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Studies on effect of organic sources and foliar spray on yield and quality of Safed Musli under inceptisols

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Abstract
The present investigation entitled, "Studies on effect of organic sources and foliar spray on yield and quality of Safed Musli under inceptisols" was conducted during kharif, 2021-22 and 2022-23 at Research Farm, Nagarjun Medicinal Plants Garden, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. The soil of the experimental site was moderately alkaline in reaction, low in available nitrogen, medium in available phosphorus and high in available potassium. The objectives were to study the effect of vermicompost and foliar application of humic acid and fulvic acid on growth, yield and quality of Safed Musli. The results showed that the yield of safed musli recorded significantly highest in the treatment vermicompost @ 2.5 t ha^{-1} with 2 sprays of 0.5% humic acid and fulvic acid at 45 & 75DAP also the quality parameters such as saponin content (%), protein content (%) and fiber content (%) in roots of Safed Musli were recorded in the same treatment which was found at par with the application vermicompost @ 2.5 t ha^{-1} with 0.5% humic acid spraying at 45 & 75 DAP.

Keywords: Safed musli, quality parameters, fresh root yield, medicinal crop.

Introduction
Safed Musli (*Chlorophytum borivilianum*) is one of the important medicinal root herbs in the Liliaceae family. It is widely spread throughout India, especially in the Himalayan valley, Satpuda, Vindhya, and Aravalli, as well as in some regions of Rajasthan, Gujarat, and Maharashtra. In Maharashtra, particularly in Vidarbha, Safed Musli found widely in the forest of Melghat, chikhaldara and Satpuda hills nearby Akot (Akola) and Jalgaon Jamod (Buldana). Safed Musli's fasciculated storage roots are economically important because they have aphrodisiac properties and are used in herbal tonics (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 Bordia *et al.* (1995). The roots of Safed Musli have also been scientifically proven to have anti stress and antioxidant properties and hence its potential in the herbal industry. Due to its high saponin content, the roots of Safed Musli are extremely valuable as a medicinal plant and are frequently used in Ayurvedic treatments (Wankhede *et al.* 2004). Foreign demand has been estimated as 300-400 tons annually (Kothari and Singh, 2003). For obtaining good quality roots, the plant growth medium should be porous with optimum fertility status. In that context, the application of organic source might be proved best for improving physical properties of soil as well as provide nutrients to the crop. Application organic sources accelerate the growth which in turn provide efficient framework for high rate of nutrient absorption for productive metabolism of Safed Musli.
Humic substances play a vital role in soil fertility and plant nutrition. Humic substances are criteria of soil fertilization because in addition to supplying the plants needed nitrogen they provide the best suitable perimeter for plant growing. In this context, an attempt has been made to extract the humic substances from vermicompost available at the site to check its effects on Safed Musli applied through foliar application and fulvic by commercially taken.

Materials and Methods
The field experiment was conducted at Research Farm, Nagarjun Medicinal Plant Garden,

Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during kharif season 2021-22 and 2022-23 which lies in the subtropical region at the latitude of 22° 42' 19.2" North and 77° 03' 43.2" East at the altitude of 30.78 (m) above mean sea level (MSL). The experiment was laid out in Randomized Block Design with seven treatments replicated in three replications. The treatments comprised of T_1-absolute control, T_2-Vermicompost @ 2.5 t ha^{-1}, T_3-FYM @ 5 t ha^{-1},T_4- Vermicompost @ 2.5 tha^{-1} + 0.5% humic acid spraying at 45 &75DAP, T_5- FYM @ 5.0 t ha^{-1}+ 0.5% humic acid spraying at 45 &75DAP, T_6- Vermicompost @ 2.5 t ha^{-1} + 0.5% fulvic acid at 45 DAP+0.5% humic acid spraying at 75DAP, T_7- FYM @ 5 t ha^{-1}+ 0.5% fulvic acid at 45DAP+0.5% humic acid spraying at 75DAP.The humic acid and fulvic acid sprayed at 45 and 75 days after planting of safed musli. Fasciculated roots @ 3.33 lakh sprouted roots ha^{-1} were planted at 30 × 10 cm on raised bed in first week of June and July and sesame @2.5kg by drilling method at 30 x 10cm during summer (February) of 2021-22 and 2022-23. Uniform cultivation practices were followed during the growth period of both crop. The quality parameters of Safed Musli *viz*., saponin content (%), protein content (%), fiber content (%) were recorded. Saponin content was estimated by root extract was treated with Chloroform and Ethyl acetate by Gravimetric method. The protein content was determined by multiplying the percent N in root and leaves sample by constant factor 6.25 for Safed Musli as described by A.O.A.C. (1975) [1]. The fiber content was estimated by root digestion in acid and alkali by Acid-Alkali method as described by Maynard (1970) [9]. The soil samples collected before sowing and after harvest were analysed for the soil properties *viz*., pH, EC, organic carbon content, available nitrogen, phosphorus, potassium. Soil organic carbon was determined by using wet oxidation method (Walkley and Black, 1934) [12]. The available nitrogen was determined by using Kjeldahl method (Subbiah and Asija, 1956) [11]. Available phosphorus was determined Colorimetrically by Olsen's method. Available potassium in soil samples were determined by using the method of Jackson, 1973 [6]. The data was subjected to analysis of variance (ANOVA) in randomized block design (RBD) and interpreted as described by Gomez and Gomez (1984) [5].

Results and Discussion

The pooled data on number of roots/plant, root length, girth of root, fresh and dry root yield, saponin content, GMR, NMR, B:C ratio as influenced by different intercropping systems were recorded and presented in Table 1 to 2.

Yield contributing characters

Number of roots/plant

Number of roots/plant (12.26) was observed higher in T_6 (vermicompost @ 2.5 t ha^{-1} with 2 sprays of 0.5% humic acid and fulvic acid at 45 & 75DAP) which was at par with other treatments except T_4 (vermicompost @ 2.5 t ha^{-1} with 0.5% Humic acid spraying at 45 & 75 DAP) showed minimum number of roots(11.72) during both years. These results are inclose agreement with Wankhade *et al*., (2004) [15] and Anonymous (2015) [2].

Root length

During 2021-22 and 2022-23 treatment T_6 (vermicompost @ 2.5 t ha^{-1} with 2 sprays of 0.5% humic acid and fulvic acid at 45 & 75DAP) recorded highest root length/plant (7.73cm) which was at par with T_4 (vermicompost @ 2.5 t ha^{-1} with 0.5% Humic acid spraying at 45 & 75 DAP) i.e.7.65cm.

Root girth

Higher girth of root (2.97 mm) was recorded in T_6 (vermicompost @ 2.5 t ha^{-1} with 2 sprays of 0.5% humic acid and fulvic acid at 45 & 75DAP)which were at par with T_4 (vermicompost @ 2.5 t ha^{-1} with 0.5% Humic acid spraying at 45 & 75 DAP) showed lower root girth (2.79 mm) during 2021-22 and 2022-23.These results are in conformity of findings of studies on safed musli + Pigeon pea intercropping conducted at Akola Anonymous 2015 [2] and Shivankar, 2015 [11].

Fresh root yield

T_6 (vermicompost @ 2.5 t ha^{-1} with 2 sprays of 0.5% humic acid and fulvic acid at 45 & 75DAP) recorded highest fresh root yield per plant (12.47 g) which was at par with $T_4$and T_2 whereas, during both years lowest observed in T_1. Higher fresh root yield (4291 kg/ha) was recorded in T_6 which was at par with T_4 and T_2 whereas minimum was observed in T_1 (3030 kg/ha).

Dry root yield

Maximum dry root yield per plant was observed in T_6 (vermicompost @ 2.5 t ha^{-1} with 2 sprays of 0.5% humic acid and fulvic acid at 45 & 75DAP) i.e. 3.05 g which was at par with $T_4$and T_2 whereas, minimum observed in T_1.

T_6 (vermicompost @ 2.5 t ha^{-1} with 2 sprays of 0.5% humic acid and fulvic acid at 45 & 75DAP) recorded highest dry root yield (994 kg/ha) which was at par with T_4 and T_2 whereas, minimum dry root weight was observed in T_1 (585 kg/ha). This is might be due to favorable partial shade effect which recorded in better crop growth and ultimately the root yield. These results are supported by the findings of Tapre *et al*., (2020) [13].

Saponin content

During both years i.e. 2021-22 and 2022-23,non-significant data was reported but maximum saponin content (7.17%) was recorded in T_6(vermicompost @ 2.5 t ha^{-1}with 2 sprays of 0.5% humic acid and fulvic acid at 45 & 75DAP followed by T_4 and T_2 whereas, minimum was recorded in T_1. Safed musli with organic sources resulted in better root quality in terms of saponin which is the active ingredient might due to proper utilization of solar light with balanced nutrition resulted in better synthesis of secondary metabolites and ultimately the root quality with good yield (Dhayal *et al.*, 2022) [10].

Economics

Significantly higher GMR (Rs13,76,700/ha), NMR (Rs. 10,48,150/ha) and B:C ratio (4.19) was recorded in T_6 (vermicompost @ 2.5 t ha^{-1} with 2 sprays of 0.5% humic acid and fulvic acid at 45 & 75DAP).

Table 1: Effect of different organic treatments on number of roots/plant, root length/plant, girth of roots, fresh and dry root wt./ plant and fresh root wt.(kg/ha) of Safed Musli

Treatment	No. of fasciculatedoots/plant	Root length/ plant (cm)	Girth of roots (mm)	Fresh root wt./plant (g)	Dry root wt. /plant (g)	Fresh root wt. (kg/ha)
T_1-Control	7.11	6.71	1.56	11.40	1.18	3030
T_2-Vermicompost @ 2.5 t ha^{-1}	11.01	7.48	2.51	15.55	2.44	4097
T_3-FYM @ 5 t ha^{-1}	9.21	7.20	2.07	13.12	2.23	3649
T_4-Vermicompost @ 2.5 t ha^{-1} + 0.5% humic acid spraying at 45 &75DAP	11.72	7.65	2.79	16.14	2.99	4186
T_5-FYM @ 5.0 t ha^{-1}+ 0.5% humic acid spraying at 45 &75DAP	10.88	7.38	2.21	14.25	2.35	3744
T_6-Vermicompost @ 2.5 t ha^{-1} + 0.5% fulvic acid at 45 DAS+0.5% humic acid spraying at 75DAP	12.26	7.73	2.97	18.57	3.05	4291
T_7-FYM @ 5 t ha^{-1}+ 0.5% fulvic acid at 45DAS+0.5% humic acid spraying at 75DAP	10.94	7.46	2.28	14.73	2.37	3846
SE (m)±	0.43	0.05	0.13	0.75	0.16	60
CD at 5%	1.33	0.16	0.40	2.21	0.49	182

Table 2: Effect of different organic nutrient management practices on dry root yield (Kg/ha), saponin content and economics of Safed Musli

Treatment	Dry root yield (Kg/ha)	Saponin Content (%)	GMR(Rs/ha)	NMR(Rs/ha)	B:C Ratio
T_1-Control	585	6.69	811125	497425	2.59
T_2-Vermicompost @ 2.5 t ha^{-1}	790	7.10	1095000	768950	3.36
T_3-FYM @ 5 t ha^{-1}	634	6.73	879250	563700	2.79
T_4-Vermicompost @ 2.5 t ha^{-1} + 0.5% humic acid spraying at 45 &75DAP	892	7.14	1234425	906375	3.76
T_5-FYM @ 5.0 t ha^{-1}+ 0.5% humic acid spraying at 45 &75DAP	667	6.85	924638	607088	2.91
T_6-Vermicompost @ 2.5 t ha^{-1} + 0.5% fulvic acid at 45 DAS+0.5% humic acid spraying at 75DAP	994	7.17	1376700	1048150	4.19
T_7-FYM @ 5 t ha^{-1+} 0.5% fulvic acid at 45DAS+0.5% humic acid spraying at 75DAP	685	7.07	949063	631013	2.98
SE (m)±	23	0.41	31389	31389	-
CD at 5%	70	NS	96721	96721	-

Conclusion

Thus study indicated that application of vermicompost @ 2.5 t ha^{-1} with 2 sprays of 0.5% humic acid and fulvic acid at 45 & 75DAP recorded significantly higher average root length, girth, GMR, NMR and B:C ratio. It can be determined that organic nutrient management practices with foliar spray of humic and fulvic acid helps to increase the yield of Safed musli and net profit.

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