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**Effect of planting dates, mulching and application of
ga₃ on seed yield and quality of marigold (*Tagetes
Erecta* L.) cv. ‘Pusa Narangi Gainda’**

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Abstract

Marigold is one of the most popular flowers in our country on account of its easy culture, wider adaptability and lucrative returns. The demand for marigold flowers has shown a steady increase exponentially in the recent years. African marigold cv. ‘Pusa Narangi Gainda’ assumes greater significance as their flowers are more in demand. The demand for marigold seeds is increasing in our country owing to reasons that its cultivation is being taken up in large area, annually. So, to cope up the seed demands in terms of the quantity and quality, the technology for improving the yield and quality of marigold seeds needs to be standardised. Hence, present study had been planned to investigate the influence of planting time, application of mulches and GA₃ on growth, flowering and seed production of marigold. In the said study, marigold seedlings of cv. ‘Pusa Narangi Gainda’ were planted on (1st week of July, 3rd week of July & 1st week of August) in two consecutive years i.e. 2015-16 and 2016-17 and mulched with Black plastic mulch, Silver-black plastic mulch & Crop residue mulch along with control. The spray of GA₃ @ 0, 50, 100 & 150 ppm were given after 45 days of transplanting in both the years. 1st week of July along with application of silver-black mulch and GA₃ @ 150 ppm gives better results in term of yield and quality traits like number of seeds per head, seed yield per plant (g), seed yield plot (g), 1000 seed weight (g), germination percentage, SVI-L and SVI-M.

Keywords: GA₃, mulch, marigold, planting dates

1. Introduction

Marigold (*Tagetes erecta* L.) is an important commercial annual flower belongs to family Asteraceae (Compositae), it is native to Central and South America especially Mexico. In India, these were introduced by Portuguese (Gavhane *et al.* 2004)^[5]. Marigold spreads quickly because its cultivation is relatively easy, have longer blooming period and beautiful flowers with a long shelf life. India has devoted 15 per cent of the cultivable area for this traditional flower in world and area under marigold is 55.89 thousand hectare and production about 511.31 thousand MT (NHB database, 2014-15). Marigold is grown in all Indian states, but extensively cultivated in Tamil Nadu, Andhra Pradesh, Maharashtra, Karnataka, Haryana states.

Marigold is grown for loose flower production and also grown in Landscape gardening as flower beds, boarder plants along the paths creating mass effect, potted plants, hanging baskets, filling color in newly established gardens. Commercially flowers are used in pigment extraction industry and in dry flower making, being natural source of carotenoids (xanthophyll and Lutein (C₄₀H₅₆O₂)), oleoresins and natural dyes. The aromatic oil is also extracted from marigold flowers as "tagetis oil" used in preparation of high grade perfumes, pharmaceutical industries. The drug adoptinal is prepared from marigold flowers and is used for control eye diseases. Dry flower petals are used as food additives in poultry feed to increase the color of egg yolk as well as broiler's skin pigmentation with increased concentration of vitamin-A (Henken 1992; Levi 2001)^[8].

Growth and flowering in marigold is generally governed by the day length and temperature. To meet out the increasing demand of flowers throughout the year, it is important to grow.

quality seeds. In marigold, the seed yield of acceptable quality is greatly influenced by the planting time (Sharma *et al.* 2003)^[11]. Marigold crop is generally weak competitor and suffer from heavy infestation of many annual weeds in early stages of growth, so use of mulching is a way to prevent weeds. Black plastic mulch, silver mulch and other plastic mulches are most commonly used in agriculture as they reduce the deterioration of soil by way of preventing the runoff and soil loss, minimize the weed infestation, and reduce water evaporation and nutrient losses. Thus, facilitate more retention of soil moisture and help in reduction of temperature fluctuation, physical, chemical and biological properties of soil and ultimately enhances the growth and yield of crop, white or aluminum reflective mulch also repels aphids. (Bhardwaj, 2013)^[11].

Growth regulators are used to overcome the factors limiting growth and yield of a crop and to harness maximum benefit from seed production. It is also observed that exogenous foliar application of growth regulators stimulate flowering, pollination, fertilization and seed setting to get maximum seed yield (Doddagoudar *et al.*, 2012) and it also determines important physiological changes such as cell division and expansion, and induces and increase flowering. It is also known to increase seed yield (Kumar *et al.* 2013)^[7]. However, very little scientific research work has been done on these aspects of agro-techniques in flower crops under Himachal Pradesh conditions. Therefore, present study is being undertaken in order to study the influence of planting dates, mulches and GA₃ applications on seed yield and quality of marigold cv. 'Pusa Narangi Gandha'

2. Materials and Methods

The experiment was designed to observe the effect of planting dates, mulches and GA₃ applications on seed yield and quality of Marigold (*Tagetes Erecta* L.) cv. 'Pusa Narangi Gandha'. The study was conducted at Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) in two consecutive years i.e. 2015-16 and 2016-17. The experiment includes three planting dates (1st week of July, 3rd week of July & 1st week of August), different mulching material like Black plastic mulch, Silver-black plastic mulch & Crop residue mulch along with control. The foliar spray of GA₃@ 0, 50, 100 & 150ppm were given after 45 days of transplanting. The treatments were arranged in a design split-plot with three replications. Recommended cultural practices were followed. Observations on number of seeds per head, seed yield per plant and per plot, 1000 seed weight, germination percentage, seed vigour index- L and seed vigour index -M were recorded.

3. Results and Discussion

The results on the effect of planting dates, mulching and application of GA₃ on seeds yield per head is presented in Table 1 where significant differences were observed among the planting dates × mulch and planting dates × GA₃ where as

interaction between planting dates, mulch and GA₃ was found Non- significant. In regard to Planting dates maximum number of seeds per head were recorded in 1st week of July i.e. 271.90 seeds. Among the mulching maximum seeds yield per head (243.57) was recorded with silver black plastic mulch (M₄) and in case of GA₃ @ 150 ppm observed maximum number of seed per head (230.87). July 1st week transplanted crop produced the highest seed yield per plant, which might be due to increased number of flowers per plant. The foliar application of GA₃ has resulted in increased proper development of seed.

The seed yield per plant was significantly higher in 1st week of July i.e.18.86 g along with application of silver black mulch (18.60g) and GA₃ @ 150 ppm (17.84 g) presented in table 2. Increase in seed yield per plant can be attributed to increase in number of branches per plant, number of capitulum per plant and 1000 seed weight. The results are in conformity with the reports of Shivaprasad Shetty (1995) in China aster, Shivakumar (2000)^[13] in marigold by GA₃ spray. Significant differences were recorded for the character seed yield per square meter among the planting dates (P), mulch (M) and GA₃ (G) but their interactions found to be non significant (P×M×G) (Table 3). Among the planting dates (P), the highest seed yield per square meter (168.98 g) was recorded in P1 (1st week of July). Among the mulches silver-black mulch (M₄) and GA₃ (G₄) attributed the maximum seed yield per square meter was 171.30 g and 159.22g respectively. The highest seed yield was observed in July planting as a result of increased growth period under suitable climate condition there by increased production of larger quantity of seed yield per square meter. These results are in conformity with Seghatoleslami and Mousavi (2009)^[10] in pot marigold (*Calendula officinalis* L.).

Thousand seed weight increased significantly by silver-black mulch and GA₃ @150 ppm as compared to control in 1st week of July (2.98). The maximum 1000 seed weight was recorded with silver- black mulch(3.46g) and GA₃ @150 ppm (3.03 g) and Increase in 1000 seed weight might be due to increase in individual seed weight. Similar findings on increase in 1000 seed weight due to chemical sprays were reported by Sunitha (2007)^[12] in marigold with GA₃, Doddagoudar *et al.* (2004)^[2] in China aster due to GA₃.

The results presented in Tables 5 indicate that the Planting date (P1), silver-black mulch (M₄) and GA₃ (G₄) and their interactions were significantly affected the trait germination percentage of seed produced. Among the planting dates (P) the highest germination percentage (82.57 %) was recorded in P1 along with with silver- black mulch(85.27 %) and GA₃ @150 ppm (79.70%). Seedling vigour index (SVI) length and mass was significantly influenced by all the Planting date (P1), silver-black mulch (M₄) and GA₃ (G₄) and their interactions were also significantly different as presented in tables 6 and 7. Our findings are in agreement with the results of Shivaprasad Shetty (1995) and Doddagoudar *et al.* (2004)^[2] in China aster and Sunitha (2007)^[12] in marigold.

Table 1: Effect of planting dates, mulching and GA₃ applications on number of seed per head of marigold

	P1					P2					P3					M*G				
	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean
G1	232.42	251.40	269.10	295.73	262.16	214.55	221.50	232.06	240.19	227.08	145.49	166.07	171.83	177.75	165.28	197.49	212.99	224.33	237.89	218.17
G2	244.79	257.33	271.95	299.97	268.51	217.55	223.06	236.52	240.29	229.36	151.19	167.47	174.53	180.68	168.47	204.51	215.95	227.67	240.31	222.11
G3	248.89	265.06	281.09	307.93	275.74	222.90	227.46	239.33	241.79	232.87	159.95	170.11	176.72	185.02	172.95	210.58	220.87	232.38	244.91	227.19
G4	251.67	270.53	285.98	316.53	281.18	221.59	232.04	240.42	247.11	235.29	163.68	173.88	177.21	189.83	176.15	212.31	225.48	234.54	251.16	230.87
Mean	244.44	261.08	277.03	305.04	271.90	219.15	226.01	237.08	242.35	231.15	155.08	169.38	175.07	183.32	170.71	206.22	218.82	229.73	243.57	

C.D at 5% for:

Planting Dates: 1.91

Mulching: 2.28

GA₃: 2.28

Planting Dates × Mulching: 3.94

Planting Dates × GA₃: 3.94Mulching × GA₃: NSPlanting Dates × Mulching × GA₃: NS**Table 2:** Effect of planting dates, mulching and GA₃ applications on number of seed yield per plant (g) of marigold

	P1					P2					P3					M*G				
	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean
G1	9.84	17.00	18.67	19.73	16.31	10.00	16.00	16.67	17.00	14.92	9.12	11.03	14.00	13.68	11.96	9.65	14.68	16.44	16.80	14.40
G2	14.70	18.33	19.67	21.67	18.59	13.00	16.00	17.00	17.33	15.83	9.78	12.70	13.67	15.67	12.95	12.49	15.68	16.78	18.23	15.79
G3	16.96	19.25	18.67	23.80	19.67	14.00	16.00	17.00	18.00	16.25	11.45	13.70	14.33	14.92	13.60	14.13	16.32	16.67	18.91	16.51
G4	17.36	19.33	20.99	25.84	20.88	16.00	16.33	17.00	19.67	17.25	12.02	13.99	15.33	15.89	14.31	15.13	16.55	17.78	20.46	17.48
Mean	14.71	18.48	19.50	22.76	18.86	13.25	16.08	16.92	18.00	16.06	10.59	12.86	14.33	15.04	13.21	12.85	15.81	16.92	18.60	

C.D at 5% for:

Planting Dates: 0.38

Mulching: 0.45

GA₃: 0.45

Planting Dates × Mulching: 0.79

Planting Dates × GA₃: 0.79Mulching × GA₃: 0.91Planting Dates × Mulching × GA₃: NS**Table 3:** Effect of planting dates, mulching and GA₃ applications on number of seed yield per plot (g) of marigold

	P1					P2					P3					M*G				
	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean
G1	90.83	127.50	172.50	186.09	144.23	90.68	128.99	145.50	154.85	130.00	84.78	100.65	123.06	130.58	109.77	88.76	119.05	147.02	157.17	128.00
G2	120.27	159.00	180.00	195.03	163.58	105.03	145.31	153.21	157.14	140.17	95.01	114.14	124.50	142.64	119.07	106.77	139.48	152.57	164.94	140.94
G3	152.61	173.28	177.00	214.20	179.27	121.01	145.34	153.87	163.82	146.01	105.89	123.14	129.03	142.13	125.04	126.50	147.25	153.30	173.38	150.11
G4	156.21	174.00	188.94	235.53	188.67	144.84	148.34	157.59	185.79	159.14	108.96	124.67	138.00	147.81	129.86	136.67	149.00	161.51	189.71	159.22
Mean	129.98	158.45	179.61	207.71	168.94	115.39	141.99	152.54	165.40	143.83	98.66	115.65	128.65	140.79	120.93	114.68	138.69	153.60	171.30	

C.D at 5% for:

Planting Dates: 3.39

Mulching: 4.13

GA₃: 4.13

Planting Dates × Mulching: 7.16

Planting Dates × GA₃: 7.16Mulching × GA₃: 8.26Planting Dates × Mulching × GA₃: NS**Table 4:** Effect of planting dates, mulching and GA₃ applications on 1000 seed weight (g) of marigold

	P1					P2					P3					M*G				
	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean
G1	2.20	2.05	3.01	3.58	2.71	2.09	2.06	2.91	3.23	2.57	1.87	2.45	2.78	3.09	2.55	2.05	2.19	2.90	3.30	2.61
G2	2.29	2.19	3.16	3.73	2.84	2.13	2.24	3.04	3.46	2.72	2.17	2.72	2.94	3.18	2.75	2.20	2.38	3.05	3.46	2.77
G3	2.42	2.94	3.28	3.83	3.12	2.21	2.72	3.09	3.52	2.89	2.43	2.80	2.93	3.17	2.83	2.35	2.82	3.10	3.51	2.94
G4	2.76	2.99	3.34	3.95	3.26	2.21	2.77	3.19	3.61	2.95	2.66	2.72	2.99	3.22	2.90	2.54	2.83	3.17	3.59	3.03
Mean	2.42	2.54	3.20	3.77	2.98	2.16	2.45	3.06	3.46	2.78	2.28	2.67	2.91	3.16	2.76	2.29	2.55	3.05	3.46	

C.D at 5% for:

Planting Dates: 0.06

Mulching: 0.07

GA₃: 0.07

Planting Dates × Mulching: 0.17

Planting Dates × GA₃: 0.17Mulching × GA₃: 1.13Planting Dates × Mulching × GA₃: 0.23

Table 5: Effect of planting dates, mulching and GA₃ applications on germination percentage (%) of marigold

	P1					P2					P3					M*G				
	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean
G1	74.06	74.85	82.34	86.02	79.32	70.73	70.30	81.96	85.32	77.08	50.55	55.40	67.00	73.36	61.58	65.11	66.85	77.10	81.57	72.66
G2	75.68	77.85	84.60	88.87	81.75	73.34	73.85	82.60	87.55	79.34	51.90	62.71	67.74	76.18	64.63	66.97	71.47	78.31	84.20	75.24
G3	76.26	79.84	85.36	92.39	83.46	75.19	80.00	84.76	90.05	82.50	53.88	64.41	69.56	78.11	66.49	68.44	74.75	79.89	86.85	77.48
G4	78.51	83.16	86.60	94.76	85.76	80.01	82.16	88.17	91.10	85.36	55.22	65.48	71.81	79.48	68.00	71.25	76.93	82.19	88.45	79.70
Mean	76.13	78.92	84.73	90.51	82.57	74.82	76.58	84.37	88.51	81.07	52.89	62.00	69.03	76.78	65.17	67.94	72.50	79.37	85.27	

C.D at 5% for:

Planting Dates: 0.42

Mulching: 0.49

GA₃: 0.49

Planting Dates × Mulching: 0.84

Planting Dates × GA₃: 0.84Mulching × GA₃: 1.97Planting Dates × Mulching × GA₃: 0.69**Table 6:** Effect of planting dates, mulching and GA₃ applications on SVI-I (length-mm) of marigold

	P1					P2					P3					M*G				
	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean
G1	744.80	855.22	1097.82	1337.75	1008.90	362.95	576.16	863.39	1047.54	712.51	315.16	441.31	531.90	727.76	504.03	474.30	624.23	831.03	1037.68	741.81
G2	853.77	994.18	1189.07	1418.87	1113.97	381.78	727.48	898.52	1063.50	767.82	335.96	512.80	566.99	776.59	548.09	523.84	744.82	884.86	1086.32	809.96
G3	930.90	1095.31	1236.82	1478.55	1185.40	438.11	756.25	929.45	1127.05	812.71	367.41	529.75	624.29	869.00	597.61	578.81	793.77	930.19	1158.20	865.24
G4	971.22	1135.10	1344.00	1565.92	1254.06	550.49	860.67	1069.88	1262.74	935.94	383.29	574.16	683.67	940.42	645.38	635.00	856.64	1032.51	1256.36	945.13
Mean	875.17	1019.95	1216.93	1450.27	1140.58	433.33	730.14	940.31	1125.21	807.25	350.46	514.51	601.71	828.44	573.78	552.99	754.87	919.65	1134.64	

C.D at 5% for:

Planting Dates: 17.88

Mulching: 20.64

GA₃: 35.74

Planting Dates × Mulching: 35.75

Planting Dates × GA₃: 35.75Mulching × GA₃: 41.28Planting Dates × Mulching × GA₃: 71.49**Table 7:** Effect of planting dates, mulching and GA₃ applications on number of SVI-II (mass-mg) of marigold

	P1					P2					P3					M*G				
	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean	M1	M2	M3	M4	Mean
G1	537.61	553.61	682.68	745.34	629.81	500.51	519.99	589.61	735.51	586.41	296.25	360.27	454.18	496.25	401.74	444.79	477.96	575.49	659.03	539.32
G2	559.47	555.03	699.39	790.08	650.99	524.27	531.45	616.61	781.38	613.43	321.46	407.57	449.11	485.06	415.80	468.40	498.02	588.37	685.51	560.07
G3	569.85	620.57	738.97	976.67	726.52	553.16	605.62	616.26	866.36	660.35	332.45	432.72	457.43	520.24	435.71	485.15	552.97	604.22	787.76	607.53
G4	600.24	679.66	766.72	1222.34	817.24	595.54	617.91	690.77	1029.81	733.51	359.81	430.53	482.55	553.87	456.69	518.53	576.03	646.68	935.34	669.15
Mean	566.79	602.22	721.94	933.61	706.14	543.37	568.74	628.31	853.27	648.42	327.49	407.77	460.82	513.85	427.48	479.22	526.25	603.69	766.91	

C.D at 5% for:

Planting Dates: 15.17

Mulching: 17.52

GA₃: 17.52

Planting Dates × Mulching: 30.34

Planting Dates × GA₃: 30.34Mulching × GA₃: 35.04Planting Dates × Mulching × GA₃: 60.69

4. Conclusion

From the present investigations it can be concluded that the treatment combination of 1st week of July planting dates, silver-black plastic mulch along with foliar spray of GA₃@ 150ppm after 45 days of transplanting was found superior over all other treatments in terms of seed yield and seed quality characters.

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