Fundamental and Applied Agriculture
Vol. 6(3), pp. 272–278: 2021
doi: 10.5455/faa.103177

HORTICULTURE | ORIGINAL ARTICLE

Effect of maleic hydrazide and gibberellic acid on growth and yield of African marigold (*Tagetes erecta* L.) cv. Calcuttia Orange

Poonam Karki* [1], **Padma Nath Atreya** [2], **Sudhir Shrestha** [3]

[1]Himalayan College of Agricultural Sciences and Technology, Kirtipur, Kathmandu, Nepal
[2]Temperate Horticulture Development Centre, Marpha, Mustang, Nepal
[3]Floriculture Development Centre, Godawari, Lalitpur, Nepal

ARTICLE INFORMATION

Article History
Submitted: 28 Jul 2021
Accepted: 19 Aug 2021
First online: 23 Sep 2021

Academic Editor
Md Harun Ar Rashid
harun_hort@bau.edu.bd

**Corresponding Author*
Poonam Karki
poonamkarki.pk@gmail.com

ABSTRACT

A field experiment was carried out during the month of August – December 2020 at the Floriculture Development Center, Godawari, Lalitpur, Nepal. The experiment was conducted in randomized block design with seven treatments comprising of 3 levels each of maleic hydrazide (MH) (T2 : 200 ppm, T3: 300 ppm, T4 : 400 ppm) and gibberellic acid (GA3) (T5: 100 ppm, T6: 200 ppm, T7: 300 ppm) along with control (T1) replicated thrice with an objective to access the impact of MH and GA3 on production and productivity of African marigold (*Tagetes erecta* L.) cv. Calcuttia Orange. The foliar spray of the growth regulators was applied at 30 days after transplanting (DAT). The result revealed that vegetative growth *viz.* plant spread (2083 cm^2), stem diameter (1.2 cm), number of primary (8.13) and secondary branches (28.27) was recorded significantly maximum with the treatment of MH at 400 ppm. The plant height (56.33 cm) was found to be maximum when treated with GA3 at 200 ppm whereas MH at 300 ppm resulted in highest number of leaves (139.26). First flowering (45 d), 50% flowering (50 d), full bloom (54 d), maximum flower weight (11.33 g) and maximum flower diameter (8.10 cm) were achieved with GA3 at 200 ppm. However, the maximum number of flowers (29) was obtained by the foliar spray of MH at 400 ppm. MH at 400 ppm resulted the maximum yield of the flowers (23.528 t ha^{-1}) followed by GA3 at 200 ppm (23.079 t ha^{-1}). The experiment concluded that MH at 400 ppm and GA3 at 200 ppm contributed to increased growth, flowering and yield of the crop.

Keywords: African marigold, treatment, yield, foliar spray

Cite this article: Karki P, Atreya PN, Shrestha S. 2021. Effect of maleic hydrazide and gibberellic acid on growth and yield of African marigold (*Tagetes erecta* L.) cv. Calcuttia Orange. Fundamental and Applied Agriculture 6(3): 272–278. doi: 10.5455/faa.103177

1 Introduction

African marigold (*Tagetes erecta* L.) belonging to family Asteraceae is one of the most popular annual flower crop grown on a commercial scale (Sunayana et al., 2018). *Tagetes erecta* (African marigold) and *Tagetes patula* (French marigold) are popular for commercial purpose in Nepal (Dhakal, 2017). The African marigold is the tallest of all species, growing to a height of three to four feet. Its growing popularity is due to its ease of culture, adaptability, habit of free flowering, variety of colors and requires short time to produce marketable flowers, and profitable returns (Kumar et al., 2010). African marigold has been identified as a possible source of carotenoids including lutein and zeaxanthin. They are currently used in ophthalmology to combat diseases like cataract and age-related macular degeneration (ARMD), as well as food colorants, dietary nutrients, and poultry feed additives to enhance the color of egg yolks and poultry skin (Gupta, 2014). Marigold flowers have an important position during Tihar festival in Nepal. It is estimated that the Kathmandu valley alone consumes around 75% of the marigolds sold across the country during Tihar (Floral Daily, 2017). The sale of marigold garland per day is 10,000-15,000 and the price of each garland is NRs. 60-70 (FAN, 2020).

Different agrochemicals have been used in recent years to ensure proper growth and flowering. Plant growth regulators (PGRs) or phytohormones are organic compounds produced naturally in higher plants other than nutrients that control growth or other physiological functions at a site remote from their source of production and are active in minute amounts (Bisht et al., 2018). Among the different plant growth regulators, some are growth promoters while others are growth retardants. Growth promoters such as GA3 play a vital role in improving the vegetative characters of the plants as it enhances the elongation and cell division by promoting the DNA synthesis in the cell (Meshram et al., 2015). Plant growth retardants such as MH are chemical compounds that regulate plant growth and development and are widely used in the floriculture industry (Sunayana et al., 2018).

Maleic hydrazide causes decrease in plant height with an increase in leaf area and chlorophyll content as well as flower diameter and results in an increase in flower weight. It might be due to accumulation of more metabolites and availability of reserve food for the reproductive growth thereby increased flower yield (Ahmad et al., 2019).On the other hand, Gibberellins reduces juvenile period and with the termination of juvenile phase, the shoot apical meristem instead of producing leaves and branches start producing buds and therefore the flowering is hastened (Kumar et al., 2014).

A study was carried out at Godawari in 2020 with an objective to access the impact of maleic hydrazide and gibberellic acid on production and productivity of African marigold in Godawari of Nepal. The output of the study will serve as valuable information to the marigold farmers as it gives them basic idea about how the crop responds to GA3 and MH.

2 Materials and Methods

2.1 Study site and condition

The field experiment was conducted from September 2020 to December 2020 at the Floriculture Development Center, Godawari, Lalitpur, Nepal. Geographically, it is located at 27.59° N latitude and 85.39° E longitude having subtropical climate. Since, the research work was done under greenhouse condition; a psychrometer was attached to note the temperature as well as relative humidity inside the green house. It was noted each day and then the average was taken which is presented at Table 1.

2.2 Treatment and design

The experiment comprised 7 treatments (Table 2) and was laid out in single factorial randomized complete block design with 3 replications. The total gross area and each plot area were found to be 112.95 m^2 2.8 m^2 (2.8 m × 1 m), respectively. The treatments were randomly allocated using a random number table. The foliar application of the treatments was given to the experimental marigold plants at 30 DAT by using hand atomizer at morning time. 1 mL of GA3 were dissolved in 1 L of distilled water to make 1000 ppm stock solution. Then, 200 mL, 400 mL, 600 mL of stock solution was mixed with 2 L of water each separately to obtain 100 ppm, 200 ppm and 300 ppm of the solution, respectively. Similarly, 1 g of maleic hydrazide was dissolved in 1 L of distilled water to make 1000 ppm stock solution. Then 400 mL, 600 mL, 800 mL of stock solution was mixed with 2 L of water each separately to obtain 200 ppm, 300 ppm and 400 ppm of stock solution, respectively.

Table 1. Average temperature and relative humidity (RH) inside the green house

Parameters	Avg. temp. (°C)	RH (%)
August	33.30	89
September	30.01	88
October	29.25	71
November	25.50	62
December	23.20	63

Table 2. List of treatments used in the study

#	Treatment	Notation
1	Control	T1
2	MH 200 ppm	T2
3	MH 300 ppm	T3
4	MH 400 ppm	T4
5	GA3 100 ppm	T5
6	GA3 200 ppm	T6
7	GA3 300 ppm	T7

2.3 Agronomy

The seeds of African marigold cv. Calcuttia Orange were obtained from the Floriculture Development Center (FDC), Godawari, Lalitpur. The seeds were sown in the nursery bed which was ready to be transplanted onto the poly bags within 8 days (two leaf stage). The seedlings were transplanted onto the main field at 24 days after sowing. The experimental field was divided into twenty-one plots resulting in the total net area to be 58.8 m^2. The experimental field was prepared with thorough ploughing followed by planking and was transplanted at a distance of 40 cm × 35 cm. It was provided with 1.5 kg of diammonium phosphate, 1.35 kg of urea and 1.35 kg of potash as basal dose and an additional 1.35 kg urea was applied to the plants as top dressing. Each experimental plot was applied with 70 gm of diammonium phosphate and 60 gm each of urea and potash as basal dose. In addition, each plot was provided with 60 gm of urea as top dressing at 30 DAT.

2.4 Observation and data collection

Observations on the growth and yield parameters were recorded from five plants which did not suffer from border effect and were selected per replication from each treatment. The growth parameters included plant height (cm), plant spread (cm^2), number of leaves, stem diameter (cm), number of primary and secondary branches which were measured or counted at 15 DAT, 30 DAT, 45 DAT, 60 DAT, 75 DAT, and 90 DAT. The height of the plant was measured from the ground to the tip of the plant whereas plant spread was measured with measuring tape from North-South and East-West direction. Stem diameter was measured with the help of vernier caliper from 5 cm above the ground. Number of leaves, number of primary and secondary branches were counted and reported on mean basis. The flowering parameters included days to first flowering, days to 50% flowering, days to 100% flowering, number of flowers per plant, flower diameter (cm), flower weight (g) and flower yield (t ha^{-1}). The number of days taken for first flowering, 50% flowering and 100% flowering from the date of transplanting was counted and then the average was taken. Total number of flowers per plant was recorded from each tagged plant at each harvest. After the final harvest, the number of flowers of every picking was counted and then their average was worked out. The flower diameter was measured with the help of scale whereas the average flower weight was measured with the help of weighing balance and their mean was calculated. The flower yield was calculated by multiplying total number of plants and flower yield.

2.5 Data analysis

The data were collected, tabulated and processed in Microsoft Excel 2016 and statistically analyzed by using Genstat 18th edition statistical package. Means were separated using Duncan's Multiple Range Test (DMRT) at 5% level of significance. Pearson's correlation coefficient and regression equation were run to establish the relationship between different parameters and yield of African marigold.

3 Results and Discussion

3.1 Growth parameters

All the growth parameters were influenced significantly due to the application of various growth regulators (Table 3). The maximum plant height at 90 DAT was obtained in T6 (56.33 cm) whereas the minimum plant height was observed in T4 (46.33 cm) followed by T2 (48.63 cm). Similar findings were observed by Sarkar et al. (2018) who reported that the application of GA3 at 200 ppm recorded significantly higher plant height (85.36 cm) in African marigold. The minimum plant height of African marigold was obtained when treated with MH at 250 ppm (Sathappan, 2018). MH reduces the auxin activity thereby inhabiting cell division and elongation and as a result the height of plant is reduced (Patil, 1995). On the other hand, Meshram et al. (2015) reported that an application of GA3 in African marigold plant at different concentrations increases the growth of plant by increasing internodal length.

The treatment MH 400 ppm produced maximum plant spread (2132 cm^2) followed by MH 300 ppm (2083 cm^2) (Table 3). On the contrary, control (1402 cm^2) recorded least plant spread followed by GA3 at 200 ppm (1719 cm^2). The application of MH tends to encourage the growth of lateral branches and as a result the plant spread will be more. The stem diameter varied from 1.018 cm to 1.20 cm at 90 DAT. The maximum stem diameter was observed in MH 400 ppm whereas minimum stem diameter was observed in Control. The treatments T2, T3, T5, T6, and T7 were statistically at par.

The result showed that high significant variation in number of leaves was recorded (Table 3). T3 produced highest number (139) of leaves followed by T4 (118.3) whereas the lowest number of leaves was obtained with T1 (95) followed by T7 (103). It is evident from the findings that the number of leaves significantly increased with the spray of MH. Increase in leaf area and number might be due to the role of MH that suppresses the apical dominance and increases leaf number and area of the leaf.

Maximum number of primary (8) and secondary branches (28) were obtained with the application of MH 400 ppm (Table 3). On the other hand, control (T1) recorded minimum number of primary (6) and secondary branches (16). MH tends to cut off the basipetal flow of auxins and induce the sprouting of lateral vegetative buds to enhance the production of more number of primary and secondary branches (Goren et al., 2010).

3.2 Flowering and yield parameters

The data from Table 4 revealed that treatment GA3 at 200 ppm recorded earliest first flowering (44.67 d), earliest 50% flowering (49.67 d) and earliest full bloom (54 d). On the contrary, the maximum days taken for first flowering (54.33 d), 50% flowering (59.67 d), 100% flowering (68.67 d) was observed in Control (T1). GA3 reduces juvenile period and with the termination of juvenile phase, the shoot apical

Table 3. Effect of MH and GA3 on different growth parameters of African marigold at 90 DAT in Lalitpur, Nepal

Treatments	Plant height (cm)	Plant spread (cm^2)	Stem diameter (cm)	Number of leaves	Number of 1° branch	Number of 2° branch
T1	52.80 abc	1402 a	1.018 a	94.7 a	5.533 a	16.47 a
T2	48.63 ab	1761 b	1.027 ab	118.2 b	7.233 bc	20.20 ab
T3	49.37 abc	2083 c	1.090 ab	139.3 c	7.333 bc	24.20 bc
T4	46.33 a	2132 c	1.200 b	118.3 b	8.133 c	28.27 c
T5	55.47 bc	1720 ab	1.098 ab	117.6 b	6.333 ab	21.23 ab
T6	56.33 c	1719 b	1.167 ab	108.8 ab	7.067 bc	25.67 bc
T7	56.13 c	1695 ab	1.067 ab	102.6 ab	6.467 ab	19.73 ab
SEM (±)	2.16	96.8	0.05	5.63	0.41	1.77
CV (%)	7.2	9.4	8	8.5	10.5	13.8
P value	0.031	0.003	0.187	0.031	0.05	<0.001

Means within the column followed by the same letter are not significantly different at 5% level of significance by DMRT at 5% level of significance; 1° and ° denote primary and secondary.

Table 4. Effect of MH and GA3 on different yield parameters of African marigold in Lalitpur, Nepal

Treatments	Days to first flowering	Days to 50% flowering	Days to 100% flowering	Flowers no. at 105 DAT	Flower wt. (g)	Flower dia (cm)	Yield (t ha^{-1})
T1	54.33 d	59.67 c	68.67 e	18.09 a	8.333 a	5.630 a	11.293 a
T2	50.33 c	54.67 b	59.33 bd	20.78 ab	9.000 ab	6.477 b	13.947 ab
T3	47 ab	51.67 ab	55.67 a	27.51 cd	9.667 abc	7.143 c	19.834 cd
T4	48.33 bc	54.33 b	56 ab	29.34 d	10.667 cd	8.107 d	23.528 d
T5	48.67 bc	52 ab	56 abc	23.61 bc	10 bcd	6.710 bc	17.705 bc
T6	44.67 a	49.67 a	54 a	27.15 cd	11.333 d	7.253 c	23.079 d
T7	49.67 bc	54.33 b	60.33 d	23.32 bc	9.000 ab	6.353 b	15.887 bc
SEM (±)	0.87	1.12	1.07	1.31	0.47	0.19	1369
CV (%)	3.1	3.6	3.2	9.4	8.5	5	13.2
P value	<0.001	0.001	<0.001	<0.001	0.001	<0.001	<0.001

Means within the column followed by the same letter are not significantly different at 5% level of significance by DMRT at 5% Level of significance.

meristem instead of producing leaves and branches start producing buds and therefore the flowering is fastened (Kumar et al., 2014).

It is clear from the findings that the fresh flower weight was increased with the treatment of GA3 200 ppm followed by MH 400 ppm whereas the minimum flower weight was obtained with control (T1). It might be due to accumulation of more metabolites and availability of reserve food for the reproductive growth. The results are in agreement with the findings of Arshid (2009) and Haque et al. (2013) who found a significant increase in fresh and dry flower weight respectively in chrysanthemum with the application of growth retardants. The maximum flower diameter was obtained at T6 (8.10 cm) followed by T7 (7.25 cm). Minimum flower diameter was observed in Control (5.6 cm). However the maximum number of flowers at 105 DAT (27.15) was obtained with the plants that were treated with MH at 400 ppm (T4) followed by GA3 at 200 ppm (T6). The minimum number of flowers was obtained at T1 (18.09) followed by T2 (20.78).

MH resulted in reduction in plant height by suppressing the role of auxin and gibberillin which ultimately increased the number of main and secondary branches, thereby increasing flowers yield (Sharma et al., 1995; Dutta et al., 1998; Navale M U et al.). On the other hand, GA3 spray may provide better crop growth, more number of branches thus increase in number of flowers per plant. Also, the plants sprayed with GA3 had sufficient time to accumulate carbohydrate for proper flower bud differentiation due to enhanced reproductive efficiency and photosynthesis restrictive plant type.

The maximum yield (23.538 t ha^{-1}) was noted with the application of MH 400 ppm (T4) followed by GA3 200 ppm (23.079 t ha^{-1}). The minimum yield (11.293 t ha^{-1}) was recorded at control. Similar findings were obtained by Sunitha et al. (2007) and Kumar et al. (2010) in African marigold. The authors reported that, GA3 200 ppm recorded maximum flower yield in African marigold. As the apical dominance of the plant was suppressed, it allowed the lateral branches to grow more, resulting increase in the number of flowers subsequently increase in the yield.

3.3 Correlation with yield

All the growth and flowering parameters showed positive correlation with the yield (in kg ha^{-1}). The determination of different parameters on the yield is given in the Table 5. A positive correlation was observed between number of secondary branches and yield (kg ha^{-1}). It means that when the number of secondary branches increases, the flower yield also increases and vice-versa. The coefficient of determination 0.939 signifies that the contribution of number of secondary branches on flower yield (kg $ropani^{-1}$) is 93.9% and the rest of the effect was due to other factors.

Table 5. Coefficient of determination of different parameters on yield

Parameters	R^2
Plant height	0.019
Plant spread	0.536
Stem Diameter	0.897
Number of leaves	0.21
Primary branches	0.568
Secondary branches	0.939
Days to first flowering	0.761
Days to 50% flowering	0.563
Days to 100% flowering	0.73
Number of flowers	0.936
Flower weight	0.886
Flower diameter	0.884

3.4 Profitability

The result of this research and study (Table 6) shows that the benefit-cost ratio (BCR) ranged from 1.99 (control) to 5.23 (T4), which indicates that the farming of African marigold flower is financially viable. The plants treated with MH at 400 ppm (T4) had the maximum plant spread, number of secondary branches resulting in maximum number of flowers and maximum yield and therefore ultimately leading to highest BCR. Similarly the BCR was found to be 1.62 in African marigold grown in Kathmandu, Dhading and Kavre districts (Pradhan, 2016).

4 Conclusion

After the assessment of the response of different concentrations of GA3 and MH on marigold plant, it could be concluded that MH at 400 ppm and GA3 at 200 ppm contributed to increased growth, flowering and yield of the crop. Maleic hydrazide reduced the auxin activity resulting in decreased plant height, increased plant spread, increased leaf number, maximum primary and secondary branches and maximum number of flowers thereby resulting in maximum flower yield. GA3 on the other hand increased the inter nodal length and reduced the juvenile period resulting in maximum plant height, early flowering, maximum flower diameter and maximum flower weight. The flower yield obtained at 400 ppm MH is statistically at par with GA3 at 200 ppm. It can be concluded that though the working pathway of GA3 and MH were different, both of the hormones were able to contribute to maximum production and productivity.

Table 6. Gross and net return of cultivating African marigold with different experimental treatments

Treatment	Average price (NRs kg^{-1})	Productivity (kg ha^{-1})	Gross return (Nrs ha^{-1})	TCP (Nrs ha^{-1})	Net return (Nrs ha^{-1})	B/C ratio
T1	150	11293	1693950	566263.5	1127687	1.99
T2	150	13947	2092050	566263.5	1525787	2.69
T3	150	19834	2975100	566263.5	2408837	4.25
T4	150	23528	3529200	566263.5	2962937	5.23
T5	150	17705	2655750	566263.5	2089487	3.68
T6	150	23079	3461850	566263.5	2895587	5.11
T7	150	15887	2383050	566263.5	1816787	3.2

TCP = total cost of production; B/C ratio = benefit-cost ratio

Acknowledgments

The authors would like to thank Floriculture Development Center (FDC), Godawari for providing platform and technical support during the strenuous research work.

Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

References

Ahmad M, Ayaz S, Jadoon S, Alam M, Rab A, Khalil I, Ayub G, Ali H. 2019. Application of maleic hydrazide controlled plant height and ameliorate flower production in local dahlia. Bioscience Research 16:1882–1890.

Arshid AL. 2009. Effect of photoperiod and chemical retardants on growth and flowering of chrysanthemum. MS Thesis, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar.

Bisht TS, Rawat L, Chakraborty B, Yadav V. 2018. A recent advances in use of plant growth regulators (PGRs) in fruit crops - a review. International Journal of Current Microbiology and Applied Sciences 7:1307–1336. doi: 10.20546/ijcmas.2018.705.159.

Dhakal M. 2017. Sayapatri Phul Jath: Calcuttia orange Baemaushami Kheti Prabidhi. Nepal Agriculture Research Council, Horticulture Research Division, Lalitpur, Nepal.

Dutta JP, Seemanthini R, Ramdas S. 1998. Growth and flowering response of chrysanthemum (*Dendranthema grandiflora* Tzelev.) to growth regulator treatments. Orissa Journal of Horticulture 26:70–75.

FAN. 2020. Floriculture Business Scenario of Nepal. Floriculture Association of Nepal, Kathmandu, Nepal.

Floral Daily. 2017. Nepal: Marigold sale booms in Kathmandu. http://www.floraldaily.com/article/12330/Nepal-Marigold-sale-booms-in-Kathmandu, Accessed on 20 September 2020.

Goren R, Huberman M, Goldschmidt EE. 2010. Girdling: Physiological and horticultural aspects. In: Horticultural Reviews. John Wiley & Sons, Inc.. p. 1–36. doi: 10.1002/9780470650837.ch1.

Gupta P. 2014. Carotenoids of therapeutic significance from marigold. Natural Products Chemistry & Research 2:1000e110. doi: 10.4172/2329-6836.1000e110.

Haque MA, Miah MAM, Hossain S, Alam M. 2013. Economics of marigold cultivation in some selected areas of Bangladesh. Bangladesh Journal of Agricultural Research 37:711–720. doi: 10.3329/bjar.v37i4.14395.

Kumar M, Singh AK, Kumar A. 2014. Effect of plant growth regulators on flowering and yield attributes of African marigold (*Tagetes erecta* L.) cv Pusa Narangi Gainda. Plant Archives 14:363–365.

Kumar R, Ram M, Gaur GS. 2010. Effect of GA3 and ethrel on growth and flowering of African marigold cv. Pusa Narangi Gainda. Indian Journal of Horticulture 67:362–366.

Meshram P, Badge S, Gaidhani A. 2015. Influence of Foliar Application of Gibberellic Acid and NAA on Growth, Quality and Flower Yield in African marigold. Journal of Agroecology and Natural Resource Management 2394-0794:162–164.

Navale M U SA Akalade, Desai JR, Nannavare PV. ???? Influence of plant growth regulators on growth, flowering and yield of Chrysanthemum (*Dendranthema grandiflorum*). International Journal of Pharma and Bio Sciences 1:396–399.

Patil SR. 1995. Effect of growth substances and chemicals on growth, development and shelf life of golden rod (*Saliclago canadensis* L.). PhD Thesis, University of Agricultural Sciences, Dharwad.

Pradhan U. 2016. Report on Economic Analysis of Marigold, Rose and Chrysanthemum in Nepal. Floriculture Association Nepal.

Sarkar D, Saud BK, Mahanta P, Kalita P, Neog B, Talukdar MC. 2018. Response of pinching and gibberellic acid on growth and physiological characteristics of African marigold. International Journal of Current Microbiology and Applied Sciences 7:1666–1672. doi: 10.20546/ijcmas.2018.703.199.

Sathappan CT. 2018. Effect of plant growth regulators and pinching on growth and flower yield of African marigold (*Tagetes erecta* L.). Journal of Horticultural Sciences 13:42–47. doi: 10.24154/jhs.2018.v13i01.004.

Sharma HG, Verma LS, Jain V, Tiwary BL. 1995. Effect of foliar application of some plant growth regulators on growth and flowering of chrysanthemum var. Move-in-Carvin. Orissa Journal of Horticulture 23:61–64.

Sunayana S, Manjusha AVM, Rajagopalan A, Madala A. 2018. Effect of growth retardants (Alar and Cycocel) on flower yield and carotenoid content in African marigold (*Tagetes erecta* L.) varieties. Journal of Tropical Agriculture 55:205–208.

Sunitha HM, Hunje R, Vyakaranahal B, Bablad HB. 2007. Effect of pinching and growth regulators on plant growth, flowering and seed yield in African marigold (*Tagetes erecta* Linn.). Journal of ornamental Horticulture 10:91–95.

The Official Journal of the
Farm to Fork Foundation
ISSN: 2518–2021 (print)
ISSN: 2415–4474 (electronic)
http://www.f2ffoundation.org/faa