Effect of organic inputs on the yield, dry matter production, solasodine content and nutrient uptake of medicinal solanum (*Solanum viarum* Dunal)

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ABSTRACT

An investigation was conducted to study the effect of various organic inputs on the yield, dry matter production, solasodine content and nutrient uptake of medical solanum. The experiment was carried out by following the principles of Randomized Block Design with 13 treatments in three replications. Organic inputs such as Farmyard manure (25 t/ha) and vermicompost (5 t/ha) were applied as basal and panchakavya (3%) and humic acid (0.2%) were applied as foliar spray thrice viz, vegetative, flowering and fruiting stages. The results of the experiment revealed that combination of Farmyard manure 12.5t/ha + vermicompost 2.5t/ha + panchakavya 3% enhanced the yield characters like early flowering, number of fruits, fruit set percentage, fruit diameter, single fruit weight and fruit yield per plant, Physiological attributes like dry matter production (DMP) and biochemical parameter like solasodine content when compared to the other treatments.

Key words: Medicinal Solanum, Farm yard manure,Vermicompost, Panchakavya, Humic acid.

Introduction

Steroid bearing Solanum (*Solanum viarum* dunal) is an important medicinal plant belonging to the family Solanaceae and is a source of glyco-alkaloid solasodine, a nitrogen analogue of diosgenin. Solasodine through 16 dehydropregnenolone (16 DPA) is converted to a group of drugs like testosterone and methyl-testosterone and corticosteroids like predinisolone and hydrocortisone. These steroidal compounds have anti-inflammatory, anabolic and anti - fertility properties due to which they find large scale use in the health and family planning programmes all over the world.

Because of its hardy nature it can be grown in different types of soils. Continuous use of chemical fertilizers has resulted in the depletion of soil health and moreover, with the indiscriminate use of fertilizers and chemicals there is increased risk of health hazards (Sharu and Meerabai, 2001). Organic substances are used to maintain soil productivity and to supply plant nutrients and also used in various aspects of biological control of weeds, pests and diseases, (Dahama 1997). In this context, the present investigation was undertaken with an objective of finding out the effect of organic inputs on the yield, dry matter production

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(DMP) and solasodine content of medicinal solanum.

Materials and methods

The investigation was conducted in the medicinal plant unit, Department of Horticulture, Annamalai University. The experiment was set up in a Randamized Block Design with 13 treatments in three replications. The organic inputs viz., Farmyard manure (25 t/ha) and vermicompost (5 t/ ha) were applied as basal and panchakavya (@ 3%) and humic acid (@ 0.2%) were applied as foliar spray thrice viz., vegetative, flowering and fruit set stages. The observations on yield characters like early flowering, number of fruits plant^{-1}, fruit set percentage, fruit diameter, single fruit weight and fruit yield plant^{-1}, Physiological attributes like dry matter production (DMP) and biochemical parameter like solasodine content were recorded at 150 DAP and the results were analyzed statistically (Panse and Sukhatme, 1985).

Results and discussion

Yield is a complex character which is influenced by the interaction of many factors and the ultimate goal of any scientific crop production is to achieve the highest possible yield. It can be inferred from the results presented in Table 1 that the application of Farmyardmanure 50% + vermicompost 50% + panchakavya 3% (T_{10}) recorded the early flowering (56.35 days), highest number of flowers plant^{-1} (89.15) followed by T_{11} (Farmyard manure50% +vermicompost 50% + Humicacid 0.2%) which took 57.32 days and recorded 87.54 flowers plant^{-1}. The control (T_{13}) took the maximum days for first flowering (65.21 days) and recorded the least number of flowers plant^{-1} (73.46). Early flowering along with greater flower production due to application of organic manures (viz., FYM, vermicompost and panchakavya) might be due to the better nutritional status of the plant, which was favoured by this treatment. Further, due to greater photosynthetic effect, flowering was induced, thus effecting early initiation of flower bud formation. Earlier reports by Subbarao and Ravisankar (2001) also revealed that application of FYM and vermicompost along with panchakavya resulted in earlier flowering and higher flower production. They further suggested that the increased synthesis of cytokinin and auxin in the root tissue by their enhanced activity due to the application of panchakavya and their simultaneous transport to the axillary buds would have resulted in a better mobilization of assimilates from the source to the sink at a faster rate which in turn, would have helped in the early transformation from the vegetative phase to reproductive phase. The induction of early flower bud formation might have been influenced by the triggering of such metabolic processes and narrowing of carbon: nitrogen ratio by the significant accumulation of carbohydrates. Furthermore, foliar spray of panchakavya facilitates greater uptake of nutrients which leads to the effective conversion of vegetative phase to flowering phase. The enhanced vegetative growth coupled with adequate reserve food material promotes early differentiation of vegetative buds into flower buds leading to earliness in flowering as suggested by Cynthia Starlyn Emily (2003). The results of the present study are in accordance with the findings of Sivakumar (2004) in black night shade and Arjunan (2005) in tomato. Higher flower production might be due to the better nutritional status of the plant, which was favoured by this treatment.

The data in Table 1 shows the effect of organic inputs on the number of fruits per plant and fruit set percentage T_{10} (Farmyardmanure 50% + vermicompost 50% + panchakavya 3%) recorded the maximum number of fruits and fruits set percentage (51.08 and 57.29 % respectively) followed by T_{11}(Farmyard manure 50% + vermicompost 50% + humic acid 0.2%) which recorded the values of 48.94 and 55.91 % respectively. The control recorded the least values of 30.58 and 41.63 % respectively. The increased fruit set percentage observed in the present study might be due to the presence of auxins in panchakavya which is attributed to the increased number of developing ovaries and the treatments would have inhibited the pre-abscission pectinase and cellulose activities. This might have been the probable reason for the increased fruit set through a decrease in the abscission of set fruits. Besides its action in increasing the fruit set, it might have been involved in the process of ovary development, probably protecting the native auxin from enzymatic destruction as observed by Beaulah (2001).

Further more application of Farmyard manure 50 per cent + vermicompost 50 per cent + panchakavya 3 per cent (T_{10}) recorded the maximum single fruit weight (5.08g), diameter of fruit (2.47 cm) and fruit yield plant^{-1} (259.49 g) followed by T_{11} (Farmyard manure 50% + vermicompost 50% + humic acid 0.2%) in which the values of 4.69g, 2.38 cm and 229.53g plant^{-1} respectively were registered. The least values were registered in the control (3.27 g, 2.05 cm and 99.99 g respectively).

Higher yield due to the application of organic inputs may also be attributed to their favourable effects in improving the physical condition of the soil, besides supplying adequate major and minor nutrients which might have enhanced the absorption, translocation and assimilation of nutrients resulting in higher yield as suggested by Dange *et al* (2002) in chilli. Further more, Sharma *et al*. (2003) opined that the beneficial effects of organic manures on yield and yield components could be attributed to the fact that after proper decomposition and mineralization, the manures supplied available nutrients directly to the plant and also had a solubilising effect on fixed form of nutrients in soil.

An increase in the number of fruits plant^{-1} due to panchakavya application was observed. The enhancing effect of panchakavya in vegetative phase accompanied with highest number of flowers in reproductive phase positively contributed to the highest number of fruits plant^{-1}. The pronounced increase in yield with panchakavya might also be due to the sustained availability of N throughout the growing phase and also due to enhanced carbohydrate synthesis and effective translocation of photosynthates to the developing sink *i.e.,* fruit. The proportion and activity of beneficial microbes would have been at higher rates in panchakavya, which helps in the synthesis of growth promoting substances that might have increased the yield. This is in line with the findings of Sarma and Anandaraj (2003).

Further, the increased nutrient availability from the organic manures might have increased the various endogenous hormonal levels in the plant tissue, which might be responsible for enhanced pollen germination and pollen tube growth, which ultimately increased the number of fruits per plant, resulting in higher yields. (Arjunan, 2005). The results of the present study are in agreement with the findings of Selvaraj *et al* (2003) in thyme and rosemary.

The data presented in Table 2 revealed that the combined application of organic manures and foliar application of panchakavya and humic acid markedly influenced the dry matter production and solasodine content of medicinal solanum. Application of Farm yard manure 50 per cent + vermicompost 50 per cent + panchakavya 3 per cent (T_{10}) recorded the maximum dry matter production and solasodine content (217.33 g and 1.28 % respectively) followed by farmyard manure 50 per cent + vermicompost 50 per cent +humic acid 0 .2 per cent (T_{11}) which registered the values of 208.77 g and 1.25 per cent respectively. The least values were observed in the control. As suggested by Krishnamoorthy and Ravikumar (1973), higher production of dry matter by the plant could be attributed to the fact that organic manures have high amount of humus, facilitate N-fixation by microbes, regulate the nitrogen supply to the plants and also helps in the production of plant growth promoters. Organic manures might have provided a continuous supply of nutrients and might have enabled the leaf area duration to extend, thus providing an opportunity for the plants to increase the photosynthetic rates, which could have led to the higher accumulation of dry matter (Padmanaban, 2003). More the number of leaves plant^{-1}, greater the leaf area, which in turn produces more photoassimilates leading to higher dry matter accumulation. The presence of humic acid in FYM may have also encouraged greater uptake of nitrogen resulting in heavier total dry matter accumulation. This is in accordance with the earlier reports of Selvarajan and Cheziyan (2001). Furthermore, Sridhar (2003) opined that high organic matter content, presence of numerous active enzymes, vitamins and macro and micro nutrients in panchakavya might have contributed to the increased dry matter production. The results of this study are in accordance with the reports of Bharathi (2004) in medicinal coleus, Ponni and Arumugam Shakila (2007) in *Phyllanthus niruri* and Sanjutha *et al*. (2008) in kalmegh.

From this study, it was observed that the active principle solasodine was significantly influenced by the application of organic manures. This may be attributed to the positive effect of organic manures and panchakavya and also due to the increased uptake of nutrients by the plants. This is in conformity with the findings of Neelam Sharma *et al*., (1991) in medicinal coleus and Saraswathy (2003) in ashwagandha. The possible reason for acceleration in the alkaloid content might be due to the growth promoters present in the organic manures. Further, the enhanced dry matter production would also have invariably determined the alkaloid content as it supplied the required metabolites to the filling sink. Higher availability and uptake of nutrients would have enhanced the higher photosynthetic activity and accumulation of more photosynthates at the sink, which in turn, correspond to the higher amounts of alkaloids. Similar findings were also reported by Kanimozhi (2003) in medicinal coleus.

In the present investigation, the nitrogen, phosphorus and potassium uptake was maximum(49.97, 28.57 and 41.83 kg ha^{-1} respectively) in the treatment in which combination of organic manures viz., FYM 12.5 t ha^{-1} and vermicompost 2.5 t ha^{-1} along with panchakavya 3 per cent as foliar spray was applied. This was followed by T_{11} (Farmyard manure 50% + vermicompost 50% + humic acid 0.2%) which registered the values of 47.89, 27.46 and 40.31 kg ha^{-1} respectively. The least uptake of NPK were registered in the control (31.08, 19.34 and 27.14 kg ha^{-1} respectively). Organic manures like FYM when applied to the soil result in the breakdown of complex nitrogenous compounds by the action of microorganisms and increase its availability to the soil in the form of nitrate nitrogen as observed by Chavan *et al*. (1997). Moreover, resistant fractions of organic matter, including the intermediate degradation products derived from organic manures would have actively absorbed the ammoniacal N, thus preventing it from volatalization and leaching losses (Rajukannu and Manickam, 1995). Similar effects were observed by Meera Nair and Peter (1990) in chilli. Earlier reports by Subbaiah *et al*. (1982) also revealed increased uptake of NPK with the application of FYM and vermicompost, which could be attributed to the solubilisation effect of plant nutrients by the addition of FYM and vermicompost.

Further, Budhawant (1994) found that the phosphorus uptake was increased with the application of organic manures especially FYM, which may be attributed to the greater solubilisation of native phosphorus from the soil due to the action of various organic acids liberated during the decomposition of FYM. Similar results on increase in phosphorus uptake due to application of organic manures have been reported by Sen *et al*. (1996) and Kannan (2004).

The use of a combination of organic manures increased the potassium content, which may be ascribed to its role in improving the soil properties, leading to better penetration of roots, thereby resulting in greater uptake of potassium from native source (Budhawant, 1994). Similar findings have been reported by Paul *et al*. (2004) in tomato, Chavan *et al*. (1997) and Meera Nair and Peter (1990) in chilli.

Added organic manures not only acted as a source of nutrients but also had influenced their availability and the cumulative effect of these treatments along with panchakavya seemed to be adequate suppliers of nutrients slowly and steadily throughout the period of crop growth as observed by Santhanalakshmi (2006). The increased content of major nutrients could be due to the chemolithic autotropic nitrifiers (ammonifiers and nitrifiers) which colonize in the leaves leading to increased ammonia uptake and enhanced total N supply (Papen *et al*. 2002). Further, Kale *et al*. (1995) observed that vermicompost contains a good amount of macro and micro nutrients. It also serves as a very good base for establishing and multiplication of beneficial symbiotic microbes which helps in fixing nitrogen in the soil, besides enhancing the availability of phosphorus and nitrogen and uptake of phosphorus by plants.

From the present investigation, it can be concluded that the combined application of Farmyard manure 12.5 t/ha Vermicompost 2.5 t/ha as basal and Panchakavya 3% as foliar spray was found to be the best for increasing yield, dry matter production, solasodine content and nutrient uptake of Medicinal Solanum.

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Table 2. Effect of organic inputs on the yield characters of Medicinal Solanum

Treatments	Days taken for first flowering	Number of flowers per plant	Number of fruits per plant	Fruit set (%)	Single fruit weight (g)	Fruit Diameter (cm)	Fruit yield / plant (g)
T_1- FYM 25t ha^{-1}	64.23	75.12	32.63	43.44	3.39	2.08	110.62
T_2- VC 5t ha^{-1}	63.30	76.61	34.75	45.36	3.46	2.11	120.24
T_3- FYM 25 t ha^{-1} + PK 3%	61.09	80.42	39.86	49.56	3.67	2.14	146.29
T_4- VC 25 t ha^{-1} + PK 3%	60.45	82.17	41.94	51.04	3.81	2.18	159.79
T_5- FYM 25 t ha-1 + HA 0.2%	62.35	78.14	36.73	47.01	3.57	2.13	131.13
T_6- VC 5t ha-1 + HA 0.2%	61.42	79.55	38.82	48.79	3.61	2.14	140.14
T_7- FYM 50% + PK 3% + HA 0.2%	60.13	83.14	42.89	51.59	3.89	2.21	166.84
T_8- VC 50% + PK 3%+ HA 0.2%	58.26	86.08	46.86	54.44	4.36	2.31	204.31
T_9 –FYM 50% +VC 50 %	60.77	91.34	40.85	50.22	3.76	2.17	153.60
T_{10}- FYM 50%+VC 50 % + PK 3%	56.35	89.15	51.08	57.29	5.08	2.47	259.49
T_{11}- FYM 50% + VC 50 % + HA 0.2%	57.32	87.54	48.94	55.91	4.69	2.38	229.53
T_{12}- FYM50% + VC 50 % + PK 3%+HA 0.2%	59.17	84.71	44.34	52.93	4.01	2.23	179.81
T_{13} Control	65.21	73.46	30.58	41.63	3.27	2.05	99.99
SED	0.16	0.50	0.57	0.43	0.09	0.02	3.53
CD (p=0.05)	0.35	0.99	1.13	0.85	0.17	0.04	7.09

Table 2. Effect of organic inputs on the dry matter production, solasodine content and nutrient uptake of Medicinal Solanum

Treatments	Dry matter production (g)	Solasodine content (%)	Nutrient uptake (kg ha^{-1})		
			Nitrogen	Phosphorus	Potassium
T_1- FYM 25t ha^{-1}	160.60	1.12	32.67	20.49	28.58
T_2- VC 5t ha^{-1}	162.96	1.14	34.38	21.48	29.85
T_3- FYM 25 t ha^{-1} + PK 3%	176.72	1.15	39.21	23.67	33.63
T_4- VC 25 t ha^{-1} + PK 3%	181.85	1.15	41.35	24.24	35.51
T_5- FYM 25 t ha-1 + HA 0.2%	165.63	1.14	36.25	22.55	31.21
T_6- VC 5t ha-1 + HA 0.2%	173.06	1.14	38.27	23.46	32.69
T_7- FYM 50% + PK 3% + HA 0.2%	185.83	1.15	42.53	24.61	36.36
T_8- VC 50% + PK 3%+ HA 0.2%	200.92	1.22	45.95	26.43	38.91
T_9 –FYM 50% +VC 50 %	178.87	1.15	40.36	23.98	34.52
T_{10}- FYM 50%+VC 50 % + PK 3%	217.33	1.28	49.97	28.57	41.83
T_{11}- FYM 50% + VC 50 % + HA 0.2%	208.77	1.25	47.89	27.46	40.31
T_{12}- FYM50% + VC 50 % + PK 3%+HA 0.2%	193.90	1.19	44.17	25.48	37.59
T_{13} Control	157.31	1.09	31.08	19.34	27.14
SED	2.01	0.01	0.62	0.21	0.52
CD (p=0.05)	4.02	0.02	1.23	0.41	1.04