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EFFECT OF LAND CONFIGURATION AND NUTRIENT MANAGEMENT ON GROWTH AND YIELD OF AFRICAN MARIGOLD VAR. PUNJAB GAINDA-1 UNDER SOUTH GUJARAT CONDITIONS

SANGEETHA PRIYA S.[1], DIPAL S. BHATT[1]*, CHAWLA S. L.[1], S. T. BHATT[2] AND G. D. PATEL[3]
[1]Department of Floriculture and Landscape Architecture,
ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari - 396 450, Gujarat, INDIA
[2]Polytechnic in Horticulture, Navsari Agricultural University, Navsari - 396 450, Gujarat, INDIA
[3]Polytechnic in Horticulture, Navsari Agricultural University, Paria - 396 145, Gujarat, INDIA
e-mail ID: dipalk1984@gmail.com

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***Corresponding author**

ABSTRACT
The experiment was laid out in split plot design with nine treatment combinations, consisting of three land configuration methods *i.e.* flat bed (L_1), raised bed (L_2) and ridge and furrow system (L_3) and three doses of fertilizers *i.e.* 10 t FYM + 100% RDF/ha (N_1), 8 t FYM + 80% RDF/ha (N_2) and 6 t FYM + 60% RDF/ha (N_3) replicated five times. The results revealed that maximum plant height (104.41 cm), plant spread (70.95 cm and 73.18 cm in N-S and E-W directions, respectively), more number of branches (11.91/plant), earlier flowering, prolonged flowering duration (99.67 days) and extended shelf life (4.40 days) with the flower yield of 14.62 t/ha were obtained from the plants grown on raised bed system. Moreover, plants receiving 10 t/ha FYM + 100% RDF (150:100:100 kg NPK/ha) improved the plant vegetative growth in terms of maximum plant height (98.46 cm), plant spread (65.75 cm and 68.53 cm in N-S and E-W directions, respectively), no. of branches (10.13), fresh and dry weight of plant (966.53 g and 473.60 g, respectively) and flowering characters like early flowering, maximum flower diameter (4.91 cm), weight of 10 flowers (61.55 g), no. of flowers (128.16/plant), longest flower duration (96.93 days) and maximum shelf life (3.73 days) with the flower yield being 500.68 g/plant and 11.30 t/ha.

INTRODUCTION

African marigold (*Tagetes erecta* L.) belonging to the family Asteraceae occupies an importance place in ornamental horticulture. It is commercially grown and extensively used on religious and social functions as well as in landscaping. Moreover, marigold flowers contain a valuable anti-oxidant compound called lutein, which is used as feed additive in poultry industry to intensify the yellow colour of egg and broiler skin of chicken (Dipal *et al.*, 2016). Jambhulkar *et al.* (2012) reported that intercrop of marigold in tomato gave additional monetary gain due to fruit borer (*Helicoverpa armigera*) management. In India, marigold is cultivated in an area of 66,130 ha with the production of 6,03,180 MT (Anonymous, 2017). Its profuse flowering habit, short duration to produce marketable flowers and good keeping quality attracted the attention of producers and traders most.

Despite these advantages, the marigold cultivation is found to be extremely affected by heavy rains during its peak season of demand which may be attributed to the poor soil characteristics. Majority of the soils under heavy rainfall zones of south Gujarat are characterized by low infiltration, poor internal drainage, loss of soil structure, low organic matter, high cation exchange capacity and alkaline reaction which makes the soil less suitable for crop cultivation. In rainfed areas with poor soil properties, land configuration could help in conservation of maximum possible rainwater in the soil as the soil profile acts as reservoir of moisture storage (Narkhede *et al.*, 2015). Land management system plays a significant role in minimizing soil erosion, improving water use efficiency and increasing nutrient availability to crops (Chiroma *et al.*, 2008). Better land configuration may ameliorate soil fertility and break the cycle of weed and disease complex against the cultivated crop over extended period of time (Indu Bala *et al.*, 2016). Thus, the physical conditions of soil can be improved through land management system to enhance crop production (Ardeshna *et al.*, 2013).

Besides land configuration, the successful commercial cultivation of marigold depends on nutrition for good plant growth and yielding ability of crop. Nitrogen is an essential part of nucleic acid which promotes the vegetative growth in terms of plant growth and spread (Gupta and Prashad, 1991). Phosphorous is involved in many physiological processes including cell division, development of meristematic tissues, photosynthesis, metabolism of carbohydrates, fats and proteins (Sharma *et al.*, 2006). Potassium improves the quality of the produce which determines the market value of flowers. As these nutrients are insufficient and less available in the soil, there will be great demand for chemical fertilizers to overcome such impediments. Application of N, P and K through inorganic fertilizers can enhance the growth and yield of the crop considerably (Mamta *et al.*, 2017). But the indiscriminate

application of chemical fertilizers hampers the soil fertility and also increases the cost of cultivation which seems unaffordable by small and marginal farmers. Thus, arriving at an optimum dose of fertilizers with proper land configuration is expected to improve the flower production in African marigold economically. Keeping these points in view, the present investigation was carried out to study the effect of land configuration and nutrient management on growth and yield of African marigold var. Punjab Gainda-1 under south Gujarat conditions.

MATERIALS AND METHODS

An experiment was carried out at Floriculture Research Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during *Kharif* 2018. The soil of the experimental site was deep, moderately clay with good water holding capacity, medium to poor drainage, pH 7.10, electrical conductivity 0.468 dS m^{-1}, 0.692% organic carbon, 263.82 kg/ha available N, 39.64 kg/ha available P_2O_5, 320.36 kg/ha available K_2O, 1.264% bulk density and 80.20% aggregate stability. The experiment was laid out in split plot design with nine treatment combinations comprising three land configuration methods *viz.*, flat bed (L_1), raised bed (L_2) and ridge and furrow system (L_3) and three doses of fertilizers *viz.*, 10 t FYM/ha + 100% RDF (150:100:100 kg NPK/ha) (N_1), 8 t FYM/ha + 80% RDF (120:80:80 kg NPK/ha) (N_2) and 6 t FYM/ha + 60% RDF (90:60:60 kg NPK/ha) (N_3) replicated five times.

Uniform sized, well developed one month old seedlings having 3-4 leaves were transplanted at the spacing of 60 cm x 40 cm. The marigold seedlings were planted on different land configuration system according to treatment. Two equal doses of nitrogen in the form of urea was applied during transplanting as basal dose and after pinching as top dressing whereas, full dose of phosphorous and potassium were given in the form of single super phosphate and muriate of potash, respectively at the time of transplanting as per treatment. Harvesting is done early in the morning when central whorls of petals are fully opened. The observations on vegetative, flowering and yield parameters were recorded from tagged plants in the net plot of each treatment and statistically analyzed as described by Panse and Sukhatme (1985).

Plant height was measured at 90 DAT from the ground level to the highest point of the plant with the help of scale. Plant spread in N-S and E-W directions were recorded by measuring the distance between the outermost leaves in the respective directions separately at 90 DAT. Number of branches was observed by counting the number of main branches at the time of flowering. At the end of the experiment, the plants were uprooted, adhering soil particles were removed and weighed for recording fresh weight of the plant. These plants were sun dried until reaching the constant weight and weighed for observing dry weight of the plant. Days to bud initiation, bud opening and 50% flowering were recorded by counting the days from the date of transplanting. Fully opened flowers were randomly selected and measured for flower diameter using vernier caliper during second picking. Fresh weight of 10 flowers was recorded by weighing 10 fully opened flowers from each plant during second picking. The number of days taken from the date of first flower opening to the last flowering constituted the flowering duration. Ten fully opened flowers were kept under ambient conditions to observe the shelf life of flowers by counting the days from harvesting to flower senescence. Yield of flowers produced per plant were converted to hectare basis by deriving the plant population per hectare.

RESULTS AND DISCUSSIONS

Effect on growth parameters

Data presented in Table 1 revealed that different land configuration methods and application of different fertilizer doses had significant effect on growth parameters of African marigold var. Punjab Gainda-1.

Effect of land configuration

The results revealed that raised bed planting method for marigold significantly achieved vigorous growth in terms of maximum plant height (104.41 cm), plant spread (70.95 cm and 73.18 cm in N-S direction and E-W direction, respectively), number of branches per plant (11.91), fresh weight of plant (1083.60 g) and dry weight of plant (594.80 g). This improved growth might be due to better aeration, good drainage, soil plant water relationship, better soil physical conditions and moisture management during water logging conditions associated with raised bed system (Ankita, 2015). Good aeration also speeds up the mineralization rate thus enhancing the growth characters considerably (Kumar and Singh, 2014). Significant improvement noticed in vegetative parameters as influenced by raised bed configuration might be due to adequate moisture conservation during the crop growth period which enhanced the cell division and elongation resulting in taller plants with more dry weight per plant (Augustina *et al.*, 2017). These results are in accordance with Kumar *et al.* (2016) in marigold, Chawla *et al.* (2018) in tuberose, Kumar and Singh (2014) in French bean and Ardeshna *et al.* (2013) in turmeric.

Effect of nutrient management

Application of 10 t FYM/ha + 100% RDF (150:100:100 kg NPK/ha) enhanced the growth parameters like plant height (98.46 cm), plant spread (65.75 cm and 68.53 cm in N-S direction and E-W direction, respectively), number of branches per plant (10.13), fresh weight of plant (966.53 g) and dry weight of plant (473.60 g). The improved growth noticed might be due to better soil physical conditions because of abundant farmyard manure, prolonged availability of macro and micronutrients to crop during entire growing season (Augustina *et al.*, 2017). The overall enhancement in plant growth with the addition of fertilizers could be ascribed to their vital role in physiological and biochemical processes such as photosynthesis, energy transfer reaction and root development (Tomar *et al.*, 2016). Similar results are highlighted by Acharya and Dashora (2004) in African marigold, Ahmed *et al.* (2017) in French marigold and Priyadarshini (2018) in China aster.

Effect on flowering parameters

Data with respect to flowering parameters of African marigold var. Punjab Gainda-1 as influenced by different methods of

Table 1: Effect of land configuration and nutrient management on growth parameters of African marigold var. Punjab Gainda-1

Treatments	Plant height (cm)	Plant spread (N-S) (cm)	Plant spread (E-W) (cm)	No. of branches per plant	Fresh weight of plant (g)	Dry weight of plant (g)
Land configuration (L)						
L_1	89.47	60.50	62.64	8.26	736.93	338.33
L_2	104.41	70.95	73.18	11.91	1083.60	594.80
L_3	92.87	61.20	62.77	8.63	890.53	428.53
S.Em. ±	1.82	1.28	1.01	0.24	30.10	13.65
C.D. at 5%	5.92	4.19	3.30	0.79	98.16	44.52
Nutrient management (N)						
N_1	98.46	65.75	68.53	10.13	966.53	473.60
N_2	97.24	65.70	68.25	9.90	925.60	470.87
N_3	91.05	61.20	61.82	8.77	818.93	417.20
S.Em. ±	1.51	0.88	1.35	0.23	23.55	15.45
C.D. at 5%	4.42	2.56	3.93	0.66	68.73	45.08

Table 2: Effect of land configuration and nutrient management on flowering and quality parameters of African marigold var. Punjab Gainda-1

Treatments	Days to bud initiation	Days to bud opening	Days to 50% flowering	Flower diameter (cm)	Fresh weight of 10 flowers (g)	No. of flowers per plant	Flowering duration (days)	Shelf life (days)
Land configuration (L)								
L_1	59.93	71.47	80.73	4.44	55.17	103.72	87.47	2.73
L_2	47.06	60.95	69.93	5.36	65.05	139.53	99.67	4.40
L_3	58.51	69.68	79.93	4.60	55.69	105.36	89.27	2.87
S.Em. ±	1.28	1.14	1.56	0.12	1.50	2.81	1.49	0.09
C.D. at 5%	4.17	3.73	5.08	0.38	4.90	9.16	4.87	0.29
Nutrient management (N)								
N_1	53.97	66.27	72.47	4.91	61.55	128.16	96.93	3.73
N_2	54.98	66.56	75.93	4.89	61.48	127.97	94.53	3.67
N_3	56.54	69.27	82.20	4.62	52.89	92.48	84.93	2.60
S.Em. ±	0.67	0.83	1.37	0.09	1.40	1.58	1.82	0.10
C.D. at 5%	1.95	2.42	4.01	0.25	4.08	4.60	5.31	0.30

Table 3: Effect of land configuration and nutrient management on yield parameters of African marigold var. Punjab Gainda-1

Treatments	Flower yield per plant (g)	Flower yield per ha (t)
Land configuration (L)		
L_1	358.76	8.99
L_2	567.11	14.62
L_3	436.33	9.03
S.Em. ±	11.32	0.29
C.D. at 5%	36.91	0.95
Nutrient management (N)		
N_1	500.68	11.30
N_2	477.16	11.25
N_3	384.35	10.09
S.Em. ±	10.65	0.17
C.D. at 5%	31.09	0.50

land configuration and application of different fertilizer doses are presented in Table 2.

Effect of land configuration

Significantly early bud initiation (47.06 days), minimum days to bud opening (60.95 days) and days to 50% flowering (69.93 days) were observed with plants grown on raised bed system (L_2). This might be due to increased activity of metabolism, cell differentiation and enzymatic reaction which are associated with reduced moisture stress, better nutrient solubility and continuous nutrient availability in raised bed system resulting in structural change of leaf primordia to floral primordia. Moreover, raised bed configuration resulted significantly highest flower diameter (5.36 cm), fresh weight of 10 flowers (65.05 g) and number of flowers per plant (139.53) which might be because of continuous moisture present in the soil throughout the growing season enhancing the cell division and cell size, ultimately increasing the number and weight of the flowers. It might also be due to higher dry matter accumulation and photosynthetic reserves because of continuous moisture retention and nutrient uptake in raised bed system. Similar improvement in quality parameters were reported by Chawla *et al.* (2018) in tuberose and Maheriya *et al.* (2015) in radish. Raised bed system also prolonged the flowering duration (99.67 days) and shelf life (4.40 days) of

flowers due to maximum food reserves, better water and nutrient uptake, reduced starvation for nutrient and water attributed by good soil structure and physical conditions. These findings are in close conformity with Kumar and Singh (2014) in French bean, Sodavadiya *et al*. (2017) in Indian bean and Ardeshna *et al*. (2013) in turmeric.

Effect of nutrient management

Application of 10 t FYM/ha + 100% RDF (150:100:100 kg NPK/ha) *i.e.* N_1 recorded maximum flower diameter (4.91 cm), number of flowers per plant (128.16), fresh weight of 10 flowers (61.55 g) with earlier bud initiation (53.97 days), bud opening (66.27 days) and 50% flowering (72.47 days). Moreover, extended flowering duration (96.93 days) and shelf life (3.73 days) were observed in plants applied with 10 t FYM/ha + 100% RDF (150:100:100 kg NPK/ha). This improvement might be due to favourable influence of fertilizers on greater partitioning of metabolites and adequate translocation of photosynthates and nutrients to the developing reproductive structures. As the number of branches per plant were higher with the above treatment, sufficient food material accumulated in the vegetative parts through photosynthesis might have diverted towards the reproductive structures to induce early flowering (Ahmed *et al.*, 2017). These findings are in similarity with the earlier reports of Ahmed *et al*. (2017) in African marigold, Kumar and Kumar (2014) in China aster and Singh and Rashmi (2015) in chrysanthemum.

Effect on yield attributes

Data presented in Table 3 revealed that effect of different methods of land configuration and nutrient management had significant effect on yield attributes of African marigold var. Punjab Gainda-1.

Effect of land configuration

Significantly maximum flower yield (567.11 g per plant and 14.62 t per ha) were obtained in plants grown on raised bed system (L_2). This higher flower yield might be due to better drainage and aeration maintaining proper air and water balance in the plants which resulted in enhanced vegetative growth, early flowering and longer flowering duration. More photosynthates and dry matter accumulation due to enhanced plant height and plant spread might have increased the flower yield considerably. Also, maximum number of branches in plants grown on raised beds might have enhanced the number of flowers per plant which is directly related to the flower yield. The earlier bud initiation and earliest flowering achieved in raised bed system also had significant role in increasing the number of pickings and flowering duration which ultimately accelerates flower yield. Similar findings are reported by Kumar *et al*. (2016) in marigold, Chawla *et al*. (2018) in tuberose and Joshi *et al*. (2018) in cowpea.

Effect of nutrient management

Application of different fertilizer doses showed significant results with respect to yield attributes. Maximum flower production (500.68 g per plant and 11.30 t per ha) were noted with the application of 10 t FYM/ha + 100% RDF (150:100:100 kg NPK/ha) *i.e.* N_1. Application of higher doses of fertilizers which were sufficient to improve the vegetative characters might have accelerated photosynthesis, carbohydrate production and food accumulation in the vegetative parts of plants increasing flower yield. Early bud initiation and flowering might be achieved due to the translocation of food materials to the reproductive structures aided by accelerated carbohydrate and amino acid metabolism which maximized the flower production eventually. Also, the sufficient amount of fertilizers might have led to the accumulation of additional sugar and total sugar in plant body ultimately resulting in increased flower yield. These findings are similar with the works of Acharya and Dashora (2004) in African marigold, Ahmed *et al*. (2017) in French marigold, Shivshankar (2005) in chrysanthemum and Singh *et al*. (2014) in tuberose.

CONCLUSIONS

It can be concluded from the present study that marigold seedlings planted on raised bed system with the usual recommended dose of fertilizer could improve the growth, flowering quality and yield in African marigold var. Punjab Gainda-1 under south Gujarat conditions. The farmers could be benefitted by better plant growth and maximum returns associated with the compactness and excellent flower quality with adoption of proper land configuration method and appropriate fertilizer dose.

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