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# Effect of Irrigation Water (Treated industrial effluent) and Integrated Nutrients Management on Growth and Yield of Mustard (*Brassica juncea*) Crop

***Keshav Prasad Kurmi[1*], S.P. Tailor[2] and Satyavir Singh[3]***

*[1]Research Scholar, School of Agriculture Science and Technology, Sangam University Bhilwra (Rajasthan), India.*
*[2]Professor, School of Agriculture Science and Technology, Sangam University Bhilwara (Rajasthan), India.*
*[3]Assistant Professor, Institute of Agricultural Sciences, Bundelkhand University, Jhansi (Uttar Pradesh), India.*

*(Corresponding author: Keshav Prasad Kurmi*)*
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**ABSTRACT: A field experiment was conducted during *rabi* season in the year 2020-21 and 2021-22 at agricultural farm of Sangam University, Bhilwara (Rajasthan) India, to evaluate the effect of irrigation water (Treated industrial effluent) and integrated nutrients management on growth and yield of Mustard crop. The trial was consist of four irrigation water ($IW_0$) freshwater, ($IW_1$) 25% effluent + 75% fresh water, ($IW_2$) 50% effluent + 50 % fresh water, ($IW_3$) 75% effluent + 25% freshwater and four integrated nutrient management ($INM_0$) 100% RDF through inorganic fertilizer, ($INM_1$) 75% RDF through inorganic fertilizer + 25% through FYM, ($INM_2$) 75% RDF through inorganic fertilizer + 25% through Vermicompost, ($INM_3$) 50% RDF through inorganic fertilizer + 25% through FYM + 25% Vermicompost. The result revealed that treatment $IW_1$ (25% effluents + 75% fresh water) in combination with INM2 (75% RDF through inorganic fertilizer + 25% through Vermicompost recorded the highest plant height, number of primary branches, number of secondary branches, chlorophyll content and number of green leaves per plant and grain yield in comparison to remaining treatment combination, whereas it was significantly at par with treatment IW0 (100% RDF through inorganic fertilizer).**

**Keywords:** Integrated nutrient management, Industrial effluent, Vermicompost, Farm Yard Manures, Recommended dose of fertilizer.

## INTRODUCTION

A significant winter oilseed crop, mustard (*Brassica juncea*) is also known by a variety of other names, including rai, raya, laha, and raiya. After soybean and palm oil, rapeseed-mustard is the third most significant oilseed crop in the world. After groundnut, it is the second-most significant crop in India and accounts for 28.6% of all oilseed production. Rajasthan, Punjab, Haryana, Bihar, Uttar Pradesh, Madhya Pradesh, West Bengal and Gujarat are the major states that produce mustard. In India, rapeseed-mustard production is 10.11 million tones with productivity of 1511 kg per hectare, while in Rajasthan, 4.51 million tones with productivity of 1659 kg per hectare (Anonymous, 2021).

In the growth of crops and water recycling, soil is crucial. Industrial textile wastes have a negative impact on water quality, and too much effluent has a negative impact on soil quality. This also has an impact on the surroundings of humans, groundwater properties, and the environment (Makwana Surendra, 2020). The most contaminated source across all industrial sectors is wastewater from the textile processing industry, which has a negative impact on plant growth. Several crops have been discovered to be poisonous to dye waste water, and it has a negative impact on soil quality metrics such as pH, electric conductivity, organic carbon, total nitrogen, CaO, Mn, Zn, and Mo, among others (Mehta *et al.,* 2016). The presence of high nutrient levels, high total dissolved solids, heavy metals, and other elements that are introduced to the soil over time is what causes the loss in soil fertility (Sahare, 2014). Up until now, the focus has been on adding major nutrients to the soil, such as N, P, K, Ca, Mg, S, and micronutrients (Zn, Fe, Cu, and Mn), which could be obtained from the soil reserve (Gurjar *et al.,* 2017). Deep lava from the Aravalli Hills makes up the soil of the experimental field; mustard needs a good sandy loam soil. For the most part, using organic manure in addition to chemical fertilizers is necessary to increase the soil's health (Prasad *et al*., 2017). The most crucial ingredient for the growth of the mustard crop, which also boosts yield and protein content, is nitrogen. It is well known that potash and phosphorus are effectively used when nitrogen is present. It encourages blooming, siliqua setting, and increases siliqua size and production. The soil parameters were dramatically impacted by the addition of FYM and secondary and micronutrients (AICRP, RM, 2022). The amount of mustard seed yield that might be obtained using 75% RDF + S @ 40 kg $ha^{-1}$ + vermicompost @ 5t $ha^{-1}$ (Ajnar and Namdeo 2021).

## MATERIALS AND METHODS

At Sangam University's agriculture research farm in Bhilwara, Rajasthan, which is situated at 250 26' N latitude, 740 62' E longitudes, and an elevation of 421m above mean sea level, a field experiment was conducted on a mustard crop during the rabi seasons of 2020–21 and 2021–22. From 21.7 to 37.3 °C with an average of 28.73 °C in 2020–2021 and from 21.53 to 36.18 °C with an average of 27.57 °C in 2021–2022 correspondingly, were the weekly mean maximum temperatures. In 2020–21 and 2021–22, respectively, the crop period saw total rainfall of 14.7 mm and 76.3 mm. During the crop era, there were a total of 4 wet weeks in 2020–21 and 8 in 2021–22.

The weekly mean maximum relative humidity in 2020-21 ranged from 54 to 75% with an average of 63.48%, whereas it ranged from 56.65 to 80.1% with an average of 67.16% in 2021-22. The soil of the experimental field was silty loam in the texture, deep, well drained, physical properties of soil *viz*., bulk density 1.37 (g/cm$^3$) (Piper, 1950) and particle density 2.54 (g/cm$^3$) Pycnometer method (Black, 1965) porosity 51 % and water holding capacity 60 % Bernard (1963) and Chemical properties of soil *viz*., pH 7.95 and 8.2 (1:2 soil: water suspension) EC 0.16 and 0.20 dSm$^{-1}$ with medium in organic carbon (0.40% and 0.59%), low in available N (275.67 and 276.21 kg/ha) (Subbiah and Assja 1956), medium in available P (24.0 and 23.1 kg/ha) (Olsen *et al.,* 1954) and medium in available K (272.67 and 275.32 kg/ha) (Jackson, 1973) during 2020-21 and 2021-22, respectively. Dyeing industry effluent (Treated wastes water) was collected from textile industries situated at Chittorgarh by pass, Bhilwara, Rajasthan India in 25 liter plastic containers. The collected effluent was analyzed in the lab and after that it was used for irrigation as per treatment requirement.

The experiment was conducted in Randomized Block design (factorial) with three replication to understand the effect of irrigation water (industrial effluent) and integrated nutrient management at different doses combination on growth and yield of mustard (*Brassica juncea*) crop variety SM-21. The treatment combination of 4 irrigation water were main treatment *viz.,* fresh water ($IW_0$), 25% effluents + 75% freshwater ($IW_1$), 50% effluents + 50% freshwater ($IW_2$), 75% effluents + 25% freshwater ($IW_3$), and 4sub treatment of integrated nutrient management *viz.,* 100% RDF through inorganic fertilizer ($INM_0$), 75% RDF through inorganic fertilizer + 25% through FYM ($INM_1$), 75% RDF through inorganic fertilizer + 25% through Vermicompost ($INM_2$), 50% RDF through inorganic fertilizer + 25% through FYM + 25% Vermicompost ($INM_3$).

Dry weeds and stubble were pulled out of the experimental field before seeding with a tractor-drawn moldboard plough and discing. After applying fertilizers and manures to the soil one day prior to sowing, the mustard cultivar "SM-21" was manually sowed at a spacing of 30 × 10 cm. Irrigation water and fertilizers were used as a form of treatment. Before sowing, 100% of phosphate, 100% of potash, 50% of nitrogen, and organic manures were applied. 50% of the nitrogen was still applied, but in two splits. For the purpose of documenting biometrical observations and yield, standard procedures were used. Information on growth and yield characteristics was gathered.

## RESULTS AND DISCUSSION

**Effect on crop growth parameters.** The data pertaining to the effect of irrigation levels on plant growth is presented in Table 1 which revealed that different levels of irrigation treatments were significantly affected to most of the growth parameters. The highest values for growth parameters *viz.*, chlorophyll content and number of green leaves per plant were detected during both the years of study when irrigation water applied in combination of 25% effluents + 75% fresh water and it was followed by application of 100% fresh water however, both the treatment showed similar results for number of primary and secondary branches while all the treatments had non-significant effect on plant height during both the years. These results are found in Pokhriya *et al.* (2017); Sahay *et al*. (2015)

INM significantly influenced the growth parameters of the mustard. Among different nutrients management treatments, treatment $INM_2$ (75% RDF through inorganic fertilizer + 25% through Vermicompost) resulted higher chlorophyll content and number of green leaves per plant while, it was showed similar results for number of primary and secondary branches per plant with treatment $INM_0$ (100% RDF through inorganic fertilizers). All the treatments had non-significant effect on plant height during both the years. Increase in growth parameters with 75% RDF through inorganic fertilizers + 25% through vermicompost ($INM_2$) was due to improve mention the soil physical and chemical properties of soil and growth of mustard on account of adequate and prolonged supply of essential major and micro nutrients to the plants which might have promoted the maximum vegetative growth as compare to treatment $INM_0$ (100% RDF through organic fertilizers) due to limited availability of nutrients as well as with treatment $INM_1$ (75% RDF through inorganic fertilizers + 25% through FYM) due to slow release of nutrients by FYM during crop growth period. Similar findings were reported by Ranjan *et al.* (2018); Singh *et al.* (2018) in mustard.

**Effect on yield attribute.** The data presented in Table 2 revealed that yield attributes and yield was significantly affected by the different levels of irrigation water. The results showed that significantly maximum number of siliqua per plant, highest grain yield and straw yield of wheat was recorded with treatment $IW_1$ (25% effluents + 75% fresh water) over other treatments during both the experimental years however, similar results for siliqua length, number of seeds per siliqua, test weight given by treatment $IW_0$ (100% fresh water) and $IW_1$ (25% effluents + 75% fresh water). There was non-significant difference observed towards number of unfilled siliqua and harvest index during both the experimental years (Hira *et al.*, 2017; Akhtar *et al*., 2018).

The data also revealed that the yield attributes and yield was significantly affected by the different levels of nutrients management. The maximum number of siliqua per plant, siliqua length, number of seeds per siliqua, highest grain and straw yield of mustard was observed with treatment $INM_2$ (75% RDF through inorganic fertilizers + 25% through vermicompost) during both the experimental years however, it was statistically at par with treatment $INM_0$ (100% RDF through inorganic fertilizers) for siliqua length and number of seeds per siliqua. The non-significant results were found for test weight during both years. It might be due to the organic manures applied in the form of combination of vermicompost along with inorganic fertilizers might have improved the soil physical and chemical properties and increasing organic carbon leading to the adequate supply of nutrients to the plants which might have promoted the yield attributes similarly result found (Kumar *et al.*, 2017; Varma *et al.,* 2021).

**Interaction effects on grain yield.** Interaction effect of irrigation water and integrated nutrients management with respect to grain yield attribute was found significant during 2020-21 and 2021-22 crop growing years as well as their pooled basis also. The highest grain yield of mustard was recorded with treatment combination IW1INM2 (25% effluents + 75% fresh water along with 75% RDF through inorganicfertilizer + 25% through Vermicompost) during both the crop growing years and their pooled basis, respectively and it was closely followed by treatment combination IW1INM0 (25% effluents + 75% fresh water along with 100% RDF through inorganic fertilizer), IW2INM2 (50% effluents + 50% fresh water along with75% RDF through inorganic fertilizer + 25% through vermicompost) and IW0INM2 (100% fresh water along with 75% RDF through inorganic fertilizer + 25% through vermicompost) however, all these treatment combinations were statistically at par with each other during both the crop growing years and their pooled basis also.

**Table 1: Effect of irrigation water and integrated nutrients management on growth of mustard.**

| Treatment | | Plant height(cm) | Number of primary branches | Number of secondary branches | Chlorophyll content (mg $g^{-1}$) | Number of green leaves/plant |
|---|---|---|---|---|---|---|
| **Factor A. Irrigation Water (IW)** | | **Pooled data (2020-21 and 2021-22) (at harvest)** | | | **Pooled data (2020-21 and 2021-22) (at 90 DAS)** | |
| **IW0** | Freshwater | 124.97 | 5.85 | 16.63 | 1.54 | 46.39 |
| **IW1** | 25% effluents + 75% freshwater | 126.11 | 6.28 | 17.44 | 1.68 | 37.56 |
| **IW2** | 50% effluents + 50% freshwater | 120.82 | 5.46 | 15.10 | 1.41 | 44.24 |
| **IW3** | 75% effluents + 25% freshwater | 119.08 | 5.24 | 13.32 | 1.28 | 42.31 |
| **SEm±** | | **2.64** | **0.19** | **0.41** | **0.010** | **0.54** |
| **CDat5%level** | | **NS** | **0.55** | **1.19** | **0.030** | **1.56** |
| **Factor B. Integrated Nutrients Management (INM)** | | | | | | |
| **INM0** | 100% RDF through inorganic fertilizer | 127.54 | 5.75 | 16.20 | 1.48 | 45.21 |
| **INM1** | 75% RDF through inorganic fertilizer + 25% through FYM | 117.23 | 5.64 | 13.68 | 1.44 | 43.44 |
| **INM2** | 75% RDF through inorganic fertilizer + 25% through Vermicompost | 128.10 | 5.95 | 16.93 | 1.55 | 47.86 |
| **INM3** | 50% RDF through inorganic fertilizer + 25% through FYM + 25% Vermicompost | 120.71 | 5.73 | 14.56 | 1.45 | 44.44 |
| **SEm±** | | **2.64** | **0.19** | **0.41** | **0.010** | **0.54** |
| **CD at 5% level** | | **NS** | **NS** | **1.19** | **0.030** | **1.56** |
| **Interaction (I×M)** | | | | | | |
| **SEm±** | | **5.29** | **0.38** | **0.82** | **0.021** | **1.08** |
| **CD at 5% level** | | **NS** | **NS** | **NS** | **NS** | **NS** |

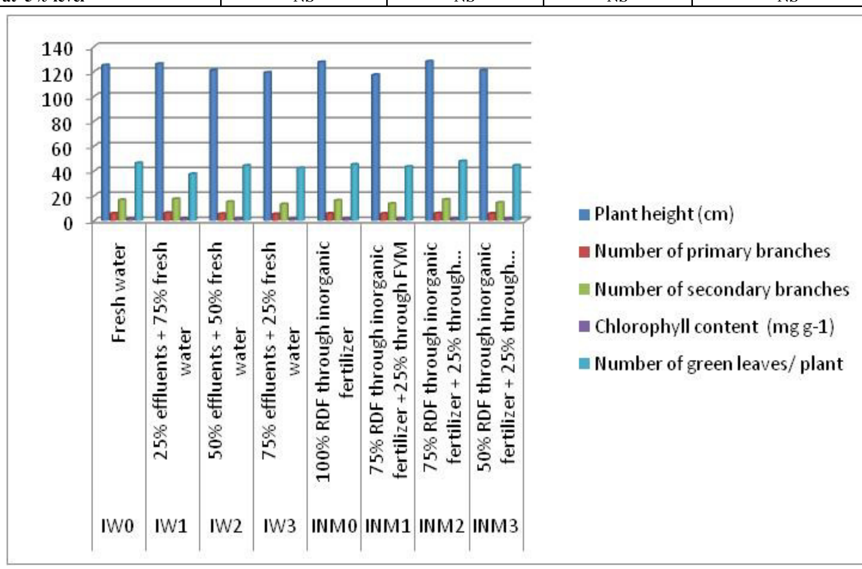


**Fig. 1.** Effect of irrigation water and integrated nutrients management on growth parameters of mustard.

**Table 2: Effect of irrigation water and integrated nutrients management on yield attributes and yield of mustard.**

| Treatment | | Number of siliqua / plant | Siliqua length (cm) | Number of seed / siliqua | Test weight (g) | Grain yield(kg/ha) | Straw yield(kg/ha) |
|---|---|---|---|---|---|---|---|
| **Factor A. Irrigation Water (IW)** | | **Pooled data (2020-21 and 2021-22)** | | | | | |
| **IW0** | Freshwater | 216.82 | 4.94 | 13.75 | 4.69 | 1698.42 | 3896.93 |
| **IW1** | 25% effluents + 75% freshwater | 233.26 | 4.96 | 14.57 | 4.77 | 1863.75 | 4039.92 |
| **IW2** | 50% effluents + 50% freshwater | 200.02 | 4.88 | 11.86 | 4.64 | 1512.58 | 3384.72 |
| **IW3** | 75% effluents + 25% freshwater | 181.72 | 4.54 | 10.88 | 4.56 | 1304.48 | 2866.28 |
| **SEm±** | | **5.14** | **0.08** | **0.30** | **0.04** | **47.96** | **106.54** |
| **CD at 5% level** | | **14.85** | **0.23** | **0.87** | **0.12** | **138.55** | **307.80** |
| **Factor B. Integrated Nutrients Management (INM)** | | | | | | | |
| **INM0** | 100% RDF through inorganic fertilizer | 225.75 | 4.90 | 14.23 | 4.69 | 1684.25 | 3754.33 |
| **INM1** | 75% RDF through inorganic fertilizer + 25% through FYM | 183.63 | 4.62 | 11.77 | 4.64 | 1457.92 | 3244.86 |
| **INM2** | 75% RDF through inorganic fertilizer+25% through Vermicompost | 242.19 | 4.95 | 14.67 | 4.74 | 1873.00 | 4169.74 |
| **INM3** | 50% RDF through inorganic fertilizer + 25% through FYM+25% Vermicompost | 199.92 | 4.83 | 12.57 | 4.64 | 1364.17 | 3018.92 |
| **SEm±** | | **5.14** | **0.08** | **0.30** | **0.04** | **47.96** | **106.54** |
| **CD at 5% level** | | **14.85** | **0.23** | **0.87** | **NS** | **138.55** | **307.80** |
| **Interaction (I×M)** | | | | | | | |
| **SEm±** | | **10.28** | **0.16** | **0.61** | **0.10** | **95.92** | **213.08** |
| **CD at 5% level** | | **NS** | **NS** | **NS** | **NS** | **277.11** | **615.59** |

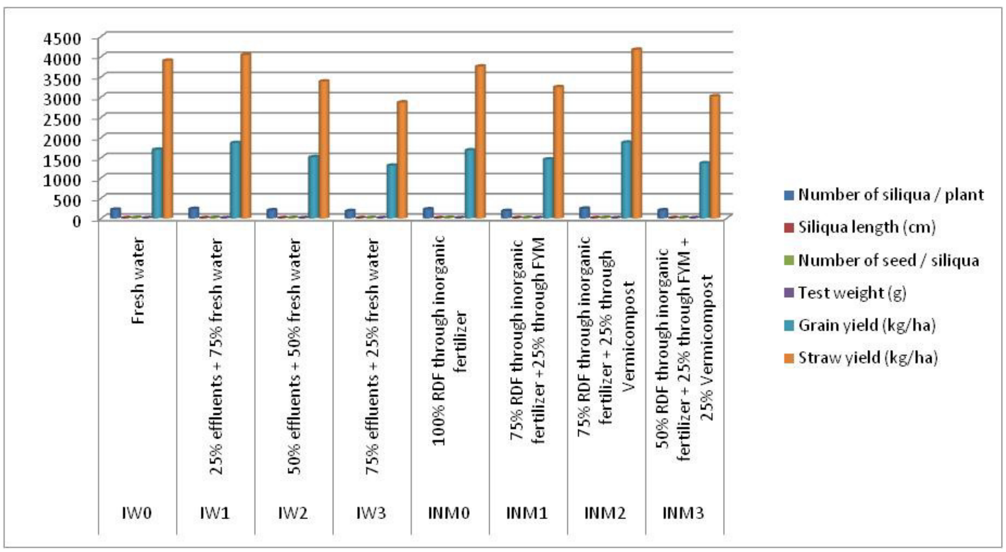


**Fig. 2.** Effect of irrigation water and integrated nutrients management on yield attributes and yield of mustard.

The lowest grain yield was recorded with treatment combination IW3INM1 (75% effluents + 25% fresh water along with 75% RDF through inorganic fertilizer + 25% through FYM), which was significantly inferior of over other treatment combinations except IW2INM3 (50% effluents + 50% fresh water along with 50% RDF through inorganic fertilizer + 25% through FYM + 25% through vermicompost) and IW3INM3 (75% effluents + 25% fresh water along with 50% RDF through inorganic fertilizer + 25% through FYM + 25% through vermicompost) during both the crop growing years and their pooled basis also.

## CONCLUSIONS

From the results, it can be inferred that concentrated industrial effluents is heavily loaded with pollutants which negatively affect plant growth and yield by interfering with physiological process. However, on dilution, toxic effects of industrial effluents are reduced. Moreover, the 25% share of industrial effluents had effect on growth, yield and chemical parameters could be stimulatory rather inhibitory. On the basis of this study, it can be concluded that the diluted industrial wastewater can be used to meet the water requirements that can also improve growth and yield of mustard crop.

Among the integrated nutrient management, application of 75% RDF through inorganic fertlizers + 25% through vermicompost found best among all nutrient management options and may be suggested for higher growth and yield in mustard crop and soil health sustainability as compare to application of 100% RDF through inorganic fertilizers during both the years of experimentation.

## FUTURE SCOPE

In recent years, the rapid development of the industry has brought convenience to people, but at the same time it generates a large amount of waste water consisting of toxic substances such as nitrogen, phosphorus, hydrocarbons and heavy metals, which adversely affect the environment and humanity. Reuse and recycling of industrial wastewater is now very necessary because the treated water can be used for irrigation of crops. In addition, through integrated nutrient management, soil fertility and quality can be continuously maintained, helping to reduce many problems such as peasant poverty and food insecurity.

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**Conflict of Interest.** None.

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