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Original Research Paper

Effect of land configuration and fertilizer dosage on growth and yield of African marigold under vertic ustochrept soil regimes

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ABSTRACT

Adopting proper land management systems and nutrient levels could improve growth, yield and quality by rendering better soil physical structure and mineral nutrition under heavy rainfall areas. An experiment was conducted to identify appropriate land configuration and fertilizer dose for African marigold var. Punjab Gainda-1, in split plot design with three land configuration methods *viz.*, flat bed, raised bed and ridge & furrow system as main plots, and three fertilizer doses (RDF/ha) *viz.*, 100%, 80% and 60% as subplots with recommended dose of fertilizer (RDF) being 10 t FYM + 150:100:100 kg/ha NPK. Results showed that adopting raised bed method of land configuration with the application of 8 t FYM + 120:80:80 kg/ha NPK exhibited enhanced vegetative growth and flower yield (16.26 t/ha) with greater benefit cost ratio (2.88) and, hence, found economically best for commercial production of African marigold.

Keywords : African marigold, fertilizer dose, land configuration, quality, yield

INTRODUCTION

African marigold (*Tagetes erecta* L.) belonging to the family Asteraceae, holds considerable importance in commercial floriculture due to its profuse flowering, short duration, ease of cultivation and wider acceptability across agro-climatic zones of the country. In India, marigold is being cultivated in 81,540 ha with the production of 9,23,430 MT (Anon., 2023). It is regarded as the 'State flower of Gujarat' since most of the festival celebrations in Gujarat rely on marigold loose flowers for decoration and worship. South Gujarat region receives relatively heavy rainfall with an average of 1675 mm. Its soil type is vertic ustochrept characterized by low infiltration, poor internal drainage, low organic matter and high cation exchange capacity. Thus, improving the physical conditions of soil to enhance crop production seems extremely important. This can partly be accomplished through land management system. 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).

Apart from land configuration, nutrition plays an important role in determining the growth and yielding ability of crop. However, their indiscriminate application alters the soil fertility leading to pollution of soil and water bodies, and also increases the cost of cultivation. Thus, deriving an optimal dose of fertilizers based on the fertility status of the above-mentioned soils could help the farmers of heavy rainfall area save additional expenditure and earn better revenue out of their produce. Keeping these issues in view, an experiment was conducted to assess the different land configuration methods and nutrient levels with respect to growth, quality and yield of African marigold var. Punjab Gainda-1 under south Gujarat conditions.

MATERIALS AND METHODS

The present investigation was conducted at Floriculture Research Farm, ASPEE College of Horticulture, Navsari Agricultural University, Navsari during *kharif* season of 2018. The experiment was laid out with nine treatment combinations in which three land configuration *viz.*, flat bed (L_1), raised bed (L_2) and ridge & furrow system (L_3) as main plots, and three fertilizer doses (RDF/ha) *viz.*, 100% (10 t FYM/ha + 150:100:100 kg, N_1), 80% (8 t FYM/ha + 120:80:80 kg NPK/ha, N_2) and 60% (6 t FYM/ha + 90:60:60 kg NPK/ha, L_3) as sub-plots with recommended dose of fertilizer (RDF) being 10 t FYM + 150:100:100 kg/ha NPK, were replicated five times in split plot design.

One month old marigold seedlings with 3-4 leaves were transplanted at the spacing of 60 cm x 40 cm at different land configuration treatments. Plants were applied with two equal doses of N in the form of urea during bed preparation and after pinching, whereas, full dose of P and K were applied as basal dose in the form of single super phosphate and muriate of potash, respectively as per the treatment. The observations were recorded on various vegetative, flowering and yield parameters from the net plot of each treatment and analyzed statistically as described by Panse & Sukhatme (1985) in Microsoft Office Excel 2007.

Observations on plant height, plant spread and number of branches per plant were recorded at 90 days after transplanting, whereas, fresh weight and dry weight of the plant were recorded at the end of experiment. Days to flower bud initiation, flower bud opening and 50% flowering were calculated from the date of transplanting to the date of first bud initiation, bud opening and the stage when the plot shows 50% flowering, respectively. Number of flowers per plant was counted during each picking and summed up at the end of the season. Similarly, flower yield was calculated by weighing flowers obtained from the single plant with the help of weighing balance. Fresh weight of 10 flowers and flower diameter were recorded at the time of second picking. The harvested flowers were kept under ambient conditions and the shelf life was calculated from the date of harvesting to flower senescence. Number of days taken from the date of first flower opening to the last flowering was recorded as the flowering duration.

RESULTS AND DISCUSSION

Effect of land configuration

Marigold plants grown on raised beds recorded significantly increased plant height (104.41 cm), plant spread (72.06 cm), number of branches per plant (11.91), fresh weight (1083.60 g) and dry weight (594.80 g) of plant when compared with flat bed system, thus, resulting in improved vegetative growth (Table 1). This might be associated with better aeration, drainage, root environment, nutrient utilization, soil plant water relationship and soil aggregate stability during water-logging conditions (Gudge, 2015). Moreover, plants on raised beds achieved first flower bud initiation, bud opening and 50% flowering by 12.87, 10.52 and 10.80 days earlier than those on flat beds, respectively, which might be due to hastened metabolic activities, cell differentiation and enzymatic reaction associated with structural change of leaf primordia to floral primordia.

Table 1 : Effect of land configuration on growth, flowering and yield of African marigold

Parameter	Flat bed	Raised bed	Ridge & furrow system	S.E.m±	C.D. at 5 %
Plant height (cm)	89.47	104.41	92.87	1.82	5.92
Plant spread (cm)	61.57	72.06	61.98	0.96	3.13
Number of branches per plant	8.26	11.91	8.63	0.24	0.79
Fresh weight of plant (g)	736.93	1083.60	890.53	30.10	98.16
Dry weight of plant (g)	338.33	594.80	428.53	13.65	44.52
Days to bud initiation	59.93	47.06	58.51	1.28	4.17
Days to bud opening	71.47	60.95	69.68	1.14	3.73
Days to 50% flowering	80.73	69.93	79.93	1.56	5.08
Flower diameter (cm)	4.44	5.36	4.60	0.12	0.38
Fresh weight of 10 flowers (g)	55.17	65.05	55.69	1.50	4.90
Number of flowers per plant	103.72	139.53	105.36	2.81	9.16
Flowering duration (days)	87.47	99.67	89.27	1.49	4.87
Shelf life (days)	2.73	4.40	2.87	0.09	0.29
Flower yield per plant (g)	358.76	567.11	436.33	11.32	36.91
Flower yield per ha (t)	8.99	14.62	9.03	0.29	0.95

Raised bed enhanced the flower production (139.53/ plant) by 34.53% than the flat beds along with maximum flower diameter (5.36 cm) and fresh weight of 10 flowers (65.05 g). Maximum food reserves, better water and nutrient uptake and reduced starvation in the plants grown on raised bed system attributed by good soil structure and physical conditions also might have exerted pronounced effects on flower quality of marigold. Further, flowering duration and shelf life were extended to 12.20 and 1.67 days, respectively, which might be associated with the consistent soil moisture availability under raised bed system. Enhanced flower yield (567.11 g/plant and 14.62 t/ha) in raised bed method which was 58-62% higher than the flat bed system could be associated with maximum number of branches and earlier bud development leading to maximum number of flowers per plant and more number of pickings, respectively. These findings were in agreement with Kumar et al. (2016) in marigold, Chawla et al. (2018) in tuberose and Kumar & Sharma (2018) in saffron.

Effect of nutrient management

Plants supplied with 10 t/ha FYM + 150:100:100 kg NPK/ha recorded maximum plant height (98.46 cm), plant spread (67.14 cm), number of branches per plant (10.13), plant fresh weight (966.53 g) and plant dry weight (473.60 g) followed by 80% RDF (Table 2). This might be because of higher availability of N and P which are directly involved in improving the vegetative growth and root development. The 100% RDF also resulted in maximum number of flowers per plant (128.16), flower diameter (4.91 cm), fresh weight of 10 flowers (61.55 g), flowering duration (96.93 days), flower yield (500.68 g/plant and 11.30 t/ha) and extended shelf life up to 3.73 days with minimum days to bud initiation (53.97), days to bud opening (66.27) and 50% flowering (72.47). The enhanced vegetative growth might have accelerated the photosynthesis, carbohydrate production and food accumulation in vegetative parts resulting in rapid transition to reproductive structures and higher number of pickings with amplified flower production. These findings are in accordance with the earlier reports of Kishore (2016) and Ahmed et al. (2017) in marigold, and Kitty et al. (2019) in chrysanthemum.

Interaction effect

Plant spread (78.33 cm) and the number of branches per plant (13.14) was significantly increased by 21 & 46%, respectively when the plants were grown on raised beds with the supply of 80% RDF compared to flat bed + 100% RDF. Similarly, number of flowers (165.68/ plant) and flower yield (16.26 t/ha) were enhanced by 29.11 and 59.10% with the raised bed system + 80% RDF (Table 3). These remarkable

Table 2 : Effect of different fertilizer doses (RDF/ha NPK) on growth, flowering and yield of African marigold

Parameter	100%	80%	60%	S.E.m ±	C.D. at 5 %
Plant height (cm)	98.46	97.24	91.05	1.51	4.42
Plant spread (cm)	67.14	66.97	61.51	0.87	2.53
Number of branches per plant	10.13	9.90	8.77	0.23	0.66
Fresh weight of plant (g)	966.53	925.60	818.93	23.55	68.73
Dry weight of plant (g)	473.60	470.87	417.20	15.45	45.08
Days to bud initiation	53.97	54.98	56.54	0.67	1.95
Days to bud opening	66.27	66.56	69.27	0.83	2.42
Days to 50% flowering	72.47	75.93	82.20	1.37	4.01
Flower diameter (cm)	4.91	4.89	4.62	0.09	0.25
Fresh weight of 10 flowers (g)	61.55	61.48	52.89	1.40	4.08
Number of flowers per plant	128.16	127.97	92.48	1.58	4.60
Flowering duration (days)	96.93	94.53	84.93	1.82	5.31
Shelf life (days)	3.73	3.67	2.60	0.10	0.30
Flower yield per plant (g)	500.68	477.16	384.35	10.65	31.09
Flower yield per ha (t)	11.30	11.25	10.09	0.17	0.50

Table 3 : Interaction effect of land configuration and fertilizer dosage on African marigold

Parameter	L_1N_1	L_2N_1	L_3N_1	L_1N_2	L_2N_2	L_3N_2	L_1N_3	L_2N_3	L_3N_3	S.Em.±	C.D. at 5 %
Plant height (cm)	95.50	104.74	95.14	88.10	109.86	93.75	84.81	98.63	89.71	2.62	NS
Plant spread (cm)	64.39	70.52	66.51	62.19	78.33	60.39	58.14	67.34	59.05	1.50	4.38
No. of branches per plant	9.00	11.88	9.50	8.18	13.14	8.38	7.60	10.70	8.02	0.39	1.14
Fresh weight of plant (g)	832.40	1125.60	941.60	699.20	1148.00	929.60	679.20	977.20	800.40	40.79	NS
Dry weight of plant (g)	377.20	571.60	472.00	323.40	659.20	430.00	314.40	553.60	383.60	26.75	NS
Days to bud initiation	59.08	45.80	57.04	61.42	46.56	56.96	59.28	48.83	61.52	1.16	NS
Days to bud opening	67.90	60.84	70.08	72.96	58.84	67.88	73.56	63.16	71.08	1.43	NS
Days to 50% flowering	74.80	66.00	76.60	84.20	65.20	78.40	83.20	78.60	84.80	2.38	NS
Flower diameter (cm)	4.32	5.47	4.92	4.56	5.62	4.47	4.44	5.00	4.42	0.15	NS
Fresh weight of 10 flowers (g)	61.08	66.98	56.58	56.78	69.80	57.86	47.66	58.38	52.64	2.42	NS
No. of flowers per plant	128.32	138.48	117.68	105.00	165.68	113.24	77.84	114.44	85.16	2.73	7.97
Flowering duration (days)	95.80	104.40	90.60	85.20	106.20	92.20	81.40	88.40	85.00	3.15	NS
Shelf life (days)	3.20	4.80	3.20	3.00	4.80	3.20	2.00	3.60	2.20	0.18	NS
Flower yield per plant (g)	422.66	545.97	533.41	361.39	657.37	412.72	292.22	497.98	362.86	18.45	53.86
Flower yield per ha (t)	10.22	13.14	10.55	8.36	16.26	9.13	8.38	14.47	7.42	0.30	0.87

Table 4 : Effect of land configuration and nutrient management on economics

Treatment	Yield (t/ ha)	Fixed cost (Rs./ha)	Variable cost (Rs./ha)	Total cost of cultivation (Rs./ha)	Gross returns* (Rs./ha)	Net returns (Rs./ha)	Benefit cost ratio
L_1N_1	10.22	61559	36415	97974	255475	157501	1.61
L_1N_2	8.36	61559	29666	91225	209075	117850	1.29
L_1N_3	8.38	61559	25845	87404	209600	122196	1.40
L_2N_1	13.14	61559	42175	103734	328425	224691	2.17
L_2N_2	16.26	61559	43200	104759	406425	301666	2.88
L_2N_3	14.47	61559	36553	98112	361725	263613	2.69
L_3N_1	10.55	61559	38725	100284	263625	163341	1.63
L_3N_2	9.13	61559	32658	94217	228150	133933	1.42
L_3N_3	7.42	61559	26131	87690	185375	97685	1.11

*Price of marigold flowers = Rs. 25/ kg

results might be due to cumulative effect of better soil conditions and deep root system attributed by raised bed configuration and continuous availability of soil nutrients throughout the growing season, better fertilizer use efficiency and nutrient uptake achieved with the nutrient application. However, the interaction effect remained non-significant for rest of the other parameters. Similar findings were also reported by Augustina et al. (2017) in guar gum and Sodavadiya et al. (2017) in Indian bean.

Economics

Data presented in Table 4 revealed that raised bed system along with application of 80% RDF gained higher net returns of Rs. 3,01,665 per ha with the benefit cost ratio of 2.88 in African marigold var. Punjab Gainda-1. The reduced cost of cultivation could be attributed to optimal fertilizer application and higher returns to the greater flower yield obtained by better nutrient availability and soil physical conditions.

CONCLUSION

It can be concluded that growing of marigold on raised bed system along with the application of 8 t/ha FYM + 120:80:80 kg/ha NPK (80% RDF) could enhance the vegetative, flowering and yield attributes with maximum net returns in African marigold var. Punjab Gainda-1 under high rainfall areas having vertic

ustochrept type of soil. Thus, the farmers could be benefitted by better plant growth with the adoption of proper land configuration and less production costs with the application of optimized fertilizer dose. This would also be environmentally sustainable as it curbs the indiscriminate application of fertilizers and maintains the soil health.

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