International Journal of Agricultural Extension and Rural Development Vol. 1 (1), pp. 005-007, January, 2013. Available online at www.internationalscholarsjournals.org © International Scholars Journals

*Full Length Research Paper*

# Influence of spacing and organics on plant nutrient uptake of black nightshade (*Solanum nigrum)*

**Sivakumar V.[1]* and Ponnusami V.[2]**

[1]Agricultural research Station, Tamil Nadu Agricultural University, Bhavanisagar – 638451, Erode District, Tamil Nadu, India.
[2]Horticultural College and Research Institute, Tamil Nadu Agricultural University, Periyakulam - 625 604, Theni District, Tamil Nadu, India.

Accepted 29 of November, 2013

**Investigations were carried out at the Horticultural College and Research Institute to study the effect of spacing and bio-stimulants on the plant nutrient uptake of *Solanum nigrum*. The experiments were laid out in split plot design with three replications. The treatments consisted of four levels of spacing ($M_1$ – 30 × 30 cm, $M_2$ – 45 × 45 cm, $M_3$ – 60 × 30 cm and $M_4$ – 60 × 45 cm) and nine bio-stimulants/organics ($S_1$– Recommended dose of fertilizer (RDF), $S_2$ – control, $S_3$ – panchagavya 2%, $S_4$ – panchagavya 3%, $S_5$ – moringa leaf extract 2%, $S_6$ – moringa leaf extract 4%, $S_7$ – humic acid, $S_8$ – cytozyme 1% and $S_9$ – vermicompost). Observations on nutrient uptake found that, the treatment closer spacing + RDF ($M_1S_1$) registered higher nitrogen uptake (223.83 kg ha$^{-1}$) and phosphorous uptake (22.02 kg ha$^{-1}$) followed by closer spacing + panchagavya 3% spray ($M_1S_4$) (202.64 kg ha$^{-1}$) (Nitrogen uptake - 202.64 kg ha$^{-1}$ and Phosphorous uptake -20.03 kg ha$^{-1}$). Regarding the potassium uptake the treatment wider spacing + RDF ($M_4S_1$) combination recorded the highest K uptake (252.83 kg ha$^{-1}$) followed by the treatment wider spacing + humic acid combination ($M_4S_7$) (227.14 kg ha$^{-1}$).**

**Key words:** *Solanum nigrum,* spacing, organics, plant nutrient uptake.

## INTRODUCTION

Among various medicinal plant species, black nightshade, or (*Solanum nigrum* L. Mana thakkali, Family *Solananceae*) has great demand in the Indian system of medicine. This herb is recently gaining importance in pharmaceutical industry due to its amazing drug potential. The whole plant is recommended for use as cardiac tonic, alterative, diuretic, sedative, expectorant, diaphoretic, cathartic and anodyne. The active principle in this herb is solasodine; a glucosidal alkaloid, used as a starting material for the synthesis of hydrocortisones. It is in great demand in the pharmaceutical industry (Dhawan, 1986). Fertilizers and organic manures constitute im-portant inputs in the production of all crop species. Plants require essential mineral nutrients to complete their life cycle and the quantities required for optimum growth and production vary with species. Increased fertilizers for the development of more efficient fertility management program. Organic formulations are chemical fertilizer cost and awareness of environmental pollution have necessitated the use of organic sources of apparently environment and farmer friendly renewable source of non-bulky, low cost organic agricultural inputs for impro-ving soil quality status in consumable medicinal plants. Organic manures are fairly good source of nutrients which has direct influence on plant growth like other commercial fertilizers. Mukherjee et al. (1991) and Prasad and Singhania (1989) also reported that applica-tion of organic manures increased the leaf nutrient status. Jambhekar (1992) and Shivputra et al. (2004) also reported similar result. However, little information is avail-able in this area; therefore this study was designed and conducted to identify the effect of spacing and organics on plant nutrient uptake of black nightshade.

## MATERIALS AND METHODS

The Experiment was carried out at the Botanical Garden, Department of Floriculture and Medicinal plants, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. The experiment was laid out in a split plot design with

*Corresponding author. E-mail: shivafruitscience@gmail.com.

13 treatment combinations replicated three times. The field lay out and randomizations of treatments to plots of size 2 × 2 m (4 square meters) were carried out as per the statistical methods suggested by Panse and Sukhatme (1985). The treatments consisted of four levels of spacing and nine bio-stimulants/organics.

**Treatment details**

***Main plot treatments***

Spacing: $M_1$ – 30 × 30 cm; $M_2$ – 45 × 45 cm; $M_3$ – 60 × 30 cm; $M_4$ – 60 × 45 cm.

***Sub plot treatments***

**Bio-regulators/organics:** $S_1$ – Recommended fertilizer dose; $S_2$ – Control (only FYM); $S_3$ – FYM + Panchagavya foliar spray – 2% at 15 days interval; $S_4$ – FYM + Panchagavya foliar spray – 3% at 15 days interval; $S_5$ –FYM + Moringa leaf extract foliar spray – 2% at 15 days interval; $S_6$ –FYM + Moringa leaf extract foliar spray – 4% at 15 days interval; $S_7$ – FYM + Humic acid 20 kg ha$^{-1}$ as basal; $S_8$ – FYM + Cytozyme foliar spray – 1% at 15 days interval; $S_9$ – FYM + Vermicompost – 2.5 t ha$^{-1}$ as basal.

The observations that were recorded are plant nitrogen uptake, plant phosphorous uptake and plant potassium uptake. The organics were sprayed at 15 days interval starting from 30 days after transplanting. The observations were recorded at 80 days after transplanting that is at harvest stage.

## RESULTS AND DISCUSSION

### Nitrogen uptake

The effect of M, S, M × S and S ×M exerted a significant influence on nitrogen uptake (Table 1). Closer spacing ($M_1$) recorded significantly higher nitrogen uptake (184.16 kg ha$^{-1}$) and wider spacing ($M_4$) registered the lowest nitrogen uptake (73.10 kg ha$^{-1}$). Of various organics and bio regulators tried, RDF ($S_1$) treated plants recorded more nitrogen uptake (139.68 kg ha$^{-1}$) followed by panchagavya 3% ($S_4$) sprayed plants (125.39 kg ha$^{-1}$). The uptake was low (105.84 kg ha$^{-1}$) in control ($S_2$). The interaction effect of closer spacing + RDF ($M_1S_1$) registered higher nitrogen uptake (223.83 kg ha$^{-1}$) which was followed by closer spacing + panchagavya 3% spray ($M_1S_4$) (202.64 kg ha$^{-1}$). Lesser nitrogen uptake of 67.80 kg ha$^{-1}$ was recorded in wider spacing + control ($M_4S_2$) combination. The uptake of nutrients is primarily a function of total biomass production and nutrient content at cellular level. Increase in uptake of nutrients coincides with the rapid growth phase with a very low rate of uptake during initial vegetative phase. In the present study, nitrogen and phosphorus uptake was more under closer spacing + RDF followed by panchagavya and humic acid treatments. This may be attributed due to more population per plot. The increased uptake of nitrogen was supposed to be due to the better use efficiency of applied nitrogen fertilizer in the presence of humic acid coupled with the retarded nitrification process enabling the slow availability of applied nitrogen (Guminski, 1968). The principal physiological function of humic acid may be that they reduced the oxygen deficiency in plants which resulted in uptake of larger amount of nitrogen (Khristeva and Luk'Yanenko, 1962). According to Yadav (1989), the reactions of ammonium ion with humic acid yielding covalent compounds maintain the mobility of ammonium in solution and aids in the increase uptake of the same by plants. Another possible reason for enhanced nitrogen uptake in the presence of humic acid was suggested by Piccolo et al. (1992) who stated that the acid functionality of humic acid could simulate the nitrate uptake by plants. Nitrate reductase is the key enzyme for nitrogen assimilation by most of the plants (Campbell, 1999). Humic substances induced the activity of enzymes such as invertase and nitrate reductase and there by helped in increased assimilation of nitrogen by plants (Ferretti et al., 1991). Higher uptake of nitrogen by shoot could be due to the fact that nitrogen is the mobile element and it is utilized more in shoot than in root.

### Phosphorous uptake

The effect of spacing, organics and bio regulators and interactions M × S and S × M exhibited a significant influence on phosphorous uptake (Table 1). Higher plant density ($M_1$) recorded more phosphorous uptake (17.99 kg ha$^{-1}$) and lesser plant density ($M_4$) registered lower phosphorous uptake (6.68 kg ha$^{-1}$). Among the different organics and bio regulators used, RDF ($S_1$) applied plants recorded greater phosphorous uptake (13.57 kg ha$^{-1}$) followed by panchagavya ($S_4$) sprayed plants (11.88 kg ha$^{-1}$) and humic acid ($S_8$) applied plants (10.72 kg ha$^{-1}$). The phosphorous uptake was lower (9.56 kg ha$^{-1}$) in control ($S_2$) treatment. Closer spacing + RDF ($M_1S_1$) combination recorded significantly higher phosphorous uptake (22.02 kg ha$^{-1}$) followed by $M_1S_4$ (20.03 kg ha$^{-1}$). The less phosphorous uptake (5.76 kg ha$^{-1}$) was observed in wider spacing + control ($M_4S_2$) interaction. Dell 'Agnola and Nardi (1987) concluded that humic substances extracted from soil stimulated ion uptake by roots. Humic acid is known to be surface active and increases the permeability of root membranes and thereby enhances the nutrient uptake as stated by Rauthan and Schnitzer (1991). Application of humic acid increased the root growth by 58% and this could help in better assimilation of phosphorus by plants (Vaughan and Malcolm, 1979). The increase in phosphorus uptake may be due to the prevention of phosphorus fixation in the soil and also by forming humophospho complexes which are easily assimilated by plants (Raina and Goswami, 1988). The increase in phosphorus accumulation in tomato shoot suggested that humic acid may enhance the uptake of phosphorus indirectly by complexing the iron (David et al., 1994). Addition of humic acid maintained high levels of acid phosphatase activity which increased phosphatase activity and holds key for increased

**Table 1.** Effect of spacing, organics and bio-regulators on N and P uptake (kg ha$^{-1}$) in black nightshade.

| Treatment | N | | | | | P | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $M_1$ | $M_2$ | $M_3$ | $M_4$ | Mean | $M_1$ | $M_2$ | $M_3$ | $M_4$ | Mean |
| $S_1$ | 223.83 | 116.304 | 124.67 | 93.90 | 139.68 | 22.02 | 11.50 | 11.19 | 9.59 | 13.57 |
| $S_2$ | 166.40 | 89.86 | 99.28 | 67.80 | 105.84 | 16.50 | 7.42 | 8.59 | 5.76 | 9.56 |
| $S_3$ | 170.57 | 93.37 | 103.10 | 68.81 | 108.96 | 16.54 | 8.00 | 9.15 | 6.12 | 9.95 |
| $S_4$ | 202.64 | 105.83 | 116.93 | 76.18 | 125.39 | 20.03 | 9.20 | 11.06 | 7.24 | 11.88 |
| $S_5$ | 169.19 | 94.12 | 101.8 | 68.06 | 110.25 | 16.62 | 7.55 | 8.13 | 6.09 | 9.87 |
| $S_6$ | 173.93 | 95.44 | 102.38 | 70.31 | 110.52 | 16.64 | 8.03 | 8.61 | 6.39 | 9.91 |
| $S_7$ | 191.00 | 102.07 | 113.53 | 72.82 | 119.86 | 18.69 | 8.66 | 9.04 | 6.49 | 10.72 |
| $S_8$ | 180.99 | 97.33 | 106.36 | 69.88 | 113.64 | 17.23 | 8.04 | 8.33 | 6.13 | 9.93 |
| $S_9$ | 178.92 | 97.03 | 105.80 | 70.16 | 112.98 | 17.61 | 8.38 | 8.62 | 6.30 | 10.22 |
| Mean | 184.16 | 99.91 | 108.21 | 73.10 | 116.34 | 17.98 | 8.65 | 9.19 | 6.67 | 10.62 |

| | M | S | MS | SM | M | S | MS | SM |
|---|---|---|---|---|---|---|---|---|
| SEd | 0.82819 | 0.97562 | 1.95123 | 2.01747 | 0.27667 | 0.21132 | 0.48510 | 0.42264 |
| CD (0.05) | 2.02659 | 1.94903 | 3.89806 | 4.18312 | 0.67702 | 0.42216 | 1.04000 | 0.84433 |

phosphorus uptake by plants (Malcolm and Vaughan, 1979). Organic phosphorus content in soil comprises of 30-70 percentage of the total phosphorus. Hydrolysis of these organic phosphorus compounds is essential for uptake by plants (Bhattacharyya and Ghosh, 2001) and humic acid brought out this hydrolysis (Adani et al., 1998).

## Potassium uptake

The individual effect of spacing, organics and bio regulators and the interaction effect of M × S and S × M on potassium uptake were significant (Table 2). Among the spacing levels, potassium uptake was significantly higher (204.92 kg ha$^{-1}$) under closer spacing ($M_1$) followed by $M_3$ (117.35 kg ha$^{-1}$). Lesser score (71.45 kg ha$^{-1}$) was recorded in $M_4$ (wider spacing) level. Of different organics and bio regulators used, RDF ($S_1$) applied plants expressed more potassium uptake (150.32 kg ha$^{-1}$) followed by panchagavya 3% ($S_4$) given plants (134.11 kg ha$^{-1}$). The potassium uptake was less (113.03 kg ha$^{-1}$) in control ($S_2$). The effect of interaction on potassium uptake indicated that closer spacing + RDF ($M_1S_1$) combination recorded greater potassium uptake (252.83 kg ha$^{-1}$), which was followed by closer spacing + humic acid ($M_1S_7$) combination (227.14 kg ha$^{-1}$). The potassium uptake was less (64.78 kg ha$^{-1}$) at wider spacing + without spray ($M_4S_2$). From the present results it is evident that the potassium uptake was more in closer spacing + humic acid next to RDF, followed by panchagavya. David et al. (1994) suggested that the factors other than direct nutritional effect of humic acid may also operate in enhancing the potassium uptake by plants. According to Samson and Visser (1989), humic acid induced increase in the permeability of bio membranes for electrolytes accounted for increased uptake of potassium. Humic substances modify membrane bound ATPase activity and the relation between membrane ATPase activity, $H^+$ extrusion and the ion uptake suggested that humic substance influence active uptake of potassium by interfering with specific ion carrier. In the present study, the findings exhibited that more of nutrient uptake (N, P and K) was found in closer spacing than wider spacing, but the leaf nutrient content (N, P and K) was more in wider spacing than the closer spacing. This may be due to the fact that, population per unit area in closer spacing was more than under wider spacing. Leaf nutrient content namely nitrogen and phosphorous, recorded significantly higher values on wider spacing + panchagavya 3% spray next to RDF than humic acid but potassium content registered higher value in wider spacing + humic acid next to RDF than panchagavya. The reason may be that nitrogen and phosphorous content was more in panchagavya spray and more potassium content in humic acid. The same was observed in case of nutrient uptake, but closer spacing recorded significantly higher uptake than wider spacing.

## Conclusion

In the present study, wider spacing + RDF ($M_4S_1$) treatment combination recorded significantly higher values for leaf nitrogen and phosphorous consent followed by the treatment Wider spacing + panchagavya ($M_4S_4$). Regarding lead potassium content and plant potassium uptake, the treatment wider spacing + RDF ($M_4S_1$) combination recorded the highest leaf K content

**Table 2.** Effect of spacing, organics and bio-regulators on K uptake (kg ha$^{-1}$) in black nightshade.

| Treatment | K | | | | |
|---|---|---|---|---|---|
| | $M_1$ | $M_2$ | $M_3$ | $M_4$ | Mean |
| $S_1$ | 252.83 | 123.48 | 135.02 | 89.94 | 150.32 |
| $S_2$ | 183.97 | 95.97 | 107.42 | 64.78 | 113.03 |
| $S_3$ | 186.08 | 102.26 | 112.73 | 67.98 | 117.26 |
| $S_4$ | 219.38 | 109.36 | 122.58 | 71.12 | 134.11 |
| $S_5$ | 186.84 | 100.78 | 109.94 | 66.96 | 123.43 |
| $S_6$ | 186.36 | 103.92 | 112.91 | 68.92 | 118.03 |
| $S_7$ | 227.14 | 111.35 | 123.51 | 74.44 | 130.61 |
| $S_8$ | 196.96 | 105.36 | 117.14 | 69.88 | 122.34 |
| $S_9$ | 204.7 | 104.97 | 114.90 | 69.06 | 117.89 |
| Mean | 204.92 | 107.17 | 117.35 | 71.45 | 125.22 |
| | **M** | **S** | **MS** | **SM** | |
| SEd | 1.13756 | 1.44489 | 2.95245 | 2.88977 | |
| CD (0.05) | 2.78364 | 2.88651 | 5.77302 | 6.09515 | |

(2.72%) followed by the treatment wider spacing + humic acid combination ($M_4S_7$).

## REFERENCES


Adani F, Genevini P, Zaccheo, Zocchi G (1998). The effect of commercial humic acid on tomato plant growth and mineral nutrition. J. Plant Nutr., 21(3): 561-575.

Bhattacharyya P, Ghosh G (2001). Phosphorus use efficiency in Brinjal with FYM and sulphur. J. Indian Soc. Soil Sci., 49(3): 456-462.

Campbell WH (1999). Nitrate reductase activity, structure function and regulation: Bridging the gap between biochemistry and physiology. Plant Physiol. Plant Mol. Biol., 50: 277-303.

David PP, Nelson PV, Sanders DC (1994). Humic acid improves growth of Tomato seeding in solution culture. J.Plant Nutr., 17(1): 173-184.

Dell' Agnola G, Nardi S (1987). Hormone-like effect and enhanced nitrate uptake induced by depolycondenced humic fractions obtained from A*llolobophora rosea* and *A. caliginosa* faeces. Biol. Fertility Soils. 4: 115-118.

Dhawan BN (1986). Current research on medicinal plants in India, INSA, New Delhi. pp: 1-86.

Ferretti M, Ghisi R, Nardi S, Passera C (1991). Effect of humic substances on photosynthetic sulphate assimilation in maize seedlings. J. Soil Sci., 71: 249-242.

Guminski S (1968). Present day views on physiological effects induced in plant organism by humic compounds. Soviet Soil Sci., 19: 1250-1256.

Jambhekar HA (1992). Use of earthworms as potential source of decomposed organic wastes. In: Proceedings, National Seminar on Organic Farming. Mahatma Phule Krishi Vidyapeeth, Pune, pp.52-53.

Khristeva LA, Luk'Yanenko NV (1962). Role of physiologically active substances in the soil -humic acids, bitumens and vitamins B,C, P-P, A and D in the life of plants and their replenishment. Soviet Soil Sci., 3: 1137-1141.

Malcolm RE, Vaughan D (1979). Humic substances and phosphatase activities in plant tissues. Soil Biol. Biochem., 11: 253-259.

Mukherjee DS, Mitra, Das AC (1991). Effect of oilcake on changes in carbon and microbial population in soil. J. Indian Soc. Soil Sci., 39: 457 - 462.

Panse VG, Sukhatme PV (1985). Statistical methods for agricultural workers. ICAR, New Delhi.

Piccolo A, Nardi S, Concheri G (1992). Structural characteristics of humic substances as related to nitrate uptake and growth regulation in plant systems. Soil Biol. Biochem., 24(4): 373-380.

Prasad RA, Sighania RA (1989). Effect of different types of enriched manures and time of incubation on soil properties. J. Indian Soc. Soil Sci., 37: 329 - 322.

Raina JN, Goswami KP (1988). Effect of fulvic acid and fulvates on the growth and nutrient uptake by maize plant. J. Indian Soc. Soil Sci., 36: 264 - 268.

Rauthan BS, Schnitzer M (1981). Effects of a soil fulvic acid on the growth and nutrient content of cucumber (*Cucumis sativus*) plants. Plant Soil, 63: 491-495.

Samson G, Visser SA (1989). Surface active effects of humic acids on Potato cell membrane properties. Soil Biol. Biochem., 21: 343-347.

Shivputra SS, Patil CP, Swamy GSK, Patil PB (2004). Cumulative effect of VAM fungi and vermicompost on nitrogen, phosphorus, potassium and chlorophyll content of papaya leaf. Mycorrhiza News, 16(2): 15-16.

Vaughan D, Malcolm RE (1979). Effect of humic acid on invertase synthesis in roots of higher plants. Soil Biol. Biochem., 11: 247-252.

Yadav K (1989). Influence of different levels of humic acids on nutrients content and growth of maize (*Zea mays* L.). Proc. Natl. Seminar on "Humus Acids in Agriculture", Annamalai University. Tamil Nadu, India, pp. 125 - 130.