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SOIL HEALTH AS AFFECTED BY INTEGRATED NUTRIENT MANAGEMENT IN *BRASSICCA CAMPESTRIS* (BROWN SARSON)

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ABSTRACT
The present investigations were undertaken at the Mountain Research Center for field crops, SKUAST-K, Khudwani, Anantnag during Feb-May 2013 on Brown Sarson (*Brassicca Campestris*). The field is situated at a distance of 50 km from Dal Lake main Srinagar city in south direction (33^0 43.24"N latitude and 75^0 5.19" E longitudes) at 2562 meters above mean sea level. The field is divided in three replications *viz*., R1, R2, and R3 respectively. The climate of Khudwani (Anantnag) is temperate with moderately hot summers and very cold winters. The mean maximum and minimum temperature of the study site varied between 13 to 26 ^oC with July and January as hottest and coldest months respectively. The average precipitation was about 170 mm most of which was received in the form of snow during winter. The soil samples were taken to the Soil testing laboratory, SKUAST-K, Shalimar for physico-chemical analysis and SKUAST-K, Wadura (Sopore) for microbial analysis respectively.

KEY WORDS: Integrated nutrient management, Soil health, *Brassica campestris.*

INTRODUCTION

Soil is the surface on the earth's crust where geology and biology meet and the land surface that provides a home to plant, animal and microbial life. Soil offers various types of habitats like aerobic, anaerobic and "mini" aquatic, that is why soil sustains an immense diversity of microbes, it is estimated that one gram of soil contains bacteria $3.0 \times 10^6 - 5.0 \times 10^8$, actinomycetes $1.0 \times 10^6 - 2.0 \times 10^7$, fungi $5.0 \times 10^3 - 9.0 \times 10^6$, yeast ($I.0 \times 10^3 - 1.0 \times 10^6$), algae and protozoa $1.0 \times 10^3 - 5.0 \times 10^5$, nematodes 50 – 200 counts per gram of soil. Despite this large diversity most of the microorganisms have remained unexplored, moreover our understanding about soil fungi is poor as compared to bacteria, due to limitation of culture-based techniques to study them (Shah and Ahmad, 2013). Soil is the surface on the earth's crust where geology and biology meet and the land surface that provides a home to plant, animal and microbial life. Soil offers various types of habitats like aerobic, anaerobic and "mini" aquatic, that is why soil sustains an immense diversity of microbes, it is estimated that one gram of soil contains bacteria $3.0 \times 10^6 - 5.0 \times 10^8$, actinomycetes $1.0 \times 10^6 - 2.0 \times 10^7$, fungi $5.0 \times 10^3 - 9.0 \times 10^6$, yeast ($I.0 \times 10^3 - 1.0 \times 10^6$), algae and protozoa $1.0 \times 10^3 - 5.0 \times 10^5$, nematodes 50 – 200 counts per gram of soil. Despite this large diversity most of the microorganisms have remained unexplored, moreover our understanding about soil fungi is poor as compared to bacteria, due to limitation of culture-based techniques to study them (Shah and Ahmad 2013). Therefore, an INMS is the most efficient and practical way to mobilize all the available, accessible and affordable plant nutrient sources in order to optimize the productivity of the crops/cropping systems and economic return to the farmer. Three years data collected from 267 sites in India under different crops convincingly show a 22% increase in yield by following INM rather than farmer's practice (Govil and Kaore, 1997).The integrated use of organic materials and inorganic nitrogenous fertilizers has received considerable attention in the past with a hope of meeting the farmers economic need as well as maintaining favorable ecological conditions on long term basis (Kumar *et al*., 2007). The integrated nutrient management helps to restore and sustain fertility and crop productivity. It may also help to check the emerging deficiency of nutrients other than N P and K. Further, it brings economy and efficiency in fertilizers. The integrated nutrient management favorably affect the physical, chemical and biological environment of soils. Integrated nutrient supply involving conjunctive use of fertilizers and organic sources of nutrients (Roy, 1992) assumes greater significance. Long-term field experiments on nutrient management in different cropping system indicated decline in factor productivity with soil organic matter as well as available N, P and K status of the soil. Besides, the physico biochemical properties of the soil damaged significantly. Presently, Indian soils are 70 % deficient in N, 50% in P, 13% in K, 4.7% in Zn, 4.8% in Cu, 11.5 % in Fe and 4.0 % in Mn.

TABLE 1: Long Term Studies on Soil Physico Chemical Properties in Sarson (*Brassicca Campestris*) cropping system Treatment Detail-

Year 2013	Crop Brown Sarson (*Brassica campestris*)
Name of Treatments	Treatments
T1	Control
T2	25 % NPK
T3	50 % NPK
T4	75 % NPK
T5	100 % NPK
T6	25 % NPK + Vermicompost
T7	50 % NPK + Vermicompost
T8	75% NPK + Vermicompost
T9	100% NPK + Vermicompost
T10	Only Vermicompost

MATERIAL AND METHODS:

The materials used, experimental procedures followed and methods adopted during the present investigation entitled "Soil Health as Affected by Integrated Nutrient Management on *Brassicca Campestris* (Brown Sarson crop)" are described as below:

Experimental details

The Soil health as affected by integrated nutrient management was laid with the following treatment details as below:-

Species

S1 = *Brassica Campestris*

Details of layout of field

Treatments = 10
Species = 01
Design = RBD

Soil Analysis

All the experiments were carried out in triplicates. The collected soil samples were analyzed for various physicochemical parameters such as temperature, pH, moisture contents, bulk density, soil porosity, electrical conductivity, plant analysis, available nitrogen, phosphorus, inorganic phosphate, inorganic nitrate, total organic and the organic carbon *etc.* (Hooda & Kaur, 1999).The contaminated soil samples were also checked for the presence of endogenous total bacterial count.

Soil temperature

Soil temperatures were taken at the sample sites with a thermometer inserted at 7 cm depth and left in the same position until the temperature became stable (Ramakrishna, 2005).

Moisture Contents

10 g soil was weighed (W1) and dried at 105 ^{o}C in hot air oven (Narang Scientific Works Pvt. Ltd.) for 24 h. The final weight (W^2) of samples was determined using electronic weighing balance (SHIMADZU) and the moisture content (W^1 - W^2) was estimated as mg of moisture/g of soil.

Bulk density

The soil samples are collected by tube sampler of diameter 2.5 inches and length 10 cm's in such a way that while pulling out the sampler should not be disturbed in order to obtain the sample in its natural state. Remove the excess soil with the help of a spatula, so that the volume of the sample should exactly be equal to the volume of the sampler. Weigh a soil moisture box and place the sample in it. Keep the moisture box in an oven at 105 ^{o}C for 24 hours. Weigh the moisture box containing the oven-dry sample.

$$Bulk\ density\ (g\ cm-3) = \frac{\text{Weight of oven dry soil}}{\text{Volume of soil soilds}}$$

TABLE 2: Rating chart for soil test values of primary and secondary nutrients

Nutrients Rating	Low	Medium	High
Organic carbon (%)	< 0.50	0.50 – 0.75	> 0.75
Available N (Kg/ha)	< 280	281 – 560	>560
Available P (Kg/ha)	< 10	1 -25	>25
Available K (Kg/ha)	< 120	121 – 280	> 280

Soil pH

Prepare buffer solutions of pH 4.0, 7.0 and 9.2 by dissolving one commercially available buffer tablets of above pH values in 100 ml of freshly prepared distilled water. Weigh 10 gm of soil sample in 50 ml beaker, Add 25 ml of distilled water and stir well by a glass rod and keep for 30 minutes, Calibrate the pH meter with standard buffer solution, Again stir, just before immersing the electrodes and take pH reading.

Electrical conductivity

Weigh 10 gm of soil sample in 50 ml beaker, Add 25 ml of distilled water and stir well by a glass rod and keep for 30 minutes, Again stir, just before immersing the conductivity cell into the solution and take the electrical conductivity

reading. (Reading of electrical conductivity are presented in milli mhos cm-1)

Soil Porosity

Soil Porosity is the measurement of soil intercellular pore spaces of air and water made by insects and worms *etc*. Soil porosity is measured by weighing the volume of dry soil sample without disturbing the soil structure and weighing after grinding the soil samples so that the pore spaces are destroyed and the weight of soil is taken without spaces.

Plant analysis

The following procedures were adopted in the plant analysis.

Preparation of plant samples

The plant samples, collected at different plots treatment wise were first washed in running tap water to remove adhering soil and other foreign material followed by dipping in dilute hydrochloric acid (0.1 N HCl). Washing was repeated with single and double distilled water. After washing, the samples were air dried on filter paper and then oven dried at 60±5ºC for 24 hours. The dry matter weight for each plant was recorded before crushing the material. The crushed sample material was passed through 2 mm mesh sieve and stored in airtight polythene bags for subsequent chemical analysis.

Estimation of organic carbon

Oven dried plant material (0.5 g) was taken in a 500 ml conical flask and to it was added 10 ml of $K_2Cr_2O_7$ (1 N) solution and 20 ml concentrated H_2SO_4 from the side of the flask. The solution was kept for about 30 minutes for complete oxidation of organic matter. About 200 ml water and 10 ml orthophosphoric acid (85% pure) was added. After mixing, one ml of diphenylamine indicator was added. Then the contents were titrated with 0.5 N ferrous ammonium sulphate solutions till a brilliant green colour was obtained. Simultaneously, a blank was also run for final calculation (Walkley and Black, 1934).

Estimation of nitrogen

Oven dried plant material (0.5 g) was taken in Kjeldhal's digestion flask and 25 ml of concentrated H_2SO_4, 10 g of digestion mixture (K_2SO_4 + $CuSo_4$ + $FeSo_4$) in the ratio of 10 : 0.5 : 1) and 1 g of selenium powder was added. The samples were digested till solution became clear. Just after cooling of digested contents, volume was made upto 100 ml with distilled water. Then, 10 ml of the aliquot was transferred to micro-Kjeldhal's distillation flask and to it 10 ml of 40 % NaOH solution was also added. The condenser outlet of distillation apparatus was dipped into 4% boric acid solution containing bromocresol green and methyl red indicator. After completion of distillation, boric acid was titrated against 0.005 N H_2SO_4 to the original shade (pink). Blank was also run for final calculation (Subbiah and Asija, 1956).

Estimation of phosphorus

The plant material (0.5 g) was digested with 20 ml of triacid mixture (HNO_3: $HclO_4$: H_2SO_4 in the ratio of 9: 4: 1). The contents were heated until volume was reduced to 3-5 ml. The completion of digestion was confirmed when liquid became colourless. The volume was then made upto 100 ml by adding distilled water. Digested extract (20 ml) was taken in 50 ml volumetric flask and to it 10 ml of ammonium molybdate vanadate solution was added. After thorough mixing, the volume was made upto 50 ml with distilled water and mixture allowed to stand for 30 minutes for blue colour development. The colour was then read at 470 nm on spectrophotometer (Bhargava and Raghupatti, 1993).

Estimation of potassium

The estimation of available potassium was determined as per the method given by Henway and Heidal (1952). The processed plant sample was taken in a100 ml plastic bottle. To it was added 25 ml ammonium acetate solution which was shaked on electric shaker for 5 minutes. The suspension was filtered on Whatman No. 1 filter paper. The reading of the filtrate was taken on flame photometer after adjusting the instrument to 100 with 50 or 100 ppm K solution.

Estimation of exchangeable calcium and magnesium

Calcium and magnesium in the plant extract was estimated as per the procedure outlined by Jackson (1973). 5 g of plant sample was taken in a 150 ml Erlenmeyer flask. 25 ml of normal ammonium acetate (pH = 7) was added to it. The solution was shaked for 5 minutes on a mechanical shaker and then filtered through Whatman No. 1 filter paper. 25 ml aliquot was pipetted into a 125 ml Erlenmeyer flask and it was diluted to a volume of 25 ml. 10 drops (0.5 ml) ammonium chloride buffer and 4 drops of Eriochrome black T indicator was added. The solution was titrated with 0.01N EDTA using 10 ml microburette. The colour changed from wine red to blue or green. No wine red colour should remain at the end point.

Average weight loss

Average weight loss of *Brassica Campestris* live plant calculated by subtracting the final mass of dry matter after oven drying from original (initial) mass of dry matter at monthly intervals.

Microbial characteristics

One gram of sample from each treatment including control of both the species at monthly intervals July was suspended in 10 ml of sterilized distilled water and serial dilutions of the suspension were prepared by further dilutions. Total viable populations of bacteria, fungi and actinomycetes were determined as per the following procedures.

Total viable bacteria

The bacterial count in the plant samples was determined on nutrient agar medium (Aaronson, 1970) which consisted of following ingredients:

Beef extract: 3 g
Peptone: 5 g
Nacl: 3 g
Distilled water: 1000 ml
Agar: 15 g

Nutrient agar medium was prepared and poured into sterilized petriplates. One ml of appropriate dilutions was evenly spread over cooled medium in petriplates. The plates were incubated at 28± 2ºC for 2-3 days and the bacterial colonies, developed on the medium, were counted.

Total viable fungi

For the determination of total viable fungal population, potato dextrose agar (PDA) medium was used and the procedure followed was same as described earlier.

Composition of potato dextrose agar (Aaronson, 1970)
Potato 200 g
Dextrose 20 g
Distilled water 1000 ml
Agar 17 g

Total viable actinomycetes
For the determination of total viable actinomycetes Ken Knight medium was used.

Composition of Ken Knight medium (Aaronson, 1970)
K_2HPO_4: 1.0 g
$NaNO_3$: 0.1g
KCl : 0.1 g
$MgSO_4$ $7H_2O$: 0.1 g
Cellulose: 10.0 g
Distilled water: 1000 ml
pH: 7.0-7.2

Analysis of soil chemical characteristics
The soil samples were collected from the different treatment plots of *Brassica Campestris* before and at the end of the experiment to assess the INM effect on soil health. The following procedures were followed in the soil analysis.

Preparation of soil samples
The soil samples were air dried, crushed with wooden mortar and pestle and sieved through 2 mm sieve. The sieved samples were labeled and stored in polythene bags for subsequent chemical analysis.

Organic carbon
Oven dried soil sample (0.5 g) was taken in a 500 ml conical flask and to it was added 10 ml of $K_2Cr_2O_7$ (1 N) solution and 20 ml concentrated H2SO4 from the side of the flask. The solution was kept for about 30 minutes for complete oxidation of sample. About 200ml water and 10 ml orthophosphoric acid (85% pure) was added. After mixing, one ml of diphenylamine indicator was added. Then the contents were titrated with 0.5 N ferrous ammonium sulphate solutions till a brilliant green colour was obtained. Simultaneously, a blank was also run for final calculation (Walkley and Black, 1934).

Available nitrogen
Oven dried soil sample (0.5 g) was taken in Kjeldhal's digestion flask and 25 ml of concentrated H2SO4, 10 g of digestion mixture (K_2SO_4 + $CuSO_4$ + $FeSO_4$) in the ratio of 10: 0.5: 1 and 1 g of selenium powder was added. The samples were digested till solution became clear. Just after cooling of digested contents, volume was made up to 100 ml with distilled water. Then, 10 ml of the aliquot was transferred to micro-Kjeldhal's distillation flask and to it 10 ml of 40% NaOH solution was also added. The condenser outlet of distillation apparatus was dipped into 4 percent boric acid solution containing bromocresol green and methyl red indicator. After completion of distillation, boric acid was titrated against 0.005 N H2SO4 to the original shade (pink). Blank was also run for final calculation (Subbiah and Asija, 1956).

Available phosphorus
The processed soil sample (2.5 g) was taken in a 125 ml Erlenmeyer flask. To it were added 50 ml (0.5 N) NaHCO3 solution and a pinch of activated charcoal. The contents were shaked for 30 minutes on a reciprocating shaker at 120 strokes per minute. The suspension was filtered on Whatman No. 40 filter paper. 10 ml aliquot of the extract was pipetted in a 50 ml volumetric flask. To it was added 10 ml of distilled water and one drop of P-nitrophenol indicator. 5 drops of H_2SO_4 (2.5 N) were added to the contents till colour disappeared. After thorough mixing, the volume was made upto 50 ml with distilled water and mixture allowed to stand for 15 minutes for blue colour development. The colour was than read at 730 nm on spectrophotometer. Blank was also run for final calculation (Olsen *et al*., 1954).

Estimation of available potassium
The available potassium was determined as per the method given by Henway and Heidal (1952). The processed soil sample (5 g) was taken in a 100 ml plastic bottle. To it was added 25 ml ammonium acetate solution which was shaked on electric shaker for 5 minutes. The suspension was filtered on Whatman No. 1 filter paper. The reading of the filterate was taken on flame photometer.

RESULTS & DISCUSSION

The experimental findings obtained from the present studies are given in this chapter under the following heads:

Soil temperature
During the present study, the minimum value for soil temperature was recorded 5 **º**C at T2 during May and maximum value was recorded 27 ºC at T10 during May 2013, as shown in table 3 and 4 respectively.

pH
The pH of all the soil samples varied from 5 to 7.8. However, among the total ten soil samples, minimum and maximum pH value of 5 and 7.8 were observed for T5 and T10, as shown in table 3 and 4 respectively.

Moisture Content
The moisture content of the soil samples varied from 15 to 26 mg/g of soil. The results showed that T10 has highest moisture content i.e. 26 mg/g of soil and the T5 has minimum i.e. 15 mg/g of soil, as shown in table 3 and 4 respectively.

TABLE 3: Physico-Chemical analysis of soil of *Brassicca Campestris* during 1st sampling

S.No.	Physico-Chemical parameters	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
1	Soil temperature (°C)	7	6	9	12	13	10	20	22	24	27
2	pH	7	7.3	6.9	6.4	5.2	6.9	6.7	6	5.9	7.8
3	Moisture (%)	21.8	18.2	20.4	20	22.4	18.6	19.2	21.4	17.2	23.7
4	Electrical Conductivity (dSm^{-1})	6	4	7	9	4	5	8	7	6	5
5	Bulk density (gcm^{-3})	1.06	1.30	1.09	1.25	1.27	1.14	1.07	1.03	1.05	1.09
6	Soil porosity	1.8	1.61	1.52	1.47	0.97	1.24	1.30	1.35	1.37	1.53
7	Organic matter ($gmkg^{-1}$)	1.83	1.81	1.78	1.65	1.54	17.15	19.02	23.90	26.98	30.5
8	Nitrogen ($gmkg^{-1}$)	0.12	0.9	0.8	0.9	1.3	1	1.01	1.13	1.17	1.20
9	Phosphorus ($gmkg^{-1}$)	5	5.2	5.5	5.4	5.8	5.4	5.5	5	5.3	6.7
10	Potassium ($gmkg^{-1}$)	0.9	0.8	0.8	1.9	3.8	1.6	1.7	1.7	1.9	2.3

TABLE 4: Physico-Chemical analysis of soil of *Brassicca Campestris* during 2nd sampling

S.No.	Physico-Chemical parameters	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
1	Soil temperature (°C)	7	5	8	11	13	10	19	18	15	21
2	pH	7	6.5	6	5.8	5	6.1	6	5.5	5.9	7
3	Moisture (%)	25	21	17.5	17	15	17	19	23	23	26
4	Electrical Conductivity (dSm^{-1})	5.5	3.5	5	6	2	4	5.6	5.7	4.2	3.07
5	Bulk density(gcm^{-3})	1.21	1.37	1.19	1.35	1.38	1.25	1.19	1.15	1.17	1.20
6	Soil porosity	1.3	1.21	1.10	1.03	0.78	1	0.95	1.12	1.19	1.27
7	Organic matter ($gmkg^{-1}$)	1.20	1.01	1.3	1.2	1	13	15.6	16	19	17.5
8	Nitrogen ($gmkg^{-1}$)	0.06	0.02	0.05	0.04	0.07	0.05	0.02	0.04	0.03	0.05
9	Phosphorus ($gmkg^{-1}$)	4.2	3.1	3.3	4	3.9	4	5	5.3	4.7	5
10	Potassium ($gmkg^{-1}$)	0.5	0.5	0.5	1.3	2	0.9	1	1	1.2	1.7

Soil Porosity

During the present study, the minimum value for soil porosity was recorded 0.78 at T5 during May and maximum value was recorded 1.53 at T10 during May 2013, as shown in table 3 and 4 respectively.

Bulk density

During the present study, the minimum value for soil Bulk density was recorded 1.06 g/cm3 at T1 during May and maximum value was recorded 1.38 g/cm3 at T5 during May 2013, as shown in table 3 and 4 respectively.

Electrical Conductivity

During the present study, the minimum value for electrical conductivity was recorded 2 at T5 during May and maximum value was recorded 9 at T4 during May 2013, as shown in table 3 and 4 respectively.

Nitrogen

The nitrate contents of the soil samples showed variation from 0.02 to 1.3 µg/g of soil. Of various soil samples collected, T2 has minimum inorganic nitrate content (0.02 µg/g of soil), while T5 has maximum (1.3 µg/g of soil), as shown in table 3 and 4 respectively.

Phosphorus

The inorganic phosphate content of the soil samples varied from 3.1 to 5.8 mg/g of soil. However, among the total ten soil samples, minimum and maximum inorganic phosphate content of 3.1 mg/g and 5.8 mg/g was observed for T2 and T5 respectively, as shown in table 3 and 4 respectively.

Potassium

During the present study, the minimum value for Potassium was recorded 0.5 at T3 during May and maximum value was recorded 3.8 at T5 during May 2013, as shown in table 3 and 4 respectively.

Total Organic Matter

The total organic matter content of the soil samples varied from 1 to 30.5 g/kg of soil. Among the total ten soil samples, minimum and maximum total organic matter content of 1 g/kg and 30.5 g/kg was observed for T5 and T10 respectively, as shown in table 3 and 4 respectively.

Bacteria

During the present study, the minimum value for total bacterial count was recorded 97 X 10^4 /gm at T5 during May and maximum value was recorded 660 X 10^4 /gm at T10 during May 2013, as shown in table 5 and 6 respectively.

Actinomycities

During the present study, the minimum value for total actinomycities count was recorded 42 X 10^4 /gm at T3 during May and maximum value was recorded 178 X 10^4 /gm at T10 during May 2013, as shown in table 5 and 6 respectively.

Fungi

During the present study, the minimum value for total Fungi count was recorded 23 X 10^4 /gm at T3 during May and maximum value was recorded 72 X 10^4 /gm at T10 during May 2013, as shown in table 5 and 6 respectively.

TABLE 5: Microbial Analysis of Soil of *Brassicca Campestris* during 1st sampling. (Microbial Pop. X 10^4/gm.)

S.No.	Microbial Count	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
1	Bacteria	230	190	179	154	123	221	234	250	627	660
2	Actinomycetes	97	72	63	54	67	111	120	110	148	178
3	Fungi	50	57	51	47	40	55	59	63	69	72

TABLE 6: Microbial Population of Soil of *Brassicca Campestris* during 2nd sampling. . (Microbial Pop. X 10^4/gm.)

S.No.	Microbial Count	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
1	Bacteria	194	175	163	137	97	212	214	230	550	579
2	Actinomycities	60	63	50	47	42	92	110	93	112	150
3	Fungi	30	32	27	40	23	40	43	41	50	64

CONCLUSION

From the present study of " Soil Health as affected by integrated nutrient management in *Brassicca campestris* (Brown sarson)" it is concluded that due to application of integrated nutrient management system the soil physical, chemical and biological health remains good, where as if only chemical fertilizers are applied to the field crops there is no doubt increase in crop production and carbohydrate content but at the same time there is low protein content, soil health is affected and limited nutrients are available for future crops which is opposite to INM system. So it is concluded from the present study that for better crop production and good soil health chemical as well as biofertilizers, manures or vermicompost must be applied to the crop fields.

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