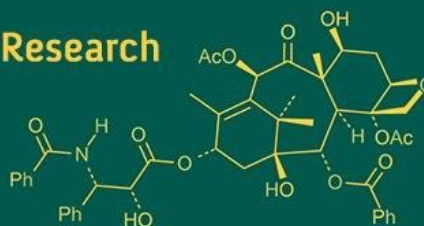


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Samiksha N Kale
M.Sc. Student, Horticulture
Section, College of Agriculture
Nagpur, Maharashtra, India

Hemlata Khobragade
Assistant Professor (Hort.),
College of Agriculture, Nagpur,
Maharashtra, India

Shalini Badge
Associate Professor (Hort.),
College of Agriculture, Nagpur,
Maharashtra, India

Ekta Bagde
Associate Professor (Plant
Pathology), Regional Fruit
Research Station, Katol,
Nagpur, Maharashtra, India

Monika Gajbhiye
M.Sc. Student, Horticulture
Section, College of Agriculture
Nagpur, Maharashtra, India

Effect of foliar application of humic acid and vermiwash on growth and flower yield of gaillardia

Samiksha N Kale, Hemlata Khobragade, Shalini Badge, Ekta Bagde and Monika Gajbhiye

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Abstract

The present study was carried out at Horticulture Section, College of Agriculture, Nagpur during 2022-23 to assess the effect of foliar application of humic acid and vermiwash on growth and flower yield of gaillardia during summer season. The experiment was laid out in Factorial Randomized Block Design consisting of sixteen treatments combinations replicated thrice with two factors viz., Factor A consist of four levels of humic acid (i.e., Control, Humic acid 0.15%, Humic acid 0.2%, & Humic acid 0.25%) and factor B consist of five levels of vermiwash (i.e., control, Vermiwash 200ml/lit of water, Vermiwash 300ml/lit of water & Vermiwash 400 ml/lit of water). The result of experiment was in respect of growth parameters viz. plant height, number of branches plant⁻¹ and stem girth were recorded significantly maximum in treatment of humic acid 0.2 percent as well as in vermiwash 400 ml/lit of water in gaillardia. For yield parameters i.e. number of flower plant⁻¹, flower yield plant⁻¹, flower yield plot⁻¹ and flower yield hectare⁻¹ were recorded maximum due to foliar application of humic acid 0.2 percent as well as in vermiwash (400 ml/lit of water). The interaction effect of treatment combination humic acid 0.2 percent along with vermiwash 400 ml/lit of water recorded significantly maximum, number of flower plant⁻¹, flower yield plant⁻¹, flower yield plot⁻¹ and flower yield hectare⁻¹ in gaillardia.

Keywords: Gaillardia, vermiwash, humic acid, flower yield, quality, foliar application

Introduction

Gaillardia is flowering annual and belongs to family 'Asteraceae', having chromosome number $2n = 36$. *Gaillardia pulchella*, also known by the name as "Blanket flowers", among one of the hardiest annuals and is grown under different types of soils and varied climatic conditions. Gaillardia is native to the US. However, because *G. pulchella* is a popular species that is able to grow on a variety of soil types and colonize disturbed habitats, it now occurs throughout the world. Gaillardia is grown as an important commercial flower crop in different parts of India. Gaillardia flourishes well in any kind of garden soil and it can also tolerate high level of light intensities, drought as well as high temperature in a better way as compared to most of the flowering plants. Presently this crop has less area under cultivation; however, in the near future it is about to increase as flowers of gaillardia are in heavy demand nowadays. In tropical climate, gaillardia can be grown throughout the year. In gaillardia cultivation among all other important factors that can affect its performance, one is the nutritional management of the crop. The quality of flowers is highly influenced by the quantity of nutrients which are applied and the sources of these nutrients.

Application of organic manures is beneficial for promoting growth and higher production of good quality flowers. Due to lack of availability of sufficient organic manures, growers are largely depending on chemical fertilizers which lead to the loss of inherent soil properties in addition to the increased cost of production. So keeping view of soil deterioration aspects, organic cultivation had a good pic up. Different organic manures like neem cake, vermicompost, vermiwash, humic acid have come to the limelight which increases yield of Gaillardia without any deterioration of soil health. Humic acid (HA) is an organic fertilizer derivative from original lignitic coal and is added in a very light concentration similarly vermiwash is a very good plant tonic which can be used for foliar spray. It contains both macro and micro element viz. N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, (Anon., 2007) ^[2]. It is the liquid extract collected after the passage of water through the different layers of worm culture unit.

Corresponding Author:
Ekta Bagde
Associate Professor (Plant
Pathology), Regional Fruit
Research Station, Katol,
Nagpur, Maharashtra, India

Therefore, an experiment was carried out to assess the effect of foliar application of humic acid and vermiwash on growth and yield of gaillardia.

Materials and Methods

Field experiment was conducted to access the effect of foliar application of Humic acid and Vermiwash on growth and flower yield of gaillardia at farm of Horticulture Section, College of Agriculture, Nagpur during Summer season of 2023. The experiment was laid out in factorial randomized block design consisting of two factor, Factor "A" consist of four levels of humic acid viz., H₁:Control, H₂:Humic acid 0.15%, H₃:Humic acid 0.2%, & H₄: Humic acid 0.25% and Factor "B" consist of four levels of vermiwash viz., V₁ : Control, V₂ :Vermiwash 200ml/lit of water, V₃:Vermiwash 300ml/lit of water & V₄: Vermiwash 400ml/lit of water. Overall there were sixteen treatment combinations which were replicated thrice.

The seeds of Gaillardia were sown in raised nursery bed. All the precautions were taken regarding nursery management till the seedlings were ready for transplanting. Flat bed of 1.6 m X 1.9 m was prepared for the transplanting of seedling of the 30 x 30 cm dimension. The healthy seedlings were transplanted on flat bed. All the cultural practices were done at regular intervals as per the requirement of crop during the period of experiment. The humic acid and vermiwash of the respective concentrations were sprayed twice, first at 30 days after transplanting and second at 45 days after transplanting as per the treatment in gaillardia. During the research trial, from each replication, randomly selected five plants were used for recording various observations on growth, flowering and yield parameters during whole of the cropping period. The obtained data were subjected to the statistical analysis by adopting analysis of variance technique as described by Panse and Sukhatme (1997) [9] for the Factorial Randomized Block Design (FRBD)

Results and Discussion

The results obtained from present investigation are presented below on table 1 & 2

Effect of Humic acid on growth parameters

The result exhibited the significant differences among the different concentration of humic acid regarding plant height, number of branches and stem girth at 75 DAT the treatment. Humic acid @ 0.2 percent had recorded significantly maximum plant height (63.84 cm), number of branches plant⁻¹ (20.11) and stem girth (1.88 cm) which was found at par with the treatment humic acid @ 0.25 percent (61.50 cm, 19.22 & 1.82 cm respectively). Whereas, minimum plant height (57.38 cm), number of branches plant⁻¹ (16.67) & stem girth (1.57cm) was recorded in control treatment. This effect is observed due to humic acid because it is a potential natural resources that can be utilized to increase nutrient availability, increase the nutrient uptake of crop. It has been reported that application of humic acid increase the soil fertility and enhanced the availability of nutrients (Yildirim, 2007) [15]. This result are close conformity with Ahmad *et al.* (2013) [1] in gladiolus and Yasser I. EI-Nashar (2021) [14] in calendula.

Effects of Vermwash on growth parameters

The result exhibited the significant differences among the

different concentration of vermi- wash regarding growth parameters at 75 DAT. The treatment Vermiwash @ 400 ml/lit had recorded significantly maximum plant height (63.20 cm), number of branches plant⁻¹ (19.48) & stem girth (1.93 cm) which was found at par with the treatment Vermiwash @ 300 ml/lit (61.23 cm, 19.03 & 1.82 cm respectively). Whereas, minimum plant height (58.17 cm), number of branches plant⁻¹ (17.29) & minimum (1.57 cm) stem girth was recorded in control treatment. These increase growth parameters might be due to increase activity of more exchangeable nutrients in the soil by application of vermi wash (Cock *et al.* 1980) [3]. This effect was observed due to enhanced cytokinin formation in vermiwash applied to the plant which resulted for more cell division. Increase cell division causes more vegetative growth. These findings are closely conformity with Sivasubramanian and Ganesh Kumar (2004) [12] studies the impact of vermiwash on the growth of African marigolds and Tamrakar *et al.* (2018) [13] in gladiolus cv. Candyman & Nathan *et al.* (2019) [8] in Gomphrena

Interaction effect

The data presented in Table 1 revealed that, interaction effect due to foliar application of humic acid and vermi wash on growth parameters of gaillardia was found non significant at all growth stages during experimentation.

Yield Parameters

The data regarding the yield parameters as influenced due to foliar application of humic acid and vermiwash treatments found significant during year 2023 are presented in Table.1

Effect of humic acid on yield parameters

The result exhibited the significant differences among different concentrations of humic acid regarding number of flower plant⁻¹, flower yield plant⁻¹, flower yield plot⁻¹ & flower yield ha⁻¹. The treatment humic acid @ 0.2 percent recorded significantly maximum number of flower plant⁻¹ (44.73), flower yield plant⁻¹ (168.60 g), flower yield plot⁻¹ (5.06 kg) & flower yield hectare-1 (121.75 q) in gaillardia which was found at par with treatment humic acid @ 0.25 percent (44.11, 167.42 g, 5.02 kg & 120.93 q respectively). Whereas, control treatment recorded minimum number of flower plant⁻¹ (40.50), flower yield plant⁻¹ (141.08 g), flower yield plot⁻¹ (5.06 kg) & flower yield hectare⁻¹ (101.88 q) in gaillardia. This might be due to used HA on pelargonium plant lead to augmented flowers number with elements absorption and its hormone - like properties. Savvas and Gizas (2002) [11] and Ehsan *et al.* (2012) [4] mention that HA had helpful influence on flower number and yield which might be owing to the positive impact of HA compounds on nutrients absorption and this eventually augments the number of flowers. These findings are closely related with Mohammadipour *et al.* (2012) [6] in marigold & Khodakhah *et al.* (2014) [5] in tuberose.

Effect of vermiwash on yield parameters

The result exhibited the significant differences among different concentration of vermiwash regarding number of flower plant⁻¹, flower yield plant⁻¹, flower yield plot⁻¹ & flower yield ha⁻¹. The treatment vermiwash @ 400 ml/lit recorded significantly maximum number of flower plant⁻¹ (44.88), flower yield plant⁻¹ (169.10 g), flower yield plot⁻¹ (5.07 kg), and flower yield hectare⁻¹ (122.13 q) which

followed by treatment V₃ - vermiwash @ 300 ml/lit (43.92) and treatment V₂ - vermiwash @ 200 ml/lit (42.66). Whereas, control treatment recorded minimum number of flower plant⁻¹ (40.47), flower yield plant⁻¹ (141.05 g), flower yield plot⁻¹ (4.23 kg) & flower yield hectare⁻¹ (101.85 q) in gaillardia. From the above results, this might be due to the fact that the higher number of flower and maximum flower yield in gaillardia were found to be the result from enhanced uptake of mineral nutrients from soil, chiefly immobile ions like P, Cu and Zn. These results are closely related with Pathak and Prabhat Kumar (2009) [10] in gladiolus cv. White Prosperity, Nathan *et al.* (2019) [8] in Gomphrena and Nagalakshmi *et al.* (2009) in anthurium.

Interaction effect on yield parameters

The result exhibited the significant differences among different concentration of humic acid and vermiwash

regarding number of flower plant⁻¹, flower yield plant⁻¹, flower yield plot⁻¹ & flower yield ha⁻¹. Significantly maximum number of flower (47.87), flower yield plant⁻¹ (188.09 g), flower yield plot⁻¹ (5.64 kg) and flower yield hectare⁻¹ (135.84 q) were recorded in treatment H₃V₄ i.e. humic acid @ 0.2 percent and vermiwash @ 400 ml/lit which is followed by treatment humic acid @ 0.25 percent and V₄ - vermiwash @ 300 ml/lit. The minimum number of flower plant⁻¹ (38.30), flower yield plant⁻¹ (132.16 g), flower yield plot⁻¹ (3.96 kg) and flower yield hectare⁻¹ (3.96 kg) were recorded in control treatment. Interaction effect of humic acid and vermiwash is might be due, humic acid is known to enhance the availability and uptake of essential nutrients by plants. When combined with vermiwash, which is rich in organic matter and beneficial microorganisms, it creates a favorable soil environment for nutrient absorption.

Table 1: Effect of foliar application of humic acid and vermiwash on growth and yield in gaillardia

Treatments	Growth parameters			Yield parameter			
	Plant height (cm)	Number of branches plant ⁻¹	Stem girth (cm)	Number of flower plant ⁻¹	Flower yield plant ⁻¹ (g)	Flower yield plot ⁻¹ (kg)	Flower yield hectare ⁻¹ (q)
Factor "A" : Humic acid (H)							
H ₁ - (Control)	57.38	16.67	1.57	40.50	141.08	4.23	101.88
H ₂ -0.15%	58.88	18.25	1.71	42.59	151.55	4.55	109.46
H ₃ -0.2%	63.84	20.11	1.88	44.73	168.60	5.06	121.75
H ₄ -0.25%	61.50	19.22	1.82	44.11	167.42	5.02	120.93
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	1.06	0.17	0.06	0.26	1.75	0.05	1.26
CD at 5%	3.08	0.49	0.18	0.74	5.05	0.15	3.71
Factor "B" : Vermiwash (V)							
V ₁ (Control)	58.17	17.29	1.57	40.47	141.05	4.23	101.85
V ₂ -200 ml/lit	59.00	18.46	1.67	42.66	154.79	4.65	111.79
V ₃ -300 ml/lit	61.23	19.03	1.82	43.92	163.72	4.91	118.24
V ₄ -400 ml/lit	63.20	19.48	1.93	44.88	169.10	5.07	122.13
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	1.06	0.17	0.06	0.26	1.75	0.05	1.26
CD at 5%	3.08	0.49	0.18	0.74	5.05	0.15	3.71
C) Interaction effect (A×B)							
'F' test	NS	Sig	NS	Sig	Sig	Sig	Sig
SE (m) ±	2.13	0.34	0.12	0.52	3.50	0.10	2.53
CD at 5%	-	-	-	1.49	10.11	0.30	7.42

Table 2: Interaction effect of foliar application of Humic acid and Vermiwash on yield parameter of gaillardia

Treatments	Number of flower plant ⁻¹	Flower yield plant ⁻¹ (g)	Flower yield plot ⁻¹ (kg)	Flower yield hectare ⁻¹ (q)
H ₁ V ₁	38.48	132.16	3.96	95.45
H ₁ V ₂	39.89	137.57	4.13	99.36
H ₁ V ₃	41.21	144.25	4.33	104.18
H ₁ V ₄	42.61	150.27	4.51	108.53
H ₂ V ₁	40.36	139.78	4.19	100.95
H ₂ V ₂	42.66	150.87	4.53	108.96
H ₂ V ₃	43.39	155.76	4.67	112.50
H ₂ V ₄	43.96	159.74	4.79	115.37
H ₃ V ₁	42.14	147.50	4.43	106.53
H ₃ V ₂	44.12	164.30	4.93	118.66
H ₃ V ₃	44.80	174.41	5.23	125.96
H ₃ V ₄	47.87	188.08	5.64	135.84
H ₄ V ₁	41.09	144.62	4.34	104.45
H ₄ V ₂	43.98	166.38	4.99	120.17
H ₄ V ₃	46.27	180.44	5.41	130.32
H ₄ V ₄	45.09	178.29	5.35	128.76
F test	Sig	Sig	Sig	Sig
S.E(m) ±	0.52	3.50	0.10	2.53
CD at 5%	1.49	10.11	0.30	7.42

Conclusion

From the above investigation, it is concluded that maximum plant height, number of branches plant⁻¹, stem girth, number of flower plant⁻¹, flower yield plant⁻¹, flower yield plot⁻¹, flower yield hectare⁻¹ in gaillardia were recorded maximum with the treatment humic acid 0.2 percent and vermiwash 400 ml/lit. In case of yield parameters maximum yield parameters were recorded in treatment combination H₃V₄ (humic acid 0.2% + vermiwash 400 ml/lit). Hence, interaction of humic acid (0.2%) and vermiwash (400ml /lit) of water can be used to obtain maximum growth and flower yield in gaillardia.

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