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# Effect of integrated nutrient management on yield of brinjal and bhendi in a mixed black soil (Vertic Ustropept)

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**Abstract:** The foliar application of microfood / straight micronutrients recorded higher fruit yields of brinjal compared to soil application. The highest yield was recorded by the conjoint application of stanes microfood (foliar), composted coirpith and Azospirillum followed by foliar application of straight micronutrients in a similar combination. The application of foliar microfood with NPK recorded an yield increase of 26.1 per cent over NPK alone and in combination with composted coirpith, the yield was increased to 40.2 per cent and in combination with composted coirpith and Azospirillum, the yield was further increased to 52.6 per cent. The yield increase in bhendi due to the combined aplication of microfood with composted coir pith and Azospirillum was in the range of 35 to 38 per cent over the applicatioin of NPK alone. Also the integrated nutrient application yielded higher net return compared to others.

*Key words: Integrated nutrient management, Brinjal, Bhendi, Micronutrients, Composted coirpith, Azospirillum, Calcareous soil.*

## Introduction

Vegetables play an important role in formulating balanced diet specially in a vegetarian country like India. Vegetables are excellent source of roughage, carbohydrates, proteins, vitamins A, B, C, calcium and iron. Though India produces about 54 million tonnes of vegetables from 3.2 million hectares but it's share on the world trade is miserably low (1%). Okra is one of the important vegetable crops which is grown throughout the year except in the months of extreme winter and extremely cold regions. It requires heavy manuring for its potential production (Naik and Shrinivas, 1992). Also the improved use of high yielding varieties and high analysis fertilizers which are devoid of micronutrients deplete soil micronutrients heavily. Application of micronutrients to deficient soils along with major nutrients has produced remarkable increase in fruit yield of vegetables in different soils of Tamil Nadu. Keeping this in view, the present investigation was undertaken to assess the effect of microfood with/without organics and biofertiliser on fruit yield of brinjal and bhendi in a mixed black calcareous soil.

## Materials and Methods

A pot culture experiment was conducted in the green house of the Department of Soil Science and Agricultural Chemistry, Tamil Nadu Agriculatual University, Coimbatore during 1995-96 with brinjal var. CVK (Coimbatore vari kathiri) in an Inceptisol (Calcareous mixed black soil Periyanaickenpalayam series - Sandy caly loam). The experiment was laid out in a Completely Randomised Block Design with two replications. The fourteen treatments were *viz.*

$T_1$ - Absolute Control
$T_2$ - NPK alone
$T_3$ - NPK + Micronutrients (MNS) Soil application (S)
$T_4$ - NPK + MNS Foliar applicatioin (F)
$T_5$ - NPK + Composted coirpith (CCP) + MNS (S)
$T_6$ - NPK + CCP + MNS (F)
$T_7$ - NPK + CCP + Azospirillum (Azo) + MNS(S)
$T_8$ - NPK + CCP + Azo + MNS (F)
$T_9$ - NPK + Stanes microfood (SMF) (S)
$T_{10}$ - NPK + SMF (F)
$T_{11}$ - NPK + CCP + SMF (S)
$T_{12}$ - NPK + CCP + SMF (F)
$T_{13}$ - NPK + CCP + Azo + SMF (S)
$T_{14}$ - NPK + CCP + Azo +SMF (F)

The brinjal crop received an uniform dose of 100:50:50 kg NPK $ha^{-1}$ through urea, single superphosphate and muriate of potash respectively except for absolute control. A field experiment was conducted in a farmer's holding at Thekkupalayam, Coimbatore (Tamil Nadu) in an Inceptisol (Mixed black calcareous soil) which was alkaline in (pH 8.5) reaction, sandy clay loam in texture (Vertic Ustropept), deficient in DTPA extractable Zn and Fe on bhendi with selected treatments. The ten treatments consisted of absolute control, recommended NPK (40:50:30 kg $ha^{-1}$ of NPK) alone and in combination with microfood as foliar/ soil applied with/without organics and biofertilizer. The composted coirpith (CCP) was incorporated as basal at 25 t $ha^{-1}$ and mixed thoroughly in the soil as per the treatment schedule both for

**Table 1.** Physico- chemical properties of experimental soil (brinjal)

| Particulars | Mixed-black calcareous |
|---|---|
| *Physical constants* | |
| Apparent specific gravity (Mg $m^{-3}$) | 1.40 |
| Absolute specific gravity (Mg $m^{-3}$) | 2.23 |
| Pore space (%) | 48.30 |
| Maximum water holding capacity (%) | 58.60 |
| Volume expansion on wetting (%) | 28.50 |
| *Electro-chemical properties* | |
| Soil reacton (pH) | 8.3 |
| Electrical conductivity ($dSm^{-1}$) | 0.48 |
| *Chemical properties* | |
| Cation exchange capacity (cmol (p+) $kg^{-1}$ | 38.6 |
| Organic C (%) | 0.52 |
| $KMnO_4$- N(kg $ha^{-1}$) | 288.0 |
| Olsen-P (kg $ha^{-1}$) | 11.6 |
| $NH_4OAc$-K (kg $ha^{-1}$) | 556.0 |
| DTPA-Zn (ppm) | 0.82 |
| DTPA-Cu (ppm) | 1.66 |
| DTPA-Fe (ppm) | 3.18 |
| DTPA-Mn (ppm) | 9.40 |
| Soil series | Periyanaickenpalayam |
| Soil texture | Sandy clay loam |
| Taxonomy | Vertic Ustropept |

**Table 2.** Microfood with/without composted coirpith and Azospirillum on brinjal fruit yield (g $Plant^{-1}$)

| S.No. | Treatments | Fruit yield (g $plant^{-1}$) |
|---|---|---|
| 1. | Absolute control | 462.3 |
| 2. | NPK alone | 564.2 |
| 3. | NPK+MNS (S) | 660.2 (17.0) |
| 4. | NPK+MNS (F) | 695.0 (23.2) |
| 5. | NPK + CCP + MNS (S) | 733.8 (30.1) |
| 6. | NPK + CCP + MNS (F) | 759.9 (34.7) |
| 7. | NPK + CCP + Azo + MNS (S) | 799.2 (41.7) |
| 8. | NPK + CCP + Azo + MNS (F) | 830.2 47.2) |
| 9. | NPK + SMF (S) | 668.2 (18.4) |
| 10. | NPK + SMF (F) | 711.4 (26.1) |
| 11. | NPK + CCP + SMF (S) | 766.5 (35.9) |
| 12. | NPK + CCP + SMF (F) | 791.0 (40.2) |
| 13. | NPK + CCP + Azo + SMF (S) | 837.7 (48.5) |
| 14. | NPK + CCP + Azo + SMF (F) | 860.9 (52.6) |
| | CD (P=0.05) | 8.2 |

Values in parenthesis : per cent increase over NPK alone.

pot and field experiments. *Azospirillum* (Azo) @ 2 kg $ha^{-1}$ was applied as soil application. The initial soil (brinjal) was analysed (Table 1) for various parameters as per the standrd procedure and found deficient in Fe and Zn. The straight micronutrients (MNS) *viz.* $FeSO_4$ @ 50 kg $ha^{-1}$ and $ZnSO_4$ @ 25 kg $ha^{-1}$ were soil applied and foliar spray of $FeSO_4$ (1.0%) and $ZnSO_4$ (0.5%) were given thrice on 40,50 and 60[th] days after planting for brinjal and on 30,40 and 50[th] DAS for bhendi. The stanes microfood (SMF) @ 25 kg $ha^{-1}$ (soil applied) and foliar spray thrice

@ 750 g $ha^{-1}$ were applied. The SMF (both soil and foliar) contains Zn, Fe, Mn, Cu and B. In addition, the foliar SMF also contains Mo. B (as soil and foliar application) and Mo (as foliar application) were applied as borax and sodium molybdate to compensate the dosages present in SMF to other treatments. The fruit yield was recorded and analysed statistically (Panse and Sukhatme, 1967).

**Results and Discussion**

The mixed black calcareous soil used in pot experiment which belonged to Periyanaickenpalayam series was alkaline in reaction (pH 8.3) with electrical conductivity 0.48 $dSm^{-1}$ (Table 1). Thus the soil appeared to be free from salinity and sodicity hazards. The texture was sandy clay loam with high water holding capacity (58.6%). The available N, P and K status was medium, medium and high respectively. The cation exchange capacity was high and the soils were highly base saturated, indicating the predominance of montmorillonitic type of clay mineral. It was deficient in DTPA extractable Zn (0.82 ppm) and Fe (3.18 ppm) and sufficient in other micronutrients. The oxides of Fe and Zn are also fairly high due to the underlying red colluvial material.

The mean fruit yield of brinjal ranged from 462.3 to 860.9 g $plant^{-1}$ (Table 2). The foliar spray of SMF with NPK registered significantly higher yield of 790.1 g $plant^{-1}$ followed by MNS foliar spray with NPK (695.0 g $plant^{-1}$). When the microfood combined with CCP, there was a marked increase in the yield over individual effect. However, conjoint application of SMF as foliar spray, composted coirpith and Azo recorded the highest fruit yield of 860.9 g $plant^{-1}$, followed by the soil application of SMF / foliar application of straight micronutrients in a similar combination. Application of NPK alone recorded a lower yield of 564.2 g $plant^{-1}$ and the control registered the lowest brinjal yield of 462.3 g $plant^{-1}$. The yield increase due to the application of SMF (F) + NPK, SMF (F) + NPK + CCP, SMF (F) + NPK + CCP + Azo were 26.0, 40.0 and 53.0 per cent respectively over NPK alone. The MNS also exhibited a similar yield increase with CCP and Azo.

The yield increase as a result of Zn application might be due to the fact that the soil was deficient in available Zn (Sakal *et al.* 1988). In addition, the increased yield due to the Zn application might be due to the involvement of Zn in many metallo enzyme systems, regulatory function and in auxin production. The other bioparameters that could have helped in the increase of yield were synthesis of carbohydrates and their translocation to the storage organ because of better growth and more number of fruits per plant due to the application of $ZnSO_4$ (Suryanarayana Reddy *et al.* 1986) in brinjal. The favourable effect of Zn and Cu on fruit yield also could be atrributed to their effect in maintaining an optimum balance of nutrients in the plant for better growth in brinjal (Dhakshinmoorthy and Krishnamoorthy, 1989). The pronounced effect of SMF might be attributed to the beneficial role of micronutrients that are present in SMF which helps in enhancing the enzyme and photosynthetic activities, accumulation of photosynthates thereby higher yields.

The incorporation of CCP apart from improving the soil conditions conducive for plant growth with progressive build up of N in the soil could have increased the soil P availability and biological activity that assumed greater significance. This result was in accordance with the findings of Subbiah *et al.* (1985) and Darley Jose *et al.* (1986) in brinjal. The yield increase due to Azospirillum was not necessarily due to biological N fixation but could be due to some other mechanisms like production of growth hormones - gibberellic acid, indole acetic acid and dihydrozeatin by Azospirillum and thereby increased leaf area and carbohydrate synthesis and hence higher yield and formation of nutrient enriched fruits. This is in confirmity with the report of Subbiah (1990 and 1992) in tomato.

The pod yield of bhendi ranged from 12.64 to 20.67 t $ha^{-1}$ (Table 3). The application of microfood significantly influenced the fruit yield. The SMF and MNS as foliar application alone registered on par yield with each other. The foliar applicatioin of SMF followed by foliar applied MNS recorded the highest yield both in combination with CCP and Azo whereas NPK alone recorded a lower yield of 14.98 t $ha^{-1}$ and the control registered the lowest pod yield (12.64 t $ha^{-1}$).

The yield increase over NPK due to application of SMP (F) and MNS (F) were to the tune of 22.0 and 20.0 per cent respectively in bhendi. The yield increase in bhendi due to the combined application of SMF (F) / MNS (F) with CCP and Azo were to the tune of 38.0 and 35.0 per cent respectively. The yield increase as a result of Zn application might be due to the fact that the experimental soil was deficient in available Zn (Sakal *et al.* (1988). Also the

**Table 3.** Microfood with/without CCP and Azospirillum on bhendi yield (t ha$^{-1}$)

| Treatments | Pod yield |
|---|---|
| Contol | 12.64 |
| NPK | 14.98 |
| NPK + MNS (S) + CCP + Azo | 19.50 (30.2) |
| NPK + MNS (F) + CCP + Azo | 20.18 (34.7) |
| NPK + SMF (S) + CCP + Azo | 10.94 (33.1) |
| NPK + SMF (F) + CCP + Azo | 20.67 (38.0) |
| NPK + MNS (S) | 18.67 (24.6) |
| NPK + MNS (F) | 19.18 (28.0) |
| NPK + SMF (S) | 18.90 (26.2) |
| NPK + SMF (F) | 19.32 (29.0) |
| CD (P=0.05) | 1.22 |

Values in parenthesis : per cent increase over NPK

**Table 4.** Gross and Net return (Rs. ha$^{-1}$) in bhendi

| Treatments | Cultivation cost | Treatment cost | Total product in cost | Gross return | Net return |
|---|---|---|---|---|---|
| NPK | 12288 | - | 12288 | 59920 | 47632 |
| MNS(S) + CCP + Azo | 12288 | 1913 | 14201 | 78300 | 63799 (16167) |
| MNS(F) + CCP + Azo | 12288 | 1863 | 14151 | 80720 | 66569 (18937) |
| SMF (S) + CCP + Azo | 12288 | 1895 | 14118 | 79760 | 65577 (17945) |
| SMF (F) + CCP + Azo | 12288 | 1848 | 14136 | 82680 | 68544 (20912) |
| MNS (S) | 12288 | 643 | 12931 | 74680 | 61749 (14117) |
| MNS (F) | 12288 | 593 | 12881 | 76820 | 63839 (16207) |
| SMF (S) | 12288 | 625 | 12913 | 7560 | 62687 (15055) |
| SMF (F) | 12288 | 578 | 12866 | 77280 | 64414 (16782) |

Values in parenthesis : Additional income in Rs.

Zn has involved in many metallo enzyme systems, regulatory functions and in auxin production. Similar trend of enhancement in yield by application of Zn was reported by Hazra *et al.* (1987) in bhendi. The pronounced effect of SMF than MNS irrespective of the mode of application might have attributed to the beneficial role of secondary and micronutrients that are present in SMF which helps in enhancing the enzyme and photosynthetic activities, accumulation of photosynthates thereby higher yields. The benefical effect of Mn and Cu might be associated with their role in nitrogen nutrition, photosynthetic activity and carbohydrate metabolism. The inferior effect of soil application in Inceptisol may be the result of the fixation of major part of the applied Zn and other nutrients in the presence of fairly, high content of available P, calcareousness and alkaline nature of the soil. The application of $ZnSO_4$ and $FeSO_4$ as foliar alongwith NPK would have established balanced nutrient status during the active growth period supplying the Zn and Fe continuously in available form, thereby could have increased the plant growth and ultimately enhancing the pod yield of bhendi (Hazra *et al.* 1987).

The integration of both composted coir pith + biofertilizer with micronutrients brought about much greater benefit in terms of fruit yield. The composted coir pith apart from improving the soil conditions conducive for plant growth with progressive build up of N in the soil could have increased the availability of soil P and biological activity that assumed greater significance. Also the favourable C:N ratio and appreciably higher contents of all the macro, secondary and micronutrient elements and their ready availability due to its prolonged period of composting could be the possible reason for its spectacular influence on pod yield of bhendi. Similar results have been reported by Subbiah *et al.* (1984) and Abusalcha and Shanmugavel (1998) with FYM on bhendi.

Application of Azospirillum with CCP and SMF/MNS significantly increased the bhendi pod yield. The yield increase was not necessarily due to biological N fixation but could be due to some other mechanisms like production of growth hormones like gibberellic acid, indole acetic acid and dihydrozeatin by Azospirillum and inturn might have increased the photosynthetically active leaf area thereby resulting in increased synthesis of carbohydrates and other mineral nutrients and led to the higher yield and formation of nutrient enriched fruits. The results are in confirmity with the opinions of Parvatham and Vijayan (1989) and Subbiah (1991) in bhendi.

The economics interms of gross and net return for the treatments was worked out (Table 4). The application of SMF (Foliar) + CCP + Azo followed by MNS (Foliar) + CCP + Azo was the best with an additional income of Rs. 20,912 and Rs. 18,937 $ha^{-1}$ and the benefit cost ratios of 11.3 and 10.2 respectively. This clearly announced that the use of the microfoods in general and their combination with bio-softwares in particular for vegetables gives an remunerative return to the vegetable growers for micronutrient deficient soils and therefore, the same may be recommended to the vegetable growers for increasing their vegetable yields, coupled with high income and build up of soil health.

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