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Effect of NPS Compost and Foliar Application of Humic Acid on Yield and Nutrient Uptake by Safed Musli

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A B S T R A C T

The present investigation was conducted during *kharif*, 2019-20 at Research Farm, Nagarjun Medicinal Plants Garden, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. The site of experiment having history of 10 years safed musli cultivation along with application of various organic sources i.e., FYM, vermicompost, biogass slurry no chemical fertilizers were applied last 10 years only organic site of this experiment. The experiment was laid out in Randomized Block Design with nine treatments replicated in three replications. The results indicated that the soil application of NPS compost @ 4.5 t ha^{-1} + 2 spray of 0.5 % humic acid at 60 and 90 days of planting (DAP) was recorded significantly highest yield attributing characters which was found at par with application NPS compost @ 3.0 t ha^{-1} + 2 spray of 0.5 % humic acid. Similarly, the soil application of NPS compost @ 4.5 t ha^{-1} + 2 spray of 0.5 % humic acid was recorded significantly highest fresh root and dry root yield of safed musali which was found at par with application of NPS compost @ 3.0 t ha^{-1} + 2 spray of 0.5 % humic acid. The application of NPS compost @ 4.5 t ha^{-1} + 2 spray of 0.5 % humic acid was recorded significantly highest nutrient uptake i.e N, P, K, S, Zn, Fe, Mn and Cu by safed musli which was found at par with application of NPS compost @ 3.0 t ha^{-1} + 2 spray of 0.5 % humic acid and found superior over rest of the treatments and absolute control.

Introduction

Safed musli (*Chlorophytum borivilianum)* is an important medicinal perennial herb, belongs to family Liliaceae, widely distributed in India and found in hilly regions of Himalaya, Satpuda, Vindhya, Aravali and in hilly area of Bihar and Assam. This species has low rate of regeneration due to shy flowering and poor setting of viable seed. It may thus become rare and may be lost from the habitat if the large scale collection of safed musli in forest continues at the present rate (Bordia, *et al.,* 1992). The roots of

Chlorophytum borivilianum have great medicinal value due to saponin content and used extensively in Ayurvedic medicines. The economic part of the herb is root and is well known tonic and aphrodisiac drug given to cure general debility. Tribals in central India use leaves of this herb for vegetable purpose. The genus *chlorophytum* consist of more than 300 species in the world and only 13 are available in India out of which six are more important.

The species of *Chlorophytum borivilanum* contains more saponin and good yielding potentials as compared to other species of Safed musli and therefore having commercial value. Safed musli have annual demand around 35000 MT while only 15000 MT is the production. Now a day, there is a very vast demand all over the world (especially gulf countries and cold countries). Due to its vast demand it is very costly and become a hot cake among medicinal plants. The roots also having aphrodisiac properties and, therefore, it is an important ingredient of herbal tonic to cure general debility and male sterility (Kirtikar and Basu, 1975). The major constituents of safed musli are carbohydrates (42%), proteins (8- 9%), root fibers (3-4%), saponin (2-17%) reported by Seth *et al.,* (1991).

Soil organic matter with associated microbial activity plays a major role in the nutrient cycling process in soil leading to enhanced nutrient availability. Increasing plant biomass production per unit cropped area, increasing biomass return per unit to cropped area and decreasing soil organic matter loss have been identified as the major considerations to maintain the soil organic matter balance. Thus, low input sustainable agriculture and the reduced chemical input concept focus on the reconsideration of agricultural practices such as burning crop residues and organic matter recycling into soil, in order to maintain and preserve soil organic matter at an adequate level and to sustain arable land (Grubinger 1992). Farm yard manure (FYM) contains very small amounts of major nutrients (NPK). It is, however, difficult to obtain sufficient FYM, considering the fast growing urban population in India, and the cost of transportation is high. Farm residues, city rubbish and agro-based industrial wastes could be used as alternatives to FYM to maintain soil physical, chemical and biological quality (Swarup *et al.,* 2000) and to sustain crop productivity.

Humic acid effectively improves soil fertility and crop production especially in poor soils and alkaline-calcareous soils (Rajpar *et al.,* 2011). The humic acid based on fertilizers causes yield increase (Mohamed *et al.,* 2009), stimulation of plant enzymes and hormones and soil fertility (Sarir *et al.,* 2005; Mart, 2007). Several research works have been prominently shown the positive benefits of application of humic acid on higher plants (Ashraf *et al.,* 2005; Susilawati *et al.,* 2009; Mackowiak *et al.,* 2001).

In a study, application of compost and humic acid caused to increase yield of strawberry significantly in comparison with the mineral fertilizers (Shehata *et al.,* 2011). Zaki *et al.,* (2006) observed the enhancement of shoot number in the plants, leaf area, total yield, fresh weight and phosphorus amount by application of 1 g l^{-1} humic acid as foliar application. In research, all morphological traits such as plant height, number of leaf and stem in plant, fresh weight of leaf, yields and yield components of cucumber showed effective influence in response to high concentration of humic acid (3 g l^{-1}) and Ecormon (0.45 cm l^{-1}) in comparison with other treatment. Foliar application of humic acid and biostimulators led to positive effects on plant growth, fruit set and improvement of cucumber production (El-Nemr *et al.,* 2012).

Materials and Methods

The present investigation was carried out during kharif 2019-20 at Research Farm, Nagarjun Medicinal Plant Garden, Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The site of experiment was conducted having history of 10 years, safed musli cultivation along with application of various organic sources i.e., compost, FYM, biogas slurry no chemical fertilizers were applied last 10 years, only organic site of this experiment. For knowing the effect of NPS and vermicompost this experiment has been conducted on safed musli. The soil of experiment site was shallow black swell shrink, montmorillonitic mineralogy with clay texture and classified under Vertisols. The initial soil properties at the start of experiment (kharif, 2019-20) was slightly alkaline (8.11), non-saline (0.32 dS m^{-1}), moderately calcareous (8.96%) and moderately high in organic carbon (5.16 g kg^{-1}). The available nitrogen was low (226 kg ha^{-1}), medium in available phosphorus (15.83 kg ha^{-1}) and high in available potassium (267 kg ha^{-1}) while marginal in available sulphur (10.88 mg kg^{-1}). The experimental soil was sufficient in DTPA Zn, Fe, Mn and Cu. The plant samples were dried in shade and then oven dried at 65 ^{0}C. Then the plant samples were powdered with the help of grinder and stored in butter paper bags. The analysis has been done as per standard procedure. The plot wise yield of fresh and dry roots of safed musali has been recorded. The data subjected to statistical analysis as per Gomez and Gomez (1984).

Results and Discussion

Fresh, Dry root yield and Dry matter yield of safed musali

The fresh root and dry root yield of safed musali (Table1) were recorded significantly highest with application of NPS compost @ 4.5 t ha^{-1} + 2 spray of 0.5 % humic acid at 60 and 90 DAP (33.29 q ha^{-1}) and acid (5.13 q ha^{-1}) respectively which was found at par with the application of NPS compost @ 3.0 t ha^{-1} + 2 spray of 0.5 % humic acid and found superior over rest of treatments and in absolute control. The increase in root yield obtained with humic acid content with large quantity of organic matter and humic acid of safed musli which recorded in better crop growth and ultimately the root yield. The application of humic acid at 60 DAP have stimulated higher photosynthetic pigment accumulation and greater photosynthetic efficiency. These results agree with the findings of Padem *et al.*, (1999).

Similarly, the dry matter accumulation varied from 0.97 to 2.62 q ha^{-1}. The significantly highest dry matter accumulation of safed musli were recorded with application of NPS compost @ 4.5 t ha^{-1} + 2 spray of 0.5 % humic acid (2.62 q ha^{-1}) which was found at par with the application of NPS compost @ 3.0 t ha^{-1} + 2 spray of 0.5 % humic acid (2.50 q ha^{-1}). Similar results reported by (Wankhade *et al.*, 2004).

Total uptake of nitrogen

The safed musli leaves and root (Table 2) were recorded significantly highest nitrogen uptake with soil application of NPS compost @ 4.5 t ha^{-1} + 2 spray of 0.5 % humic acid at 60 and 90 DAP 7.32 kg ha^{-1} and 16.67 kg ha^{-1} respectively which was found at par with application of NPS compost @ 3.0 t ha^{-1} + 2 spray of 0.5 % humic acid (6.70 kg ha^{-1}) and 14.49 kg ha^{-1} respectively. The lowest nitrogen uptake in safed musli leaves (2.06 kg ha^{-1}) was recorded in control. However, significantly highest total nitrogen uptake by safed musli was observed with the application of NPS compost @ 4.5 t ha^{-1} + 2 spray of 0.5 % humic acid(23.99 kg ha^{-1}) which was found at par with treatment NPS compost @ 3.0 t ha^{-1} + 2 spray of 0.5 % humic acid (21.19 kg ha^{-1}). The lowest total nitrogen uptake in safed musli was recorded in control (7.85 kg ha^{-1}).

This might be attributed to favourable effects of NPS compost at sowing and 2 spray of 0.5 % humic acid at 60 and 90 DAP might have helped in higher fixation of atmospheric nitrogen resulting in increase in yield and uptake of nitrogen. The similar findings reported by Wankhade *et al.,* (2004) and Joy *et al.,* (2005).

Total uptake of phosphorus

The application of NPS compost @ 4.5 t ha^{-1} + 2 spray of 0.5 % humic acid (Table 3) was recorded significantly higher phosphorus uptake by safed musli leaves (1.88 kg ha^{-1}),root (4.23 kg ha^{-1}) and total uptake of phosphorus (6.10 kg ha^{-1}) respectively which was found at par with application of NPS compost @3.0 t ha^{-1} + 2 spray of 0.5 % humic acid 1.78 kg ha^{-1}, 3.96 kg ha^{-1}, 5.74 kg ha^{-1} respectively. The lowest phosphorus uptake by safed musli leaves and roots were recorded in absolute control. This might be due to the application of NPS compost which content organic matter and also humic acid which resulted in accumulation of nutrients by the crop. Findings are in close accordance with the result reported by Wankhade *et al.,* (2004), Tufenkci *et al.,* (2006) and Noroozisharaf *et al.,* (2018).

Total uptake of potassium

The total uptake of potassium by safed musli as influenced by various treatments is given in Table 4. The significantly higher potassium uptake by safed musli leaves was observed with the application of NPS compost @ 4.5 t ha^{-1} + 2 spray of 0.5 % humic acid (5.63 kg ha^{-1}) and it was found at par with treatment NPS compost @3.0 t ha^{-1} + 2 spray of 0.5 % humic acid (5.35 kg ha^{-1}). Similarly, the significantly higher potassium uptake by safed musli roots was observed with the application of NPS compost @ 4.5 t ha^{-1} + 2 spray of 0.5 % humic acid (16.04 kg ha^{-1}) and it was found at par with treatment NPS compost @ 3.0 t ha^{-1} + 2 spray of 0.5 % humic acid (14.82 kg ha^{-1}). Whereas the significantly highest total potassium uptake by safed musli (21.68 kg ha^{-1}) was observed with the application of NPS compost @ 4.5 t ha-1 + 2 spray of 0.5 % humic acid which was found at par with treatment NPS compost @ 3.0 t ha^{-1} + 2 spray of 0.5 % humic acid (20.17 kg ha^{-1}). The lowest total potassium uptake by safed musli (10.08 kg ha^{-1}) was recorded in absolute control. These results are in close accordance with the result reported by Wankhade *et al.,* (2004), Tufenkci *et al.,* (2006).

Total uptake of sulphur

The significantly highest sulphur uptake (Table 5) by safed musli leaves, root and total uptake observed with the application of NPS compost @ 4.5 t ha^{-1} + 2 spray of 0.5 % humic acid i.e. 1.00, 1.82 and 2.82 kg ha^{-1} respectively which was found at par with application of NPS compost @ 3.0 t ha^{-1} + 2 spray of 0.5 % humic acid and found superior over rest of the treatments and absolute control. The lowest sulphur uptake by safed musli leaves, roots and total uptake of sulphur were recorded in absolute control. The increment sulphur content in roots and leaves of safed musli with the application of NPS compost and humic acid resulted in higher content of sulphur in NPS compost and humic acid which might have promoted production of higher amount of above grounds dry matter that could have led to higher acquisition of nutrients ultimately resulted in higher nutrient content in leaves higher nutrient coupled with higher roots and leaves yield lead to higher nutrient uptake reported by Kumar *et al.,* (2003) and Chiaiese *et al.,* (2004).

Table.1 Effect of NPS compost and foliar application of humic acid on the fresh and dry yield of Safed musli

Treatments		Yield (q ha^{-1})		
		Fresh root	**Dry root**	**Dry matter**
T_1	Absolute control	22.53	3.17	0.97
T_2	Vermicompost @ 5 t ha^{-1}	25.76	4.03	1.98
T_3	NPS Compost @ 3 t ha^{-1}	27.65	4.43	2.13
T_4	Vermicompost @ 2.5 t ha^{-1} + 2 spray of 0.5 % HA	26.65	4.13	2.05
T_5	Vermicompost @ 5.0 t ha^{-1} + 2 spray of 0.5 % HA	27.38	4.47	2.10
T_6	Vermicompost @ 7.5 t ha^{-1} + 2 spray of 0.5 % HA	27.78	4.61	2.15
T_7	NPS Compost @ 1.5 t ha^{-1} + 2 spray of 0.5 % HA	29.76	4.63	2.32
T_8	NPS Compost @ 3.0 t ha^{-1} + 2 spray of 0.5 % HA	30.36	4.87	2.50
T_9	NPS Compost @ 4.5 t ha^{-1} + 2 spray of 0.5 % HA	33.29	5.13	2.62
SE(m)±		2.36	0.17	0.10
CD at 5 %		7.08	0.52	0.31

Table.2 Effect of NPS compost and foliar application of humic acid on total nitrogen uptake by safed musli.

Treatments		Nitrogen uptake (kg ha^{-1})		
		Leaves	**Roots**	**Total**
T_1	Absolute control	2.06	5.78	7.85
T_2	Vermicompost @ 5 t ha^{-1}	4.57	8.22	12.79
T_3	NPS Compost @ 3 t ha^{-1}	5.26	9.92	15.18
T_4	Vermicompost @ 2.5 t ha^{-1} + 2 spray of 0.5 % HA	5.11	9.64	14.75
T_5	Vermicompost @ 5.0 t ha^{-1} + 2 spray of 0.5 % HA	5.45	11.23	16.67
T_6	Vermicompost @ 7.5 t ha^{-1} + 2 spray of 0.5 % HA	5.70	11.79	17.49
T_7	NPS Compost @ 1.5 t ha^{-1} + 2 spray of 0.5 % HA	6.21	12.98	19.20
T_8	NPS Compost @ 3.0 t ha^{-1} + 2 spray of 0.5 % HA	6.70	14.49	21.19
T_9	NPS Compost @ 4.5 t ha^{-1} + 2 spray of 0.5 % HA	7.32	16.67	23.99
	SE (m) ±	0.50	1.18	1.21
	CD at 5%	1.51	3.55	3.63

Table.3 Effect of NPS compost and foliar application of humic acid on total phosphorus uptake by safed musli.

Treatments		Phosphorus uptake (kg ha^{-1})		
		Leaves	**Roots**	**Total**
T_1	Absolute control	0.40	2.18	2.58
T_2	Vermicompost @ 5 t ha^{-1}	0.87	3.15	4.02
T_3	NPS Compost @ 3 t ha^{-1}	1.00	3.30	4.30
T_4	Vermicompost @ 2.5 t ha^{-1} + 2 spray of 0.5 % HA	1.15	3.24	4.39
T_5	Vermicompost @ 5.0 t ha^{-1} + 2 spray of 0.5 % HA	1.19	3.22	4.41
T_6	Vermicompost @ 7.5 t ha^{-1} + 2 spray of 0.5 % HA	1.46	3.33	4.79
T_7	NPS Compost @ 1.5 t ha^{-1} + 2 spray of 0.5 % HA	1.63	3.62	5.25
T_8	NPS Compost @ 3.0 t ha^{-1} + 2 spray of 0.5 % HA	1.78	3.96	5.74
T_9	NPS Compost @ 4.5 t ha^{-1} + 2 spray of 0.5 % HA	1.88	4.23	6.10
	SE (m) ±	0.14	0.18	0.27
	CD at 5%	0.43	0.54	0.81

Table.4 Effect of NPS compost and foliar application of humic acid on total potassium uptake by Safed musli.

Treatments		Potassium uptake (kg ha^{-1})		
		Leaves	**Roots**	**Total**
T_1	Absolute control	1.83	8.25	10.08
T_2	Vermicompost @ 5 t ha^{-1}	3.76	10.94	14.70
T_3	NPS Compost @ 3 t ha^{-1}	4.12	12.26	16.39
T_4	Vermicompost @ 2.5 t ha^{-1} + 2 spray of 0.5 % HA	4.07	11.70	15.77
T_5	Vermicompost @ 5.0 t ha^{-1} + 2 spray of 0.5 % HA	4.20	11.81	16.01
T_6	Vermicompost @ 7.5 t ha^{-1} + 2 spray of 0.5 % HA	4.36	12.36	16.73
T_7	NPS Compost @ 1.5 t ha^{-1} + 2 spray of 0.5 % HA	4.77	13.79	18.56
T_8	NPS Compost @ 3.0 t ha^{-1} + 2 spray of 0.5 % HA	5.35	14.82	20.17
T_9	NPS Compost @ 4.5 t ha^{-1} + 2 spray of 0.5 % HA	5.63	16.04	21.68
	SE (m) ±	0.22	0.55	0.68
	CD at 5%	0.66	1.66	2.06

Table.5 Effect of NPS compost and foliar application of humic acid on total sulphur uptake by Safed musli.

Treatments		Sulphur uptake (kg ha^{-1})		
		Leaves	Roots	Total
T_1	Absolute control	0.26	0.77	1.03
T_2	Vermicompost @ 5 t ha^{-1}	0.57	1.06	1.63
T_3	NPS Compost @ 3 t ha^{-1}	0.63	1.31	1.94
T_4	Vermicompost @ 2.5 t ha^{-1} + 2 spray of 0.5 % HA	0.64	1.22	1.86
T_5	Vermicompost @ 5.0 t ha^{-1} + 2 spray of 0.5 % HA	0.61	1.21	1.82
T_6	Vermicompost @ 7.5 t ha^{-1} + 2 spray of 0.5 % HA	0.73	1.31	2.04
T_7	NPS Compost @ 1.5 t ha^{-1} + 2 spray of 0.5 % HA	0.80	1.48	2.28
T_8	NPS Compost @ 3.0 t ha^{-1} + 2 spray of 0.5 % HA	0.91	1.67	2.58
T_9	NPS Compost @ 4.5 t ha^{-1} + 2 spray of 0.5 % HA	1.00	1.82	2.82
	SE (m) ±	0.048	0.099	0.13
	CD at 5%	0.14	0.29	0.41

Table.6 Effect of NPS compost and foliar application of humic acid on total uptake of micronutrients by safed musli.

Treatments		Total uptake of micronutrients (g ha^{-1})			
		Fe	Mn	Zn	Cu
T_1	Absolute control	122.54	20.21	14.67	33.10
T_2	Vermicompost @ 5 t ha^{-1}	190.97	29.12	21.20	47.31
T_3	NPS Compost @ 3 t ha^{-1}	209.34	31.77	25.58	52.89
T_4	Vermicompost @ 2.5 t ha^{-1} + 2 spray of 0.5 % HA	199.40	30.65	25.46	50.11
T_5	Vermicompost @ 5.0 t ha^{-1} + 2 spray of 0.5 % HA	204.94	30.68	26.67	49.95
T_6	Vermicompost @ 7.5 t ha^{-1} + 2 spray of 0.5 % HA	212.06	32.26	28.11	52.48
T_7	NPS Compost @ 1.5 t ha^{-1} + 2 spray of 0.5 % HA	227.58	35.33	31.91	57.28
T_8	NPS Compost @ 3.0 t ha^{-1} + 2 spray of 0.5 % HA	250.02	38.19	34.87	62.58
T_9	NPS Compost @ 4.5 t ha^{-1} + 2 spray of 0.5 % HA	265.02	41.78	36.90	66.35
	SE (m) ±	10.44	1.65	1.14	1.96
	CD	31.29	4.96	3.44	5.87

Total uptake of iron and manganese

The total iron and manganese uptake (Table 6) by safed musli were noted significantly highest with the application of NPS compost @ 4.5 t ha^{-1} + 2 spray of 0.5 % humic acid 265.02 g ha^{-1} and 41.78 g ha^{-1} respectively which was found at par with NPS compost @ 3.0 t ha^{-1} + 2 spray of 0.5 % humic acid and found superior over rest of the treatments. The lowest total iron and manganese uptake by safed musli were recorded in absolute control. The maximum total iron and manganese uptake by safed musli were associated with the treatment NPS compost @ 4.5 t ha^{-1} + 2 spray of 0.5 % humic acid attributed to incorporation of NPS compost and spray of humic acid which acts as source of micronutrient and also chelating agent. The humic acid release some nutrients and binds the mobile nutrients and release slowly in available form to crop which helps in enhancing the uptake of that nutrient by crop. The results corroborate the findings are reported by Wankhade *et al.,* (2004), Tufenkci *et al.,* (2006).

Total uptake of zinc and copper

The total uptake of zinc and copper by safed musli were found significantly superior among the different treatment over absolute control. The data in respect of total uptake of zinc and copper by safed musli are presented in Table 6. The significantly highest total zinc (36.90 g ha^{-1}) and copper uptake (66.35 g ha^{-1}) by safed musli were recorded with the application of NPS compost @ 4.5 t ha^{-1} + 2 spray of 0.5 % humic acid which was found at par with application of NPS compost @ 3.0 t ha^{-1} + 2 spray of 0.5 % humic acid 34.87 g ha^{-1} and 62.58 g ha^{-1} respectively. The lowest total zinc and copper uptake by safed musli were recorded in absolute control. The results corroborate the findings in Chen *et al., (*1999).

The application of NPS compost @ 4.5 t ha^{-1} along with 2 spray of 0.5 % humic acid at 60 and 90 DAP recorded significantly highest fresh root, dry root and dry matter yield of safed musli. The nutrient uptake by safed musli were recorded significantly highest with the application NPS compost @ 4.5 t ha^{-1} along with 2 spray of 0.5 % humic acid at 60 and 90 DAP.

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