RESEARCH ARTICLE

SABRAO Journal of Breeding and Genetics
55 (5) 1604-1615, 2023
http://doi.org/10.54910/sabrao2023.55.5.14
http://sabraojournal.org/
pISSN 1029-7073; eISSN 2224-8978

FLOWERING ANNUALS PRODUCTION BEHAVIOR AGAINST DIVERSE NUTRITIONAL MANAGEMENT

F. KHAN[1], M. IQBAL[1], M. MOHIBULLAH[1], S.S. AAMIR[2], and S.A. JATOI[2*]

[1]Faculty of Agriculture, Gomal University, Dera Ismail Khan, Pakistan
[2]Plant Genetic Resources Institute, National Agriculture Research Center, Islamabad, Pakistan
*Corresponding author's email: sajatoi@gmail.com
Email addresses of co-authors: cdafarid@gmail.com, drmiqbal_61@hotmail.com, drmohib74@gmail.com, sana.syeda2014@gmail.com

SUMMARY

The marigold and zinnia are prominent in the horticulture industry and are widely growing flowering annuals in Pakistan. The well-timed study sought to investigate the effect of different fertilizer combinations on flowering annuals marigold and zinnia. The experiment comprised a completely randomized design with four replications during 2019 and 2020 at the Plant Genetic Resource Institute, National Agricultural Research Center, Islamabad, Pakistan. The data included recording days to bud formation (DBF), days to flower persistence (DFP), flowers per plant (NFP), and days to flower senescence (DFS). Significant differences were recordable among the genotypes and treatments. Average DBF under applications of NPK fertilizers and Grow More + HB101 + Vitafeed (foliar application) revealed higher during the first year of study compared with the second year. The most effective foliar application treatment for DBF of marigold and zinnia resulted in 0.18 g Grow More + 0.18 g HB101 + 0.18 g Vitafeed. A higher number of DBF marigolds occurred for treatment 20% N + 16% P + 14% K, and the same emerged for NFP. Average days for flower persistence in marigold and zinnia were higher under manures application compared with NPK and foliar application. The higher number of DFP of both plants existed for treatment 75% leaf compost (LC) + 25% soil. The organic and inorganic fertilizers may help develop plant health, resistance to early flower senescence, and large flower size of both marigold and zinnia.

Keywords: Marigold (*Tagetes erecta*), zinnia (*Zinnia elenegans*), foliar application, nutritional practices, chemical fertilizers, growth and flowering traits

Key findings: Both organic and inorganic fertilizers are vital in promoting the complete health and quality of marigold and zinnia flowers..

Communicating Editor: Dr. Samrin Gul

Manuscript received: April 13, 2023; Accepted: July 24, 2023.

Citation: Khan F, Iqbal M, Mohibullah M, Aamir SS, Jatoi SA (2023). Flowering annuals production behavior against diverse nutritional management. *SABRAO J. Breed. Genet.* 55(5): 1604-1615. http://doi.org/10.54910/sabrao2023.55.5.14.

INTRODUCTION

Production of seasonal flower crops is a lucrative business and practice globally. In the past 50 years, the cut flower market has changed dramatically to an international one. Flower and cut flower foliage worldwide are sold as bunches or combined into an arrangement and bouquets in the prime target (Aziz *et al*., 2016; Mohsin *et al*., 2023). The marigold (*Tagetes erecta*) places prominently in ornamental horticulture, a commercially exploited flower crop. It is an eminent ornamental, medicinal, and decorative plant. The floral industry in Pakistan hugely benefits from these blooming annual plants, which acquire seeds from local and exotic sources.

Flowers, single or double, are exceptionally fascinating in yellow and orange. The plant can grow in soil types, from sand to clay (Shubha, 2006; Hussain *et al.*, 2011). Similarly, zinnia (*Zinnia elenegans*) is a beautiful summer annual flower, gaining rapid popularity for its varied, colorful blooms. The most cultivated zinnia varieties, "Blue Point" and "Oklahoma," are the best because of their superior performance and various color blooms. The flowers have a range of appearances, from a single row of petals to a dome shape, with colors white, chartreuse, yellow, orange, red, purple, and lilac (Riaz *et al.,* 2008; Baloch *et al.,* 2010; Gola *et al.,* 2018).

Production of the high-quality yield of marigolds and zinnias, high-population growth rate, and rapid urbanization have forced farming communities to depend totally upon chemical fertilizers. Organic fertilizers have served as a source to increase soil fertility for thousands of years. Organic fertilizers promote better soil structure, supply nutrients, and even improve plant growth (Onofrei *et al.,* 2017). Using inorganic fertilizers is insufficient because of high prices and nonavailability in the market, with leached fertilizers contaminating the subsurface water table and damaging the ecosystem.

Manure from different animals may have different compositions and require different application rates. Ordinary forms of animal manure include FYM (farmyard manure) or farm slurry (liquid manure) from farm animals (Shah *et al.,* 2014). Minimum attempts have taken place to study the efficiency of organic with inorganic fertilizers on growth, flower yield, and xanthophyll content of French marigolds and zinnias. This research attempted to explore the comparative effect of different liquid fertilizers and doses on zinnia and marigold flowering to know better fertilizer application modes on zinnia and marigold flowers, obtain better vegetative growth and flowering in zinnia and marigold by using different organic manures, and work out the economics of nutrient management in seasonal flowers production.

MATERIALS AND METHODS

Conducting different experiments in 2019 and 2020 occurred to accomplish this study at the Plant Genetic Resource Institute, National Agricultural Research Center, Islamabad, Pakistan. The chief objective was to investigate the effects of different doses of liquid fertilizers, various combinations of manures, and NPK fertilizers on enhancing the marigolds and zinnias' growth and floral characteristics. The seeds with more than 90% germination, obtained from the market, proceeded to sow in pots in the first week of January yearly. The soil's slight moisture maintenance used water sprinkling until the seed germinated. Afterward, watering continued two to three times a week. After four weeks, seedlings transplant followed to big pots with 30 cm height and 30 cm diameter dimension. After three weeks of transplantation, the application of liquid fertilizers as foliar spray ensued while mixing others with the growing media used.

Detail of treatments

Three pot experiments transpired to achieve the objectives of this study. The description of treatment details appears in Table 1. Three different fertilizers used included HB-101 (granular multipurpose natural plant vitalizer), Vitafeed 111 (multipurpose soluble feed), and Grow More (water-soluble fertilizer). Solutions with different concentrations against each

Table 1. Detail of treatments of diverse fertilizers applied in different experiments.

Application of Manures		Application of NPK		Application of Liquid Fertilizers	
T1	Control	T1	Control	T1	Control
T2	PM (50%) + Soil (50%)	T2	0%N + 3%K + 2%K	T2	0.3 g GM + 0.3 g HB + 0.3 g VF
T3	PM (75%) + Soil (25%)	T3	3%N + 4%K + 3%K	T3	0.6 g GM + 0.6 g HB + 0.6 g VF
T4	LC (50%) + Soil (50%)	T4	6%N + 6%K + 4%K	T4	0.9 g GM + 0.9 g HB + 0.9 g VF
T5	LC (75%) + Soil (25%)	T5	9%N + 8%K + 6%K	T5	0.12 g GM + 0.12 g HB + 0.12 g VF
T6	FYM (50%) + Soil (50%)	T6	12%N + 10%K + 8%K	T6	0.15 g GM + 0.15 g HB + 0.15 g VF
T7	FYM (75%) + Soil (25%)	T7	15%N + 12%K + 10%K	T7	0.18 g GM + 0.18 g HB + 0.18 g VF
T8	Peat moss (50%) + Soil (50%)	T8	18%N + 14%K + 12%K		
T9	Peat moss (75%) + Soil (25%)	T9	20%N + 16%K + 14%K		

PM= Poultry Moss, LC= Leaf Compost, FYM= Farmyard Manure
GM= Grow More, HB= HB-101, VF= Vitafeed

treatment began preparations for use as foliar spray two weeks after transplantation. Various manures, viz., poultry moss, leaf compost, and farmyard manure, in differing combinations, underwent mixing with soil/potting mixture. Solutions with diverse mixes of NPK continued applying two weeks after transplantation application (Table 1).

Data recording

The description of parameters and method of data recording in different experiments of the presented study follows below. Starting to count days to bud formation (DBF) commenced from the date of sowing to the shaping of bud on flowering shoots of plants in each pot. Days to flower persistence (DFP) recording began from the date of flower opening to the beginning of decay signs of the flower from each plant. Days to flower senescence (DFS) were the flower time's total deterioration, measured by counting the days from the initial appearance of decay signs. The flowers per plant (FPP) determination ensued by counting them throughout their complete growth cycle.

Statistical analysis

The experiment, conducted as a completely randomized design (CRD), had four replications. The data's statistical analysis used the analysis of variance techniques (Singh and Chaudhary, 1985), then applying the LSD test using the MSTATC software program (MSTAT-C, 1991).

RESULTS

The traits assessed included the number of days to bud formation (DBF), days to flower persistence (DFP), days to flower senescence (DFS), and number of flowers per plant (NFP) during this study.

Days to bud formation (DBF)

Application of Grow More + HB101 + Vitafeed

For marigold, the higher (37.120) and lower (30.500) DBF resulted in the combined treatment of 0.18 g Grow More, 0.18 g HB101, and 0.18 g Vitafeed, and 0.3 g Grow More, 0.3 g HB101, and 0.3 g Vitafeed, respectively, during the first year (Table 2). For the second year, the higher (39.167) and lower (24.333) DBF occurred with 0.6 g Grow More, 0.6 g HB101, and 0.6 g Vitafeed, and 0.18 g Grow More, 0.18 g HB101, and 0.18g Vitafeed, respectively. In zinnia, the higher DBF during year one emerged with the same treatment used for marigold in the first year of study, while for the second year, the higher (34.120) and lower (22.340) DBF stemmed from combined treatment of 0.12 g Grow More, 0.12 g HB101, and 0.12 g Vitafeed, and 0.15 g Grow More, 0.15 g HB101, and 0.15 g Vitafeed, respectively.

Table 2. Days to bud formation with treatment under liquid fertilizer foliar application, manure application, and NPK fertilizer.

Liquid fertilizer foliar application				
Treatments	Year 1		Year 2	
	Marigold	Zinnia	Marigold	Zinnia
T1: Control	30.167 c	29.42 e	33.32 c	23.12 e
T2: 0.3g GM + 0.3g HB+ 0.3g VF	30.5 c	30.20 d	26.167 f	31.54 c
T3: 0.6g GM + 0.6g HB+ 0.6g VF	31 bc	33.23 c	39.167 a	25.23 de
T4: 0.9g GM + 0.9g HB + 0.9g VF	35.667 ac	34.03 b	30.833 d	26.34 d
T5: 0.12g GM + 0.12g HB + 0.12g VF	33.0 ac	30.12 d	28 e	34.12 a
T6: 0.15g GM + 0.15g HB + 0.15g VF	36.167 ab	32.54 ab	37.667 b	2.34 ef
T7: 0.18g GM + 0.18g HB + 0.18g VF	37.12 a	34.87 a	24.333 g	32.56 b
Manure application				
T1: Control	43.208 bc	43.89 de	34.760 d	32.667 d
T2: Poultry moss (50% PM+ 50% Soil)	42.083 d	48.34 c	37.260 ab	32.52 d
T3: Poultry moss (75% PM + 25% Soil)	40.375 cd	41.23 e	36.027 c	35.11 c
T4: Leaf compost (50% LC + 50% Soil)	40.792 e	31.32 h	36.853 b	30.887 f
T5: Leaf compost (75% LC + 25% Soil)	43.083 bc	36.21 f	37.013 b	31.22 e
T6: FYM (50% FYM + 50% Soil)	42.583 cd	44.23d	37.553 a	37.113 a
T7: FYM (75% FYM + 25% Soil)	44.542 a	53.32 a	35.922 c	31.11 e
T8: Peat moss (50% PM + 50% Soil)	42.083 d	33.87 g	37.047 ab	34.267 c
T9: Peat moss (75% PM + 25% Soil)	43.458 b	51.65 b	35.930 c	35.261 b
NPK fertilizer application				
T1: Control	39.833 a	41.332 a	39.793 a	43.123 a
T2: 0% N + 3% P + 2% K	31.500 d	29.334 f	36.350 ab	31.153 e
T3: 3% N + 4% P + 3% K	32.000 cd	32.233 e	33.517 bd	35.187 c
T4: 6% N + 6% P + 4% K	36.333 b	38.001 c	34.850 bd	32.333 d
T5: 9% N + 8% P + 6% K	32.500 c	33.354 d	31.683 cd	31.833 e
T6: 12% N + 10% P + 8% K	37.000 b	40.667 ab	35.350 bc	40.133 b
T7: 15% N + 12% P + 10% K	29.833 e	31.373 ef	34.350 bd	34.133 cd
T8: 18% N + 14% P + 12% K	30.053 e	33.733 d	30.850 d	28.733 f
T9: 20% N + 16% P + 14% K	39.833 a	41.833 a	39.793 a	43.833 a

Mean sharing different letters are significantly different at 5% level of probability
PM= Poultry Moss, LC= Leaf Compost, FYM= Farmyard Manure
GM= Grow More, HB= HB-101, VF= Vitafeed

Application of manures

The higher (44.542) and lower number (40.375) of DBF for marigolds came from the combined treatment of 75% FYM and 25% soil, and 75% LC and 25% soil, respectively, during year one. Meanwhile, in year two, the higher (37.553) and lower (35.922) DBF showed for combined treatment of 50% FYM and 50% soil, and 75% FYM and 25% soil, respectively. For zinnia, higher (33.870) and lower number (51.650) of DBF during the first year of treatment were 75% FYM + 25% soil and 50% PM + 50% soil, respectively. In the second year of observation, the higher (37.113) and lower (30.887) numbers of DBF were with treatment 50% FYM + 50% soil and 75% LC + 25% soil, respectively (Table 2).

Application of NPK fertilizers

During the first year, the higher (39.833) and lower (29.833) DBF of marigolds came from the combination of 20% N, 16% P, 14% K, and 15% N, 12% P, 10% K, respectively. In the second year, higher (39.793) and lower (30.850) DBF resulted in the combination of 20% N, 16% P, 14% K, and 18% N, 14% P, 12% K, respectively. For zinnia, during year one, the combined treatment of 20% N, 16% P, and 14% K induced a higher (41.833) compared with the lower (31.733) DBF

number, with the treatment of 15% N, 12% P, and 10% K. In the second year, higher (43.833) DBF appeared for treatment 20% N + 16% P + 14% K and lower (28.733) DBF with treatment 18% N + 14% P + 12% K (Table 2).

Days to flower persistence (DFP)

Application of Grow More + HB101 + Vitafeed

Higher (20.050) and lower (11.993) DFP in the first year of marigold occurred for the treatment of 0.6 g Grow More + 0.6 g HB101 + 0.6 g Vitafeed and 0.15 g Grow More + 0.15 g HB101+ 0.15 g Vitafeed, respectively. The second year had a higher (19.750) and lower (12.117) DFS from the treatment of 0.6 g Grow More + 0.6 g HB101 + 0.6 g Vitafeed and 0.15 g Grow More + 0.15 g HB101 + 0.15 g Vitafeed, respectively. For zinnia, the higher (21.333) and lower (12.333) DFP during year one surfaced for the treatment of 0.3 g Grow More + 0.3 g HB101 + 0.3 g Vitafeed and 0.15 g Grow More + 0.15 g HB101 + 0.15 g Vitafeed, respectively. In year two, the higher (24.667) and lower (15.667) DFP came about with the treatment of 0.3 g Grow More + 0.3 g HB101 + 0.3 g Vitafeed and 0.18 g Grow More + 0.18 g HB101 + 0.18 g Vitafeed, respectively (Table 3).

Table 3. Number of days to flower persistence under liquid fertilizer foliar application, manure application, and NPK fertilizer.

Liquid fertilizer foliar application				
Treatments	Year 1		Year 2	
	Marigold	Zinnia		Marigold
T1: Control	15.300 c	13.667 e	14.590 d	11.333 g
T2: 0.3g GM + 0.3g HB+ 0.3g VF	20.633 b	21.333 b	20.267 a	24.667 a
T3: 0.6g GM + 0.6g HB+ 0.6g VF	20.050 b	20.667 c	19.750 b	22.000 b
T4: 0.9g GM + 0.9g HB + 0.9g VF	15.867 bc	15.667 d	18.650 c	19.000 c
T5: 0.12g GM + 0.12g HB + 0.12g VF	23.455 a	27.333 a	19.317 b	16.333 e
T6: 0.15g GM + 0.15g HB + 0.15g VF	11.993 e	12.333 f	12.117 f	17.667 d
T7: 0.18g GM + 0.18g HB + 0.18g VF	13.167 d	14.667 e	13.267 e	15.667 f
Manure application				
T1: Control	28.665 a	28.890 a	23.167 ab	24.030 b
T2: Poultry moss (50% PM+ 50% Soil)	14.488 d	20.177 b	24.223 a	21.667 d
T3: Poultry moss (75% PM + 25% Soil)	14.052 d`1`	14.330 de	20.500 bc	16.333 g
T4: Leaf compost (50% LC + 50% Soil)	10.778 f	9.823 f	19.333 c	20.333 e
T5: Leaf compost (75% LC + 25% Soil)	21.222 b	28.890 a	23.590 a	26.847 a
T6: FYM (50% FYM + 50% Soil)	12.612 e	12.223 ef	24.090 a	22.333 c
T7: FYM (75% FYM + 25% Soil)	18.332 c	14.890 d	22.667 ab	14.667 h
T8: Peat moss (50% PM + 50% Soil)	12.178 e	12.557 e	6.667 d	21.401 de
T9: Peat moss (75% PM + 25% Soil)	18.775 c	18.777 c	25.410 a	17.153 f
NPK fertilizer application				
T1: Control	15.257 d	12.143 g	14.127 b	14.850 e
T2: 0% N + 3% P + 2% K	19.907 b	17.183 c	17.017 ab	15.850 d
T3: 3% N + 4% P + 3% K	18.333 c	12.133 g	16.517 ab	18.517 b
T4: 6% N + 6% P + 4% K	19.295 b	16.123 d	17.017 ab	15.850 d
T5: 9% N + 8% P + 6% K	22.500 a	14.233 f	16.350 ab	18.850 b
T6: 12% N + 10% P + 8% K	13.667 e	15.433 e	19.183 a	20.183 a
T7: 15% N + 12% P + 10% K	14.667 d	19.153 b	18.017 a	15.403 d
T8: 18% N + 14% P + 12% K	15.072 d	20.533 a	19.183 a	17.850 c
T9: 20% N + 16% P + 14% K	15.257 d	12.543 g	14.127 b	14.850 e

Mean sharing different letters are significantly different at 5% level of probability
PM= Poultry Moss, LC= Leaf Compost, FYM= Farmyard Manure
GM= Grow More, HB= HB-101, VF= Vitafeed

Application of manures

Table 3 showed that during the first year, higher (21.222) and lower (12.612) DFP of marigolds were notable for treatment 75% LC + 25% soil and 50% FYM + 50% soil, respectively, while in the second year, higher (24.090) and lower (6.667) DFS were visible for treatment 50% FYM + 50% soil and 50% PM + 50% soil, respectively. For zinnia, during the first year of study, the higher (28.890) and lower (9.823) DFP resulted in the treatment of 75% LC + 25% soil and 50% LC + 50% soil, respectively, while in year two, the higher (22.333) and lower (16.333) DFP appeared for the treatment 50% FYM + 50% soil and 75% PM + 25% soil, respectively.

Application of NPK fertilizers

Table 3 indicated that during the first year, the higher (22.500) and lower (13.667) DFP of marigolds occurred with the combination of 9% N, 8% P, 6% K and 12% N, 10% P, 8% K, respectively, while for the second year, higher (19.183) and lower (14.127) DFPs emerged with the combination of 12% N, 10% P, 8% K and 20% N, 16% P, 14% K, respectively. A higher (19.183) and lower (12.133) DFP in the first year for zinnias were prominent for 15% N + 12% P + 10% K and 3% N + 4% P + 3% K, respectively. For the second year, the higher (18.850) and lower (14.850) DFP were evident for treatment 9% N + 8% P + 6% K and 20% N + 16% P + 14% K, respectively.

Days to flower senescence (DFS)

Application of Grow More + HB101 + Vitafeed

In year one, higher (16.500) and lower (13.500) DFS of marigolds appeared with the combination of 0.15 g Grow More, 0.15 g HB101, and 0.15 g Vitafeed and 0.6 g Grow More, 0.6 g HB101, and 0.6 g Vitafeed, respectively (Table 4). For year two, the higher (18.500) and lower (9.750) DFS were conspicuous for treatments 0.6 g Grow More, 0.6 g HB101, and 0.6 g Vitafeed and 0.15 g Grow More, 0.15 g HB101, and 0.15 g Vitafeed, respectively. For zinnias, the higher (14.020) and lower (11.000) DFS in year one occurred for treatment 0.18 g Grow More, 0.18 g HB101, and 0.18 g Vitafeed and 0.6 g Grow More, 0.6 g HB101, 0.6 g Vitafeed, respectively. During year two, the higher (14.667) and lower (11.020) DFS were notable for treatment 0.3 g Grow More + 0.3 g HB101 + 0.3 g Vitafeed, and 0.15 g Grow More + 0.15 g HB101 + 0.15 g Vitafeed, respectively.

Application of manures

During the first year, the higher (19.440) and lower (7.300) DFS of marigolds were evident with treatments 75% LC + 25% soil and 50% FYM + 50% soil, respectively (Table 4). For the second year, higher (23.605) and lower (9.333) DFS showed with treatments 75% FYM + 25% soil and 50% PM + 50% soil, respectively. For zinnias, the higher (28.110) and lower (5.143) DFS were visible for treatments 75% LC + 25% soil and 50% LC + 50% soil, respectively, during the first year of study. During the second year, the higher (30.103) and lower (9.773) DFS were distinguishable for treatments 75% FYM + 25% soil and 50% PM + 50% soil, correspondingly.

Application of NPK fertilizers

In year one, a higher (18.035) and lower (13.035) DFS of marigolds came out for the treatment of 15% N + 12% P + 10% K and 9% N + 8% P + 6% K, respectively (Table 4). For year two, the higher (15.850) and lower (12.350) DFS occurred with treatments, 9% N + 8% P + 6% K and 15% N + 12% P + 10% K, respectively. For zinnias during the first year, the higher (17.633) and lower (11.933) DFS were visible for treatments 3% N + 4% P + 3% K and 15% N + 12% P + 10% K, respectively, which also had almost same results in the second year.

Table 4. Days to flower senescence, mean comparisons of treatments for flower senescence under liquid fertilizer foliar application, manure application, and NPK fertilizer.

Liquid fertilizer foliar application				
Treatments	Year 1		Year 2	
	Marigold	Zinnia	Marigold	Zinnia
T1: Control	16.333 a	12.010 c	15.500 c	14.667 a
T2: 0.3g GM + 0.3g HB+ 0.3g VF	14.333 ab	10.667 e	20.017 a	14.667 a
T3: 0.6g GM + 0.6g HB+ 0.6g VF	13.500 ab	11.000 d	18.833 ab	13.667 b
T4: 0.9g GM + 0.9g HB + 0.9g VF	15.217 ab	14.678 a	18.500 b	12.050 c
T5: 0.12g GM + 0.12g HB + 0.12g VF	13.650 ab	12.667 b	12.867 d	9.667 e
T6: 0.15g GM + 0.15g HB + 0.15g VF	16.500 a	12.667 b	9.750 e	11.02 d
T7: 0.18g GM + 0.18g HB + 0.18g VF	10.68 b	14.02 ab	10.60 e	13.33 b
Manure application				
T1: Control	25.592 a	25.373 b	20.667 c	19.667 c
T2: Poultry moss (50% PM+ 50% Soil)	13.030 d	19.260 c	13.220 f	9.773 h
T3: Poultry moss (75% PM + 25% Soil)	12.403 d	14.253 e	20.987 c	22.733 b
T4: Leaf compost (50% LC + 50% Soil)	7.305 f	5.143 h	15.667 d	16.667 e
T5: Leaf compost (75% LC + 25% Soil)	19.442 b	28.110 a	20.203 c	18.107 d
T6: FYM (50% FYM + 50% Soil)	11.832 d	11.330 f	14.167 e	14.053 g
T7: FYM (75% FYM + 25% Soil)	17.665 c	14.310 e	23.605 b	30.103 a
T8: Peat moss (50% PM + 50% Soil)	9.933 e	9.333 g	9.333 g	15.030 f
T9: Peat moss (75% PM + 25% Soil)	17.612 c	17.890 d	24.938 a	30.743 a
NPK fertilizer application				
T1: Control	14.035 d	14.133 d	14.627 ab	15.18ab
T2: 0% N + 3% P + 2% K	17.015 b	16.143 b	15.183 ab	15.850 a
T3: 3% N + 4% P + 3% K	14.402 cd	17.633 a	14.183 abc	15.51ab
T4: 6% N + 6% P + 4% K	14.218 cd	15.833 c	13.850 bc	12.183 d
T5: 9% N + 8% P + 6% K	13.035 e	16.923 b	15.850 a	13.517 c
T6: 12% N + 10% P + 8% K	14.368 cd	12.133 e	12.517 c	15.28ab
T7: 15% N + 12% P + 10% K	18.035 a	11.933 f	12.350 c	14.737 b
T8: 18% N + 14% P + 12% K	14.868 c	15.143 c	15.850 a	15.51 ab
T9: 20% N + 16% P + 14% K	14.035 d	14.023 d	14.627 ab	15.18 ab

Mean sharing different letters are significantly different at 5% level of probability
PM= Poultry Moss, LC= Leaf Compost, FYM= Farmyard Manure
GM= Grow More, HB= HB-101, VF= Vitafeed

Flowers per plant (FPP)

Application of Grow More + HB101 + Vitafeed

The higher (23.111) and lower (20.000) NFP of marigolds in year one were notable for the combination of 0.12 g Grow More, 0.12 g HB101, and 0.12 g Vitafeed and 0.3 g Grow More, 0.3 g HB101, and 0.3 g Vitafeed, respectively. In the second year, the higher (25.667) and lower (13.107) NFP were prominent under treatment 0.3 g Grow More + 0.3 g HB101 + 0.3 g Vitafeed and 0.15 g Grow More + 0.15 g HB101 + 0.15 g Vitafeed, respectively. For zinnias, the higher (22.000) and lower (16.333) NFP showed for treatment 0.6 g Grow More + 0.6 g HB101 + 0.6 g Vitafeed and 0.12 g Grow More + 0.12 g HB101 + 0.21 g Vitafeed, respectively, in year one of observation. During the second year, the higher (23.033) and lower (19.147) NFP were evident for treatment 0.6 g Grow More + 0.6 g HB101 + 0.6 g Vitafeed and 0.3 g Grow More + 0.3 g HB101 + 0.3 g Vitafeed, respectively (Table 5).

Application of manures

It was clear from the results in Table 5 that during the first year of the study, the higher number of flowers per plant of marigolds were distinct for treatment 50% poultry moss + 50% soil (9.500), 75% poultry moss PM +

Table 5. All pair wise mean comparisons of treatments for number of flowers per plant under liquid fertilizer foliar application, manure application, and NPK fertilizer.

Liquid fertilizer foliar application				
Treatments	Year 1		Year 2	
	Marigold	Zinnia	Marigold	Zinnia
T1: Control	20.556 c	17.000 d	25.333 a	15.333 e
T2: 0.3g GM + 0.3g HB+ 0.3g VF	20.000 c	19.333 c	25.667 a	19.147 d
T3: 0.6g GM + 0.6g HB+ 0.6g VF	20.667 c	22.000 a	18.963 c	23.033 b
T4: 0.9g GM + 0.9g HB + 0.9g VF	23.111 a	20.667 b	16.957 d	21.333 c
T5: 0.12g GM + 0.12g HB + 0.12g VF	23.111 a	16.333 d	21.333 b	18.033 de
T6: 0.15g GM + 0.15g HB + 0.15g VF	21.222 b	19.423 c	13.107 e	20.963 c
T7: 0.18g GM + 0.18g HB + 0.18g VF	22.111 ab	20.333 b	18.033 c	24.800 a
Manure application				
T1: Control	5.833 d	6.333 d	8.333 c	8.333 d
T2: Poultry moss (50% PM+ 50% Soil)	9.500 b	10.667 c	10.120 a	12.667 a
T3: Poultry moss (75% PM + 25% Soil)	7.333 cd	6.333 d	10.500 a	11.667 b
T4: Leaf compost (50% LC + 50% Soil)	6.167 d	5.667 e	10.101 a	11.333 b
T5: Leaf compost (75% LC + 25% Soil)	6.667 d	6.333 d	10.833 a	8.333 d
T6: FYM (50% FYM + 50% Soil)	11.500 a	15.667 a	10.589 a	9.667 c
T7: FYM (75% FYM + 25% Soil)	8.667 bc	9.667 c	9.667 b	10.667 bc
T8: Peat moss (50% PM + 50% Soil)	8.680 bc	10.693 c	4.333 d	9.030 c
T9: Peat moss (75% PM + 25% Soil)	9.167 b	11.667 b	10.333 ab	12.333 a
NPK fertilizer application				
T1: Control	17.557 e	18.833 c	15.793 b	20.183 a
T2: 0% N + 3% P + 2% K	21.553 c	22.133 a	18.683 a	16.850 cd
T3: 3% N + 4% P + 3% K	23.427 b	20.153 b	18.850 a	12.850 e
T4: 6% N + 6% P + 4% K	25.093 a	17.144 d	17.683 a	12.850 e
T5: 9% N + 8% P + 6% K	20.333 d	13.132 e	13.683 c	12.517 e
T6: 12% N + 10% P + 8% K	23.810 b	11.162 ef	12.017 c	12.183 e
T7: 15% N + 12% P + 10% K	24.798 a	10.156 f	13.017 c	14.737 d
T8: 18% N + 14% P + 12% K	24.883 a	12.132 ef	13.517 c	17.850 c
T9: 20% N + 16% P + 14% K	17.557 e	18.167 c	15.793 b	20.183 b

Mean sharing different letters are significantly different at 5% level of probability
PM= Poultry Moss, LC= Leaf Compost, FYM= Farmyard Manure
GM= Grow More, HB= HB-101, VF= Vitafeed

25% soil (7.333), followed under the treatment of 75% peat moss + 25% soil (9.167) and 50% farmyard manure + 50% soil (11.500), while lower number of flowers per plant of marigolds appeared under the treatment of 75% leaf compost LC + 25% soil (6.667), control (5.833), and treatment of 50% leaf compost LC + 50% soil (6.167). The results on marigolds during the second year of study showed that the higher number of flowers per plant of marigold surfaced for treatment 75% leaf compost + 25% soil (10.833) followed by treatment 50% farm yard manure + 50% soil (10.589), 50% poultry moss + 50% soil (10.500), and 75% peat moss + 25% soil (10.333), while lower number of flowers per plant of marigolds emerged under control (8.330), 50% peat moss + 50% soil (4.333), and 75% farmyard manure + 25% soil (9.667). It is distinguishable from the results revealed in Table 4 that during the first year of study, the higher number of flowers per plant of zinnias were visible for treatment 50% farmyard manure + 50% soil (15.667), followed by treatment 75% peat moss + 25% soil (11.667), 50% peat moss + 50% soil (10.693), and 50% poultry moss + 50% soil (10.667). The lower number of flowers per plant of zinnias were noteworthy under treatment 75% farmyard manure + 25% soil (37.390), followed by 75% poultry moss + 25% soil, 75% leaf compost + 25% soil, and control having same values (6.333), and 50% leaf compost + 50% soil (5.667). The results

on zinnias during the second year of study showed that the higher number of flowers per plant occurred for treatment 75% farmyard manure + 25% soil (10.667), 75% poultry moss + 25% soil (11.667), 50% poultry moss + 50% soil (12.667), 75% peat moss + 25% soil (12.333), and 50% leaf compost + 50% soil (11.333). Conversely, the lower number of flowers per plant of zinnias stood out under treatment 50% farmyard manure + 50% soil (9.667), control (8.330), and 75% leaf compost + 25% soil (8.333).

Application of NPK fertilizers

During the first year of study, the higher number of flowers per plant of marigolds were prominent for treatments 15% N + 12% P + 10% K (24.789), 18% N + 14% P + 12% K (24.883), 6% N + 6% P + 4% K (25.093), and 12% N + 10% P + 8% K (23.810), while the lower number of flowers per plant of marigolds were visible under the treatments of 10% N + 16% P + 14% K (17.557), control (17.557), and 9% N + 8% P + 6% K (20.333). The results on marigolds during the second year of study showed that the higher number of flowers per plant of marigolds were notable for treatments 0% N + 3% P + 2% K (18.683), 6% N + 6% P + 4% K (17.683), 3% N + 4% P + 3% K (18.850), 20% N + 16% P + 14% K, and control both at 15.793. Meanwhile, a lower number of flowers per plant of marigolds arose under the treatments of 15% N + 12% P + 10% K (13.017) and 12% N + 10% P + 8% K (12.017). It was clear from the results revealed in Table 4 that during year one of the study, the higher number of flowers per plant of zinnias appeared in treatments 0% N + 3% P + 2% K (22.133), 3% N + 4% P + 3% K (20.153), 6% N + 6% P + 4% K (17.144), control (18.833), and 20% N + 16% P + 14% K (18.167), while the lower number of flowers per plant of zinnias emerged under the treatments of 15% N + 12% P + 10% K (10.156) and 12% N + 10% P + 8% K (11.162). The results on zinnias during the second year of study showed that the higher number of flowers per plant were visible for treatments 0% N + 3% P + 2% K (16.850), 18% N + 14% P + 12% K (17.850), control (20.183), and 20% N + 16% P + 14% K (20.183). Inversely, the lower number of flowers per plant of zinnias was evident under the treatments of 12% N + 10% P + 8% K (12.183) and 9% N + 8% P + 6% K (12.217).

DISCUSSION

The lower number of days during the second year of the study indicated significant interaction among the genotypes and foliar application of liquid fertilizer and the early-maturing ability caused by the treatment of nutrients, and this agrees with previous reports (Pinto *et al.*, 2005; Younis *et al.*, 2014). The treatments with higher days indicated increased vegetative growth, which led to an increased number of days to maturity. The use of nutrient chemicals also provided a rise in photosynthetic rate that delayed flowering, and it aligns with earlier studies (Sreeharsha *et al.,* 2014). The treatments showing more days increased vegetative growth, increasing the days to maturity. Using nutrient chemicals also heightened photosynthetic rates that delayed flowering (Sreeharsha *et al.,* 2014; Gola *et al.,* 2018).

The higher coefficient of variation found during the first year of the study as compared with the second year indicated a significant consistency among the results. The treatments under which the days were higher signified that the vegetative growth of marigolds and zinnias intensified, which led to an increased number of days to maturity of flowering plants (Riaz *et al.,* 2008; Ahmad *et al.,* 2012; Aziz *et al*., 2016; Mohsin *et al*., 2023). The higher nutrients, water, and minerals in the soil due to added nourishment caused growth augmentation and development of flowering plants. This study validates previous findings (Salehi Sardoei *et al.,* 2014; Abid *et al.,* 2017; Adhikari *et al.,* 2020).

Fewer days during the second year showed a significant interaction among genotypes and NPK fertilizers. The lower number of days for bud formation indicated an early-maturing ability of both plants under the effect of different treatments of NPK fertilizers (Adhikari *et al.,* 2020). It was also notable that

applying varied treatments of NPK fertilizers affected the number of days for bud formation. The plant of marigolds and zinnias showed similar behavior under the applications of different doses of NPK for inducing bud formation in marigolds and zinnias (Arab *et al.,* 2015; Onofrei *et al.,* 2017).

Having shorter days for flower persistence indicated an adverse effect of liquid fertilizers on the flower-retaining ability (Bielski and Szwejkowska, 2013; Hussein *et al.,* 2011; Jevdovic *et al.,* 2013). Different doses of Grow More + HB101 + Vitafeed affected the number of days for flower persistence variably. The treatments under which more days occur implied that the vegetative growth of marigolds and zinnias enhanced, which led to increasing the survival ability of flowers for long-time plants, and the study results agree with previous findings (Maleki *et al.,* 2014; Ratajczak *et al.,* 2016).

The lower coefficient of variation indicated a significant consistency among the results of both studied years' research data of marigolds and zinnias. The higher number of days for flower persistence signified a helpful effect of manures on the health and retaining ability of marigold and zinnia flowers (Anderson *et al.,* 2016). The treatments under which higher days transpire showed an increase in vegetative growth that led to releasing such chemicals helpful to improve flower survival and ability to withstand plants (Dantas *et al.,* 2015; Chaleshtori and Kachoie, 2016).

Findings revealed that the higher the number of days (recorded during the second year), the more interaction between genotypes and NPK fertilizers. The fewer days cause a harmful effect of NPK fertilizers on the plant's survival and retaining ability (Chaleshtori and Kachoie, 2016). A report also stated that applying different treatments of NPK has influenced the number of days for flower persistence. Both plants showed similar behavior under different doses of NPK for inducing the flower opening and flower persistence longer on the plants (Jayasinghe *et al.,* 2010; Pasha *et al.,* 2015).

The higher number of days for flower senescence during the second year of the study indicated a significant interaction among the genotypes and foliar application of liquid fertilizer, while fewer days for flower senescence indicated an unfavorable effect of liquid fertilizers for flower retaining ability (Diaz-Avelar *et al.,* 2004; Danaher *et al.,* 2013; Burnett *et al.,* 2016). The study found that applying different doses of Grow More + HB101 + Vitafeed resulted in varying effects on the number of days for flower senescence.

The higher average number of days for flower senescence for the second year implied that the ability of flower retention intensified in the second generation of marigolds and zinnias (Król, 2011; Jevdovic *et al.,*2013; Maleki *et al.,* 2014). Results from the study disclosed that employing different treatments of farmyard manure, leaf compost, and peat moss influenced the number of days for flower senescence. Applying nutrient chemicals also indicated that the photosynthetic rate of marigold and zinnia plants enhanced, causing a delay in flower shedding (Król, 2011; Ahmed *et al.,* 2017).

Marigold and zinnia showed similar behavior under different doses of NPK applications for inducing the flower opening and persistence longer on the plants of marigold and zinnia. Using nutrient chemicals also indicated a positive effect and delayed flowering (Kakar *et al.,* 2002). The shorter days for flower senescence compared with manure applications provided validity of an adverse reaction of NPK fertilizers on the survival and retaining ability of marigold and zinnia flowers (Sanas, 2016; Ahmed *et al.,* 2017).

Direct relationships between a higher number of flowers per plant and foliar application of liquid fertilizer during year two of observation resulted in fewer flowers, indicating adverse effects from liquid fertilizers for bud formation. Flower growth and development during the first year of the study declined, probably due to the formation of some harmful chemical compounds that may have caused growth inhibition (Singh *et al.,* 2008; Frimpong and Osei, 2016; Hussain *et al.,* 2017). Application of different treatments of liquid fertilizer showed varied effects on the number of flowers per plant. Using chemical

fertilizers saved moisture contents in the plant, increasing flower formation and the ability of flowers to withstand harsh climate conditions.

The higher average number of flowers per plant during the first year indicated augmented growth and development of flowers, hence an improved flower size. A previous study reported similar reports (Ahmad *et al.,* 2017). Moreover, applying different farmyard manure, leaf compost, and peat moss solutions influenced the number of flowers per plant (Baloch *et al.,* 2010). The average high number of flowers per plant compared with manure and liquid fertilizer applications indicated beneficial effects of NPK on the growth and development of flowers, with the same findings previously reported (Baloch *et al.,* 2010; Frimpong and Osei, 2016). Outcomes also revealed that employing varying doses of NPK fertilizers had varied effects on the number of flowers per plant. Both plants showed similar behavior under the applications of differing concentrations of NPK for inducing more flowers per plant.

CONCLUSIONS

Employing organic and inorganic fertilizers can enhance resistance against premature flower aging and promote larger flower sizes in both marigold and zinnia plants. In turn, it allows for cultivating marigold and zinnia varieties that could thrive under diverse environmental conditions. It is essential to plant new marigold and zinnia cultivars that possess unique phenotypic characteristics well-suited to specific ecological settings.

REFERENCES

Adhikari P, Mishra K, Marasini S, Neupane RC, Shrestha AK, Shrestha J, Subedi S (2020). Effect of nitrogen doses on growth and yield of marigold (*Tagetes erecta* L.) in subtropical climate of Nepal. *Fundam. Appl. Agric.* 5(3): 414-420.

Aziz SA, Azmi TKK, Sukma D, Qonitah FZ (2016). Morphological characters of triploids and tetraploids produced by colchicine on buds and flowers of *Phalaenopsis amabilis*. *SABRAO J. Breed. Genet*. 48(3): 352-358.

Bielski S, Szwejkowska B (2013). Effect of fertilization on the development and yields of pot marigold (*Calendula officinalis* L.). *Herba Pol.* 59: 5-12.

Burnett SE, Mattson NS, Williams KA (2016). Substrates and fertilizers for organic container production of herbs, vegetables and herbaceous ornamental plants grown in greenhouses in the United States. *Sci. Hortic.* 208: 111-119.

Chaleshtori SH, Kachoie MA (2016). Chemical composition and anti-microbial effects of *Calendula officinalis* grown under chemical and biological conditions on the Methicillin-resistant *Staphylococcus aureus* isolated from hospital infections. *Biosci. Biotechnol. Res. Asia.* 13: 1787-1796.

Danaher JJ, Pickens JM, Sibley JL, Chappell JA, Hanson TR, Boyd CE (2013). Petunia growth response to container substrate amended with dewatered aquaculture effluent. *Hortic. Technol.* 23: 57-63.

Dantas SA, Cavalcante LF, Alves EU, Da-Silva SA, Dantas TA (2015). Physiological quality of yellow passion fruit seed produced under saline water, NPK and bovine biofertilizer. *Afr. J. Agric. Res.* 10: 2948-2954.

Diaz-Avelar J, Barrios J, Jimenez B (2004). Effect of the application of acid treated biosolids on marigold (*Tagetes erecta*) development. *Water Sci. Technol.* 50: 33-40.

Frimpong K, Osei B (2016). Growth, yield and leaf nutrient composition of lettuce grown in a silty loam soil amended with compost at different rates. *J. Food Agric. Environ.* 4: 4-16.

Gola AQ, Jakhro MI, Habib M, Ahmed S, Badini MA, Shahwani MW, Naseer NS, Shah SIA (2018). Influence of various growing media on growth and flowering of zinnia (*Zinnia elegans*) dreamland. *Pure Appl. Biol*. 7(3): 946-954.

Hussain M, Sakr R, Badr L, Mashat K (2011). Effect of some fertilizers on botanical and chemical characteristics of pot marigold plant (*Calendula officinalis* L.). *J. Hortic. Sci. Orn. Plants* 3: 220-231.

Hussain R, Younis A, Riaz A, Tariq U, Ali S, Ali A, Raza S (2017). Evaluating sustainable and environment-friendly substrates for quality production of potted Caladium. *Int. J. Recy. Org. Waste Agric.* 6: 13-21.

Jayasinghe G, Arachchi ID, Tokashiki (2010). Evaluation of containerized substrates developed from cattle manure compost and

synthetic aggregates for ornamental plant production as a peat alternative. *Ind. Crop Prod.* 54(1): 1412-1418.

Jevdovic R, Todorovic G, Kostic M, Protic R, Lekic S, Zivanovic T, Secanski M (2013). The effects of location and the application of different mineral fertilizers on seed yield and quality of pot marigold (*Calendula officinalis* L.). *Turk. J. Field. Crops* 18(1): 1-7.

Kakar A, Saleem M, Shah R, Shah SQ (2002). Growth and marketable green pod yield performance of pea (*Pisum sativum* L.) under varying levels of NPK fertilizers. *Asian J. Plant. Sci.* 1: 532-534.

Król B (2011). The effect of different nitrogen fertilization rates on yield and quality of marigold (*Calendula officinalis L.'Tokaj'*) raw material. *Acta Agrobot.* 64: 29.

Maleki A, Feizolahi A, Naseri R, Rezaei K, Heydari M (2014). Effects of different fertilizer sources on vegetative characteristics of pot marigold plant (*Calendula officinalis* L.). *Int. J. Biosci.* 5: 242-249.

Mohsin RM, Abd Asal KN, Kamaluddin AA, Zaky AA (2023). Genotypes and storage duration effects on the quality of cut flower - gerbera (*Gerbera jamesonii* Hook). *SABRAO J. Breed. Genet*. 55(1): 260-267. http://doi.org/10.54910/sabrao2023.55.1.24.

MSTAT-C (1991). A Software Program for the Design, Management and Analysis of Agronomic Research Experiments. Michigan State University, East Lansing.

Onofrei V, Teliban GC, Burducea M, Lobiuc A, Sandu CB, Tocai M, Robu T (2017). Organic foliar fertilization increases polyphenol content of *Calendula officinalis* L. *Ind. Crop Prod.* 109: 509-513.

Pasha MF, Ahmad HM, Qasim M, Javed I (2015). Performance evaluation of zinnia cultivars for morphological traits under the agro-climatic conditions of Faisalabad. *Eur. J. Biotechnol. Biosci.* 3: 35-38.

Pinto AC, Rodrigues TJ, Leite IC, Barbosa JC (2005). Growth retardants on development and ornamental quality of potted 'Lilliput' *Zinnia elegans Jacq*. *Sci. Agric.* 62: 337-345.

Ratajczak K, Sulewska H, Szymańska G, Wolna-Maruwka A, Faligowska A (2016). The effect of soil type and soil additives on the selected growth parameters and yield of flowerheads of *Calendula officinalis* L. *Herba Pol.* 62: 17-30.

Riaz A, Arshad M, Younis A, Raza A, Hameed M (2008). Effects of different growing media on growth and flowering of *Zinnia elegans* cv. Blue Point. *Pak. J. Bot.* 40: 1579-1585.

Salehi Sardoei A, Shahmoradzadeh FS, Ghasemi H (2014). Effects of different growing media on growth and flowering of zinnia (*Zinnia elegans*). *Int. J. Adv. Biol. Biomed. Res.* 2(6): 1894-1899.

Sanas KK (2016). Effect of plastic mulch, N and K application on quality seed production of annual chrysanthemum (*Chrysanthemum coronarium* L.) (Doctoral dissertation).

Shah S, Ali A, Ameen N, Shah M, Khan A (2014). Potassium influence on flowering and morphology of *Zinnia elegans*. *Int. J. Farm. All. Sci.* 3: 377-381.

Shubha B (2006). Integrated nutrient management for growth, flowering, and xanthophyll yield of marigold (*Tagetes erecta* L.), UAS, Dharwad.

Singh RK, Chaudhary BD (1985) Biometrical Method in Quantitative Genetics Analysis. Kalyani Publishers, New Delhi

Singh Y, Verma P, Verma J (2008). Effect of NPK, spacing and MH on flower yield of African Marigold (*Tagetes erecta* L.) cv. PNG. *Ann. Hortic.* 1: 27-31.

Sreeharsha RV, Sekhar KM, Reddy AR (2014). Delayed flowering is associated with lack of photosynthetic acclimation in Pigeon pea (*Cajanus cajan* L.) grown under elevated CO_2. *Plant Sci*. 231: 82-93.

Younis A, Anjum S, Riaz A, Hameed M, Tariq U, Ahsan M (2014). Production of quality Dahlia (*Dahlia variabilis* cv. Redskin) flowers by efficient nutrients management: Plant nutrition impacts on Dahlia quality. *Am-Eur J. Agri. Env. Sci*. 14: 137-142.