulation of soil temperature as well as conservation of soil moisture. This may include temperature moderation, reduction in salinity level, conserving soil moisture and also help in weed control. It exerts decisive effect on number day required for 50 per cent flowering. Minimum numbers of days taken for 50 per cent (124.46 days) were registered in mid June planting (D_4). June planted crop could not get sufficient time to put up requisite vegetative growth mainly because of the fact that flowering was hastened under short day conditions. Hence, June planted crop took less time in comparision to the earlier planting dates for both cultivars of China aster. These results are in close agreement with the earlier findings of Dilta *et al*. (2007) [6].

Number of flowers per plant

An inquisition pooled (Table 3) data revealed that maximum number of flowers per plant (47.89) was recorded with silver plastic mulch (M_2). In case of mulching, this might have been attributed due to better weed control, less nutrient loss through leaching, favorable soil temperature and enhanced activities of micro organisms in the soil resulting in increased availability of nutrients and better plant growth and physiological activities due to higher moisture level, resulting in increased number of flowers in silver plastic mulch. The results are in agreement with the report of Siti *et al.* (1994) [20] in bell pepper, Nagalakshmi *et al*. (2002) [16] in chilli, Hutton and Handley (2007) [9] in bell pepper and Ashrafuzzaman *et al*. (2011) [1] in chilli. Maximum numbers of flowers per plant (72.54) were registered in mid March planting (D_1). Between the cultivars, more numbers of flowers per plant (57.16) were recorded in 'Kamini' (V_1). The interaction, varieties × planting dates also revealed more number of flowers per plant (87.41) in the interaction $V_1 \times D_1$ i.e. when 'Kamini' was planted on mid March. The number of flower per plant was more in earlier planting dates than the later plantings and decreased with the corresponding delay in planting time in both varieties. The more number of flower were produced when planting was accomplished on mid of March which may be ascribed to the fact that these plants could get sufficient time for putting up more vegetative growth particularly the production of more number of shoots which later on become reproductive. So, they produced comparatively more flowering stems than the later planted crop. The results are in confirmation with the findings of Dhatt and Kumar (2010) [5]. In case of cultivars × mulch materials noted that maximum number of flowers per plant (61.36) in interaction of $V_1 \times M_2$ i.e. when 'Kamini' with silver plastic mulch. Maximum numbers of flowers (91.33) were recorded in cv. 'Kamini' with mid March planting and silver plastic mulching ($V_1 \times D_1 \times M_2$).

Flowering duration (days)

Pooled data of Table 3 exhibited maximum duration of flowering (51.53 days) with silver plastic mulch (M_2) whereas it was minimum (45.86 days) without mulch. Mulching was significantly effective over un mulched beds in increasing flowering duration. The findings are in accordance with the results reported by Gupta *et al*. (2007) [6] in gladiolus. Maximum duration of flowering (55.90 days) was registered in mid March planting (D_1). Between the cultivars, maximum duration of flowering (51.39 days) was recorded in 'Poornima' (V_2) and significantly better than cv. 'Kamini' (V_1) i.e. (46.35 days). The plants of 'Poornima' exhibited maximum duration of flowering than 'Kamini' which may be due to the effect of genotype. On contrary, minimum duration of flowering was reported in 'Kamini'. These results are in close agreement with the earlier findings of Kumar (2005) [13]. In the interaction cultivar × mulch materials, maximum duration of flowering (53.16 days) were registered when cv. 'Poornima' with silver mulch ($V_2 \times M_2$). The duration of flowering was more in earlier planting dates than the later plantings and decreased with the corresponding delay in planting time in both varieties. The maximum duration of flowering was found when planting was accomplished on mid of March which may be ascribed to the fact that these plants could get sufficient time for putting up more vegetative and reproductive growth. So, they have maximum duration of flowering than the later planted crops. These results are in close agreement with the earlier findings of Ghosh and Pal (2008) [7].

Flower diameter (cm)

The perusal of pooled data (Table 5), largest flowers (4.73 cm) were obtained with silver plastic mulch (M_2). Flower diameter increases with the use of mulching and found to be maximum in silver polythene mulch due to the fact that silver colour polythene sheet has more capacity to regulate soil temperature than other mulch materials. In addition to this, no weed infestation was seen under silver polythene mulch treatment, besides creating a more favorable micro-climate for the growth and flowering of plants in comparison to other mulches. Similar results were reported by Kumar *et al.* (2010) [12] in rose when the plants were mulched with black polythene mulch. Between the cultivars, larger flowers (4.77 cm) were recorded in 'Poornima' (V_2) than cv. 'Kamini' (V_1) i.e. (4.30 cm). This could be ascribed to the genetic makeup of cultivar and favorable climatic conditions as well during the blooming period. These findings are in accordance with the work of Kishanswaroop *et al.* (2004) [10] in China aster; Dilta *et al.* (2005) in chrysanthemum. Maximum flower diameter (5.47 cm) was registered in mid June planting (D_4). The interaction, varieties × planting dates also revealed largest flower (5.56 cm) in the interaction $V_2 \times D_4$ i.e. when 'Poornima' was planted on mid June.

Table 1: Effect of different mulch materials, planting time and their interaction on plant height (cm), plant spread (cm) and bud formation (days) of China aster cultivars

Treatment	Plant height (cm)							Plant spread (cm)								Number of days taken for bud formation (days)						
	V_1	V_2	Mean	D_1	D_2	D_3	D_4	V_1	V_2	Mean	D_1	D_2	D_3	D_4	V_1	V_2	Mean	D_1	D_2	D_3	D_4
M_0	71.50	87.50	79.50	103.67	100.83	64.83	48.33	42.55	43.60	43.08	53.08	44.75	39.77	34.72	100.84	138.23	119.53	128.61	123.21	115.93	110.38
M_1	77.08	90.97	84.03	110.26	105.68	67.83	52.33	46.46	49.11	47.79	57.64	50.28	44.30	38.94	97.41	134.93	116.07	126.07	119.68	112.50	106.02
M_2	77.41	91.55	84.48	110.31	106.33	68.28	53.00	47.15	49.64	48.39	58.30	50.87	44.98	39.42	97.20	134.41	115.91	125.58	119.27	111.99	106.78
M_3	71.66	88.12	79.89	105.81	99.57	65.00	49.17	42.80	44.48	43.64	53.00	45.48	40.62	35.46	100.00	137.65	118.82	127.96	122.30	115.24	109.80
M_4	74.17	88.69	81.43	107.72	103.17	66.50	48.67	44.62	47.70	46.16	55.29	48.22	42.79	38.33	98.19	136.70	117.44	127.49	121.42	112.53	108.33
M_5	75.03	89.20	82.11	108.46	103.81	66.67	49.50	44.70	47.99	46.35	55.95	48.46	42.59	38.39	99.04	136.28	117.66	126.59	121.51	114.45	108.11
Mean	74.47	89.34		107.70	103.23	66.52	50.17	44.71	47.09		55.54	48.01	42.51	37.54	98.78	136.37		127.05	121.23	113.77	108.24
D_1	92.78	122.63	CD 0.05					52.87	58.21	CD 0.05					110.48	143.62	CD 0.05					
D_2	89.33	117.13						47.61	48.41						102.41	140.06						
D_3	65.83	67.20	V	D	M	V×M	V×D	D×M	42.15	42.87	V	D	M	V×M	V×D	D ×M	93.47	134.08	V	D	M	V×M	V×D	D×M
D_4	49.94	50.39	0.82	1.17	1.43	NS	2.86	4.04	36.23	38.86	0.66	0.93	1.14	NS	1.31	2.27	88.76	127.71	0.87	1.22	1.50	NS	NS	NS

Table 2: Effect of different mulch materials, planting time and cultivars interactions on plant height (cm) and plant spread (cm) of China aster

Treatment	Plant height (cm)								Plant spread (cm)							
	V_1				V_2											
	D_1	D_2	D_3	D_4	D_1	D_2	D_3	D_4	D_1	D_2	D_3	D_4	D_1	D_2	D_3	D_4
M_0	88.67	86.00	65.00	46.33	118.67	115.67	64.67	51.00	50.60	45.60	39.80	34.22	55.56	43.89	39.74	35.22
M_1	96.00	92.33	67.00	53.00	124.33	119.03	68.67	51.67	54.56	49.81	43.71	37.77	60.71	50.74	44.89	40.11
M_2	96.30	92.67	67.00	53.67	124.52	119.99	69.56	52.33	55.44	50.42	44.44	38.29	61.17	51.32	45.51	40.55
M_3	89.95	85.67	64.33	46.67	121.67	113.48	65.67	51.67	50.33	45.44	41.06	34.37	55.67	45.52	40.19	36.56
M_4	92.66	89.33	66.00	48.67	122.77	117.00	67.00	48.00	52.93	47.00	42.19	36.36	57.66	49.45	43.40	40.29
M_5	93.11	90.00	65.67	51.33	123.82	117.63	67.67	47.67	53.37	47.37	41.70	36.38	58.52	49.55	43.48	40.41
$CD_{0.05}$					V× D× M				V× D× M							
					4.04				3.22							

Table 3: Effect of different mulch materials, planting time and their interaction on 50per cent flowering (days), number of flower per plant and flowering duration (days) of China aster cultivars

Treatment	Number of days taken for 50 per cent flowering (days)							Number of flower per plant								Flowering duration (Days)						
	V_1	V_2	Mean	D_1	D_2	D_3	D_4	V_1	V_2	Mean	D_1	D_2	D_3	D_4	V_1	V_2	Mean	D_1	D_2	D_3	D_4
M_0	120.59	161.79	141.19	154.45	144.98	138.54	126.79	53.17	28.36	40.76	69.54	45.92	32.58	15.02	43.09	48.63	45.86	52.85	48.50	42.34	39.73
M_1	116.31	158.56	137.44	150.13	141.77	135.22	122.63	60.29	33.77	47.03	75.38	53.28	38.33	21.13	48.44	52.80	50.62	57.21	53.77	46.53	44.98
M_2	115.61	157.58	136.60	149.00	140.78	134.95	121.67	61.36	34.41	47.89	75.89	54.29	39.50	21.86	49.90	53.16	51.53	59.17	54.50	46.83	45.62
M_3	120.14	161.06	140.60	153.50	145.20	138.27	125.43	54.19	29.06	41.63	70.00	46.64	33.73	16.15	44.35	50.51	47.43	54.37	50.30	44.10	40.96
M_4	118.84	159.77	139.30	152.40	143.10	136.58	125.13	56.70	31.20	43.95	71.92	50.48	35.25	18.15	45.47	51.42	48.44	55.55	51.48	44.71	42.03
M_5	118.04	159.68	138.86	151.50	142.77	136.04	125.12	57.24	31.85	44.55	72.54	50.94	36.17	18.54	46.86	51.83	49.34	56.28	52.04	45.33	43.73
Mean	118.25	159.74		151.83	143.10	136.60	124.46	57.16	31.44		72.54	50.26	35.93	18.48	46.35	51.39		55.90	51.77	44.97	42.84
D_1	131.89	171.77	CD 0.05					87.41	31.44	CD 0.05					55.70	56.11	CD 0.05					
D_2	120.08	166.13						66.39	31.12						49.93	53.60						
D_3	114.80	158.40	V	D	M	V×M	V×D	D×M	50.07	21.78	V	D	M	V×M	V×D	D ×M	38.83	50.12	V	D	M	V×M	V×D	D×M
D_4	106.25	142.67	1.70	2.40	2.94	NS	NS	NS	22.77	14.18	0.32	0.46	0.56	0.79	0.65	1.12	39.95	45.73	0.55	0.77	0.95	1.34	NS	NS

Table 4: Effect of different mulch materials, planting time and cultivars interactions on 50 per cent flowering (days) and number of flower per plant of China aster

Treatment	Number of days taken for 50 per cent flowering (days)								Number of flower per plant							
	V_1				V_2				V_1				V_2			
	D_1	D_2	D_3	D_4	D_1	D_2	D_3	D_4	D_1	D_2	D_3	D_4	D_1	D_2	D_3	D_4
M_0	135.12	122.79	116.99	107.45	173.79	167.16	160.09	146.12	84.50	63.50	46.00	84.50	54.57	28.34	19.17	11.37
M_1	129.09	118.09	112.91	105.16	171.17	165.46	157.53	140.09	90.83	71.83	52.50	90.83	59.93	34.72	24.17	16.26
M_2	128.17	117.39	112.72	104.17	169.83	164.17	157.17	139.17	91.33	73.17	54.17	91.33	60.44	35.42	24.83	16.94
M_3	134.49	122.28	116.70	107.09	172.50	168.13	159.83	143.77	84.61	64.24	47.43	84.61	55.39	29.03	20.03	11.80
M_4	132.98	120.09	115.12	107.16	171.82	166.12	158.05	143.09	86.33	68.50	49.83	86.33	57.50	32.46	20.67	14.16
M_5	131.50	119.83	114.35	106.46	171.50	165.71	157.72	143.77	86.83	69.13	50.50	86.83	58.25	32.74	21.83	14.57
$CD_{0.05}$						V× D× M				V× D× M						
						NS				NS						

Table 5: Effect of different mulch materials, planting time and their interaction on flower diameter (cm), flower yield per plant (g) of China aster cultivars

Treatment	Flower diameter (cm)							Flower yield per plant (g)						
	V_1	V_2	Mean	D_1	D_2	D_3	D_4	V_1	V_2	Mean	D_1	D_2	D_3	D_4
M_0	4.11	4.59	4.35	3.43	3.99	4.61	5.38	146.80	80.84	113.82	192.56	122.20	94.64	45.87
M_1	4.42	4.88	4.65	3.75	4.38	4.87	5.60	169.27	98.33	133.80	203.10	146.35	113.86	64.84
M_2	4.53	4.93	4.73	3.83	4.45	5.00	5.65	170.91	98.55	134.73	210.16	150.93	118.03	66.87
M_3	4.15	4.68	4.42	3.46	4.13	4.68	5.39	148.09	81.71	114.90	189.18	124.46	98.32	47.64
M_4	4.23	4.73	4.48	3.55	4.27	4.76	5.34	156.62	89.03	122.82	196.94	136.08	104.10	54.17
M_5	4.34	4.83	4.58	3.72	4.32	4.81	5.50	160.02	91.20	125.61	200.26	139.66	106.58	55.93
Mean	4.30	4.77		3.62	4.26	4.79	5.47	158.62	89.94		198.70	136.61	105.92	55.88
D_1	3.27	3.98						236.05	161.35					
D_2	4.07	4.44			$CD_{0.05}$			183.30	89.93					
D_3	4.47	5.11	V	D	M	V×M	V×D	D×M	146.55	65.29	V	D	M	V×M	V×D	D×M
D_4	5.39	5.56	0.06	0.09	0.11	NS	0.12	NS	68.57	43.20	1.12	1.59	1.94	2.75	2.75	3.38

Flower yield per plant (g)

Pooled data revealed (Table 6) that maximum flower yield per plant (134.73 g) was recorded with silver plastic mulch (M_2). In case of mulching increase of this yield per plant due to the application of plastic mulch might be due to the favorable soil moisture status and soil temperature. Prasad and Mohan (1993) [17] also reported similar observations in okra. Polythene mulch reduced nutrient losses, weeds control and improved hydrothermal regimes of soil, which ultimately helps in increasing yield of the plants (Ashworth and Harrison, 1983) [2]. Sethi (1966) [19] emphasized that mulches through their favorable effects on soil temperature and moisture have been found to faster rapid growth of fruit and vegetable crops. Highest flower yield per plant (198.70 g) was registered in mid March planting (D_1). The plants of 'Kamini' produced more yield per plant (158.62) than 'Poornima' (89.94 g) which may be due to the superiority of 'Kamini' over other cultivars. These results are in conformity with the earlier findings of Kumar (2005) [13] who reported higher yield in 'Kamini' under Nauni, Solan conditions than 'Shashank' and 'Violet Cushion'. Pooled data revealed that interaction, cultivars × planting dates also revealed maximum flower yield per plant (236.05 g) in the interaction ($V_1 \times D_1$) i.e. when 'Kamini' was planted on mid March. In the interaction planting time × mulch materials, maximum flower yield per plant (210.16 g) were observed when planting was done in mid March with silver mulch ($D_1 \times M_2$). Interaction effects of cultivars and mulch materials ($V \times M$) shows that higher yield per plant (170.91 g) in interaction ($V_1 \times M_2$) i.e. when cv. 'Kamini' with silver plastic mulch. In case of $V \times D \times M$ interaction, maximum flower yield per plant (249.24 g) were recorded in cv. 'Kamini' with mid March planting and silver plastic mulching ($V_1 \times D_1 \times M_2$).

Table 6: Effect of different mulch materials, planting time and cultivars interactions on 50 per cent flowering (days) and number of flower per plant of China aster

Treatment	Flower diameter								Flower yield per plant (g)							
	V_1				V_2				V_1				V_2			
	D_1	D_2	D_3	D_4	D_1	D_2	D_3	D_4	D_1	D_2	D_3	D_4	D_1	D_2	D_3	D_4
M_0	2.97	3.90	4.30	5.29	3.89	4.08	4.92	5.47	231.29	166.54	131.74	57.61	153.83	77.86	57.54	34.12
M_1	3.47	4.15	4.52	5.55	4.04	4.61	5.22	5.65	240.82	193.98	155.15	78.71	171.09	98.71	72.57	50.97
M_2	3.59	4.25	4.72	5.57	4.07	4.66	5.28	5.73	249.24	200.72	161.03	81.08	165.39	101.15	75.03	52.66
M_3	3.00	3.99	4.38	5.22	3.93	4.27	4.98	5.56	225.04	169.22	138.23	59.85	153.32	79.69	58.41	35.43
M_4	3.17	4.03	4.41	5.34	3.94	4.52	5.11	5.35	232.99	182.38	145.06	66.05	160.89	89.78	63.15	42.29
M_5	3.43	4.10	4.47	5.37	4.00	4.54	5.15	5.63	236.90	186.95	148.11	68.11	163.62	92.37	65.06	43.74
$CD_{0.05}$						V× D× M				V× D× M						
						NS				5.49						

Conclusion

Growth and flowering in China aster is genotype dependant, in present studies cv. 'Kamini' produced more flower yield as compared to cv. 'Poornima'. Mulching with silver plastic mulch resulted in production of healthier plants with more flower yield. Mid March planting date was found to be optimum for growth and flowering of China aster cultivation under mid hill condition of Himachal Pradesh.

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