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# Assessment of organic and inorganic nutrients on soil health parameters and yield of mustard (*Brassica juncea* L.)

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**Abstract**
The present investigation was conducted on Assessment of Organic and Inorganic nutrients on Soil health parameters and yield of Mustard (*Brassica juncea* L.) it was carried out during Rabi season 2020-2021 on crop research farm of department of Soil Science & Agriculture Chemistry, Sam Higginbbottom University of Agriculture, Technology and Sciences Allahabad, 211007 (U.P), laid out in a $3^2$ R.B.D factorial design on sandy loam soil. The experimental results revealed that maximum yield attributes, numbers of siliqua$^{-1}$ 250.59 g., numbers of seed siliqua$^{-1}$ 16.26 g., test weight of 1000 seeds 4.28 g., total seed yield 23.42 q ha$^{-1}$ straw yield 45.64 g., nutrients uptake $N_{80}$ $P_{60}$, $K_{40}$ and $S_{40}$ by FYM 15 t ha$^{-1}$. The increment in seed yield with application of 100% RDF + 100% FYM was 23.42 over control. It was observed that for post-harvest soil properties in treatment $N_{80}P_{60}K_{40}$ and $S_{40}$+FYM @15 t ha$^{-1}$ were improved significantly due to organic and inorganic use of inputs. Organic Carbon 0.44%, bulk density 1.31 Mg m-3,pore space 69.99%,available Nitrogen 352.11 kg ha$^{-1}$, potassium 199.15 kg ha$^{-1}$ sulphur 26.37, were found to be significant. pH 7.31, EC at 0.32 dS m$^{-1}$, particle density 4.46 Mg m$^{-3}$,phosphorus 24.81 kg ha$^{-1}$, were found to be non-significantly.

**Keywords:** Mustard, NPK, S and FYM, Soil *Physico-chemical* properties

## Introduction

Under the names rapeseed and mustard, several oilseeds are belonging to the cruciferae are grown in India. They are generally divided into four groups: Brown mustard, Sarson, Toria and Taramira. In trade sarson, toria and taramira are known as rapeseed, and rai as mustard. *Brassica juncea* L. originally introduced from China into north east India, from it has extended into Afghanistan via the Punjab. Eastern Afghanistan, together with the adjoining north western India, is one of the independent canter's of origin of Brown sarson (*Brassica compestris* var. brown sarson). Yellow sarson (*Brassica compestris* var. yellow sarson) is commonly grown in the eastern part of India where it shows much diversity of forms. Taramira is relatively recent introduction into India. It is believed to be native of southern Europe and North Africa. Rapeseed and mustard yield the most important edible oil. The oil content of the seeds of different forms ranges from 30 to 48 percent. In the case of white mustard, the oil content ranges from 25 to 33 percent. The oil obtained is the main cooking medium in northern India cannot be easily replaced by any other edible oil. The oilcake is mostly used as a cattle feed. The leaves of young plants are used as a green vegetable. The use of mustard oil for industrial purposes is rather limited on account of its high cost. The crop is grown both in subtropical and tropical countries. In Asia, it is chiefly grown in China, India and Pakistan. It is also grown in Europe, Canada and the USSR, but the forms of rapeseed and mustard grown there are different forms of rapeseed and mustard grown there are different from those grown in India. India occupies the first position, both with regard to acreage and production of rapeseed and mustard in the world. In India the Brassica crops occupy the second largest position after groundnut, with 3.5 million hectares, production about 2 million tonnes of seed annually. The chief states producing them are Uttar Pradesh, Punjab, Haryana, Assam, Bihar, Madhya Pradesh, Rajasthan, West Bengal, and Orissa. Hand book of Agriculture (2014) [3]. India is one of the largest producers of rape seed and mustard in the world. India's contribution in the world's rape seed and mustard production is the highest of any country. The production of rape seed in India is around 16.2 million tonnes which accounts for about 18 percent of the total oilseed production of the country.

The oil obtained from the different types show slight variation in percentage of oil. The oil content varies from 37 to 49 per cent. The seed and oil are used are condiment in the preparation of pickles and for flavouring curries and vegetables**.** The oil is utilized for human consumption throughout northern India in cooking and frying purpose. It is also used in the preparation of hair oils and medicines. It is used in soap making, in mixtures with mineral oils for lubrication. Oil cake is used as a cattle feed and manure. Green stems and leaves are a good fodder for cattle. The leaves of young plants are used as green vegetables as they supply enough sulphur and minerals in the diet. Singh *et al.* (2012) [8]. India, it is third most important edible oilseed crop after soyabean and groundnut sharing 27.8% in the India's oilseed economy. The global production of mustard and its oil is around 38-42 mt & 12-14 mt respectively. India contributes 28.3% and 12.0% in world acreage and production. India produces around 6.9 mt of rapeseed-mustard next to China (11-12 mt) and EU (10-13 mt) with significant contribution in world mustard industry Anonymous, (2014) [3]. In India Uttar Pradesh is the second largest producer of mustard after Rajasthan. The mustard grown in the Uttar Pradesh is 7, 85,000 ha with production about 8, 48,000 tonnes and productivity 1080 kg ha-1 area as per government estimates (2017). Indian soils are becoming deficient in N, P, and K along with S due to intensive cultivation and use of high analysis fertilizers, under such situation organic manures can be exploited to boost the soil health condition vis-à-vis production of crops and to improve fertilizer use efficiency. Nitrogen is the most important nutrient, which determines the growth of the mustard crop and increases the amount of protein and yield. Phosphorus and potash are known to be efficiently utilized in the presence of nitrogen. It promotes flowering, setting of siliqua and increase the size of siliqua and yield Singh and Meena, (2004) [7]. Judicious use of nutrients is very important as our country is importing most of the fertilizers from aboard. Under present situation, focus on nutrient management on mustard needs to be changed by integration with other option. The use of total organic or inorganic nutrient sources has some limitations Kandpal (2001) [5]. Balanced combination of FYM, bio fertilizers and chemical fertilizers facilitate profitable and sustainable production (Singh and Sinsinwar, 2006) [9]. The integrated plant nutrient management is maintenance or adjustment of soil fertility and plant nutrient supply to an optimum level for sustaining desired crop production through optimization of benefits from all possible sources of plant nutrients. Various sources of plant nutrients such as organic manures, fertilizers and bio-fertilizers were even though applied in mustard in an integrated manner Chand, (2007) [1]. Fertilizers are very important sources of plant nutrients for increasing agricultural production. The mineral fertilizer could supply one or two nutrients but integrated use of macro- and micro-nutrient fertilizers and organic residues would provide N, P, K, S, Zn, Fe and B to plant and soil and resist occurrence of multiple nutrient deficiencies. The role of organic fertilizers in plant nutrition is now attracting the attention of agriculturists and soil scientists throughout the world. If sufficient quantity of organic manures is added along with mineral fertilizers then perhaps there would be no need of adding micronutrients Prasad *et al.*, (1999) [6]. Now – a- days a variety of locally available organic manure are available. Their chemical decomposition as well as break down is variable. The pH of FYM is 7.50, total NPK is 0.94, 0.56, 0.72%, it improves the chemical and biological conditions of soil increasing cation exchange capacity and providing various, vitamins, hormones and organic acids which are very important for soil aggregation and beneficial micro-organism which involved in various bio-chemical process and release of nutrients Chandra (2005) [2].

## Materials and Methods

The experiment was conducted in the research farm of Department of Soil Science, Sam Higginbbottom Institute of Agriculture, Technology & Science, Allahabad which situated 6 km away from Allahabad city on the right bank of Yamuna river. The experimental site is located in the sub- tropical region with 25º 80º N latitude 81º 501 E longitudes and 98 meter the sea level altitudes. The experiment comprised of nine treatment combinations of organic and inorganic sources of fertilizers $T_1$ ($L_1F_1$) control, $T_2$ ($N_0$ $P_0$ $K_0$, $S_0$ + FYM @ 7.5 t $ha^{-1}$), $T_3$ ($N_0$ $P_0$ $K_0$, $S_0$ + FYM @ 15 t $ha^{-1}$, $T_4$ ($N_{40}$ $P_{30}$ $K_{20}$, $S_{20}$ + FYM @ 0, $T_5$ ($N_{40}$ $P_{30}$ $K_{20}$, $S_{20}$ + FYM @ 7.5 t $ha^{-1}$, $T_6$ ($N_{40}$ $P_{30}$ $K_{20}$, $S_{20}$ + FYM @ 100 t $ha^{-1}$, $T_7$ ($N_{80}$ $P_{40}$ $K_{40}$, $S_{40}$ + FYM @ 0, $T_8$ ($N_{80}$ $P_{60}$ $K_{40}$, $S_{40}$ + FYM @ 7.5 t $ha^{-1}$, $T_9$ ($N_{80}$ $P_{40}$ $K_{40}$, $S_{40}$ + FYM @ 15 t $ha^{-1}$. The trial was laid out in a factorial randomized block design with three replication, plot size was 2x2 m for crop seed rate is 15-20 kg $ha^{-1}$ (*Brassica juncea* L.). Mustard was fertilized uniformly with 80:40:40 kg $ha^{-1}$ of N, $P_2O_5$ $ha^{-1}$ and $K_2O$, respectively. The half dose of nitrogen and full dose of phosphorus, potassium and sulphur, was applied as basal and rest half amount of nitrogen was applied as top dressing at 35 DAS. The various plant growth studies were carried out at 30, 60, 90 DAS. Five plants were selected randomly from each plot were tagged. The height was measured in cm with the help of meter scale from the base of the plant to the top of the plant and mean values were presented. The total numbers of primary and secondary branches of plants was counted and mean values per plant have been presented. The soil of the experiment field was sandy loam with pH 7.31 having organic carbon 0.44%, available nitrogen 352.11 kg $ha^{-1}$, available phosphorus 24.81 kg $P_2O_5ha^{-1}$, available potassium 199.15 kg $K_2O$ $ha^{-1}$ and available sulphur 26.37 ppm. Mustard crop was sown on 18th November 2020 and the source of nitrogen, phosphorus, potassium sulphur, were Urea (46%N), SSP (46%$P_2O_5$), MOP (60%$K_2O$), respectively. Basal dose of fertilizer was applied in respective plots according to treatment allocation uni-furrows opened by about 5cm all the agronomic practices were carried out uniformly to raise the crop. Mustard crop was harvested on 17th march 2021.

### Number of siliqua plant$^{-1}$

Total number of siliqua of each plot were counted and average were calculated. Number of siliqua was counted separately on primary, secondary and tertiary branches. Total number of siliqua plant$^{-1}$ was worked out by totalling the siliqua number on different types of branches.

### Number of seed siliqua$^{-1}$

Number of seed siliqua$^{-1}$ were recorded at harvest by counting the number of seed of ten randomly selected siliqua from three samples plants of each plot.

### Test weight (g)

One thousand seeds were randomly collected from the seed of each plot and their weight was recorded in gram.

**Seed yield (q/ha)**

From the individual plot, the net plot area was harvested and produced was sun dried. After drying the crop was threshed and cleaned separately on the net plot basis. The final weight was recorded in $kg^{-1}$ net plot and finally converted into q/ha.

**Soil Analysis**

Soil sample were randomly collected from 0-15 cm depth from each plot, the soil was spread in a sheet and air dried kept in an oven at $105^0$C for 48hrs for drying. The soil clods or lumps are broken down into a fine particle with wooden mallet pass through 2mm sieve. The soil sample were collected by coning and quartering method. The collected soil was kept in a clean and dry polythene bag. These samples were processed and analyzed for various physico-chemical properties in the laboratory of department of Soil science, in Sam Higginbbottom University of Agriculture, Technology and Sciences Allahabad, soil were analysis by using standard procedures as described for pH 1:2 (w/v) (Jackson 1958), EC (dS $m^{-1}$) (Wilcox 1950), organic carbon (%) (Walkley Black 1947), available nitrogen kg $ha^{-1}$ (Subbiah and Asija 1956), phosphorus kg $ha^{-1}$ (Olsen *et al*. 1954) and potassium kg $ha^{-1}$ (Toth and Price 1949).

**Results and Discussions**

**Numbers of siliqua plant$^{-1}$**

The maximum number of siliqua 250.59 at 90 DAS were recorded in $T_9$ (100% RDF + FYM 15 t $ha^{-1}$) which was significantly higher than other treatments at all the stages. However, the minimum number of siliqua was recorded in $T_1$ (control) which was significantly lower than other treatments at all the stages.The number of siliqua was found to be significant at different levels of fertilizer and FYM applied. Similar result have also been reported by Baudh and Prasad., (2012)

**Numbers of seed siliqua$^{-1}$**

The maximum number of seed siliqua 16.26 at 90 DAS were recorded in $T_9$ (100% RDF + FYM 15 t $ha^{-1}$) which was significantly higher than other treatments at all the stages. However, the minimum number of seed siliqua was recorded in $T_1$ (control) which was significantly lower than other treatments at all the stages. The number of seed siliqua was found to be significant at different levels of fertilizer and FYM applied. Similar result have also been reported by Baudh and Prasad., (2012)

**Test weight (g)**

The maximum test weight 4.28 at 90 DAS were recorded in $T_9$ (100% RDF + FYM 15 t $ha^{-1}$) which was significantly higher than other treatments at all the stages. However the minimum test weight was recorded in $T_1$(control) which was significantly lower than other treatments at all the stages. The test weight of seed showed a significant increase by the increasing levels of different fertilizer and FYM applied. Similar result have also been reported by Guattam *et al*., (2013) and Yadav *et al*, (2017)

**Straw Yield (q $ha^{-1}$)**

The maximum straw yield 45.64 at 90 DAS were recorded in $T_9$ (100% RDF + FYM 15 t $ha^{-1}$) which was significantly higher than other treatments at all the stages. However the minimum straw yield was recorded in $T_1$(control) which was significantly lower than other treatments at all the stages. The straw yield showed a significant increase by the increasing levels of different fertilizer and FYM applied. Similar result have also been reported by Marak *et al*., (2016) and Kumar *et al*., (2016)

**Seed yield (q $ha^{-1}$)**

The maximum seed yield 23.42 at 90 DAS were recorded in $T_9$ (100% RDF + FYM 15 t $ha^{-1}$) which was significantly higher than other treatments at all the stages. However the minimum seed yield was recorded in $T_1$(control) which was significantly lower than other treatments at all the stages. The seed yield increased with the increasing levels showed a significant increase by the increasing levels of different fertilizer and FYM applied. Similar result have also been reported by Marak *et al*.,(2016) and Kumar *et al*., (2016)

**Table 3:** Effect of organic and inorganic nutrients sources on number of siliqua plant$^{-1}$ seed siliqua$^{-1}$1000 seed weight and total seed yield of Mustard

| Treatment | No. of siliqua plant$^{-1}$ | No. of seed siliqua$^{-1}$ | 1000 seed weight (g) | Straw yield (q $ha^{-1}$) | Total seed yield (q $ha^{-1}$) |
|---|---|---|---|---|---|
| Absolute control | 116.45 | 14.73 | 4.11 | 30.68 | 15.95 |
| (NPK+S) 0% + @ FYM 50% | 135.13 | 15.43 | 4.19 | 40.78 | 21.00 |
| (NPK+S) 0% + @ FYM 100% | 208.55 | 15.63 | 4.26 | 43.63 | 22.41 |
| (NPK+S) 50% + @ FYM 0% | 153.23 | 14.73 | 4.12 | 32.12 | 16.66 |
| (NPK+S) 50% + @ FYM 50% | 158.33 | 15.53 | 4.21 | 43.12 | 21.16 |
| (NPK+S) 50% + @ FYM 100% | 241.89 | 16.63 | 4.28 | 45.85 | 23.53 |
| (NPK+S) 100% + @ FYM 0% | 172.34 | 14.83 | 4.18 | 34.45 | 17.83 |
| (NPK+S) 100% + @ FYM 50% | 175.46 | 16.43 | 4.23 | 45.05 | 23.13 |
| (NPK+S) 100% + @ FYM 100% | 301.33 | 16.53 | 4.29 | 47.45 | 24.33 |
| S. Em. (±) | 15.867 | 0.656 | 0.073 | 0.179 | 0.124 |
| C.D. at 5% | 31.575 | 1.305 | 0.145 | 0.356 | 0.247 |

**Physical properties of soil (post-harvest)**

The results in given table 5 indicates some of the important parameter on physical properties on mustard crop. The experimental soil was sandy loam in texture with white yellowish brown colour in dry conditions and olive brown colour in wet conditions. Organic and inorganic fertilizers conjunction on bulk density and pore space to be significant and on particle density to be non-significant. The bulk density (Mg $m^{-3}$), particle density (Mg $m^{-3}$) and pore space (%) of post-harvest soil was recorded 1.31, 4.46 and 69.99 with the treatment T9 respectively. There is a slight decreased in particle density due to tillage operation and increase in plant growth. Similar results have also been recorded by Kumar *et al* (2014).

**Table 4:** Physical properties of soil (pre-sowing)

| Particulars | Results | Method employed |
|---|---|---|
| Sand (%) | 65.14 | Bouyoucous hydrometer (1952) |
| Silt (%) | 21.12 | Bouyoucous hydrometer (1952) |
| Clay (%) | 13.74 | Bouyoucous hydrometer (1952) |
| Texture class | Sandy loam | USDA triangle |
| Bulk density Mg $m^{-3}$ | 1.47 | Graduated measuring cylindrical (Black 1965) |
| Particle density Mg $m^{-3}$ | 2.52 | Graduated measuring cylindrical (Black 1965) |
| Pore space (%) | 51.68 | Graduated measuring cylindrical (Black 1965) |
| Soil pH (1:2) | 7.69 | Digital pH meter (Jackson 1958) |

**Table 5:** Effect of different levels of organic and inorganic nutrients sources on physical and chemical properties after harvest mustard crop

| Treatment combination | Bd (Mg $cm^{-3}$) | Pd (Mg $cm^{-3}$) | Pore Space (%) | pH (1:2 w/v) | EC (dS $m^{-1}$) | N (kg $ha^{-1}$) | $P_2O_5$ (kg $ha^{-1}$) | $K_2O$ (kg $ha^{-1}$) | Sulphur (ppm) | Organic Carbon (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| $T_1=L_0F_0$ | 1.25 | 3.65 | 55.47 | 7.19 | 0.25 | 315.27 | 20.78 | 166.07 | 19.68 | 0.28 |
| $T_2=L_0F_1$ | 1.22 | 5.03 | 69.95 | 7.20 | 0.26 | 336.43 | 22.38 | 177.75 | 23.48 | 0.39 |
| $T_3=L_0F_2$ | 1.22 | 3.92 | 74.53 | 7.30 | 0.31 | 339.23 | 23.98 | 189.39 | 23.55 | 0.40 |
| $T_4=L_1F_0$ | 1.28 | 3.47 | 66.87 | 7.26 | 0.28 | 327.23 | 21.28 | 168.40 | 21.33 | 0.33 |
| $T_5=L_1F_1$ | 1.33 | 5.03 | 64.24 | 7.22 | 0.31 | 342.48 | 23.08 | 183.48 | 25.63 | 0.39 |
| $T_6=L_1F_2$ | 1.25 | 4.47 | 67.38 | 7.29 | 0.31 | 354.26 | 24.82 | 197.38 | 25.74 | 0.43 |
| $T_7=L_2F_0$ | 1.30 | 4.70 | 67.55 | 7.19 | 0.32 | 332.39 | 21.78 | 171.66 | 22.83 | 0.40 |
| $T_8=L_2F_1$ | 1.28 | 4.36 | 70.00 | 7.27 | 0.28 | 342.58 | 23.45 | 187.81 | 27.79 | 0.42 |
| $T_9=L_2F_2$ | 1.33 | 4.31 | 68.04 | 7.32 | 0.32 | 362.83 | 25.62 | 210.68 | 28.48 | 0.48 |
| S. Em. (±) | 0.112 | 0.59 | 0.234 | 0.096 | 0.082 | 1.486 | 0.351 | 0.638 | 0.228 | 0.079 |
| C.D. at 5% | 0.223 | 1.174 | 0.466 | 0.191 | 0.163 | 2.957 | 0.698 | 1.270 | 0.454 | 0.157 |

**Chemical properties of soil (post-harvest)**

The results in given table 6 indicates some of the important parameters on chemical properties on mustard crop. Organic and inorganic fertilizers in conjunction on EC, pH, phosphorus (kg $ha^{-1}$) were found to be non-significant and Organic carbon (%), available nitrogen (kg $ha^{-1}$), sulphur (ppm) was found significant. EC (dS $m^{-1}$), Organic carbon (%), available nitrogen (kg $ha^{-1}$), potassium (kg $ha^{-1}$), sulphur (ppm) was recorded 0.44, 352.11, 199.15, 26.37, respectively in the treatment T9 that was significantly higher as compared to other treatment combination. pH was recorded 7.31 in the treatment $T_9$ that were significantly lower as compared to other treatment combination. The slight decreased in soil pH as well as decreased in soil EC (dS $m^{-1}$) Organic carbon (%), available nitrogen (kg $ha^{-1}$), available potassium(kg $ha^{-1}$) and sulphur(ppm) may be due to increase in levels of organic and inorganic fertilizers and plant growth, which is turn increased the plant residues into soil. It may be concluded from trial that the various levels of NPK, S and FYM used from different sources in the experiment, the treatment combination $T_9$ ($N_{80}$ $P_{40}$ $K_{40}$, $S_{40}$ + FYM @ 15 t $ha^{-1}$) was found to be the best, for improvement in physical and chemical properties of soil. Similar results have also been reported by Gauttam *et al*.,(2013) and Kumar *et al* (2014).

**Conclusion**

In the present investigation it can be concluded that the various levels of NPK,S and FYM used from different sources in the experiment that $T_9$-(NPK+S) 100% + @ FYM 100% was found to be the best treatment in terms of soil health parameters and yield attributes. As for the yield parameters are concerned, no.of siliqua $plant^{-1}$,no. of seed $siliqua^{-1}$, straw yield, test weight and the most significant yield remained with $T_9$-(NPK+S) 100% + @ FYM 100% followed by $T_5$-(NPK+S) 50% + @ FYM 50% and minimum was $T_1$ (control).

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