

**EFFECT OF ORGANIC MANURES AND SOIL MOISTURE REGIMES ON NUTRIENT AVAILABILITY  
AND YIELD OF MUSTARD IRRIGATED WITH DIFFERENT SALINE WATER****HARISH KUMAR**Research Scholar  
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**Abstract**

The ground water of north-western Rajasthan is typical water with problem of high salinity flanked with high chloride and sulphates. Such water is continuously in use for agriculture depending on the extent of hazardous constituents. Moreover, several farmers have discontinued their source of underground irrigation on account of soil deterioration leading to drastic reduction in yield of crops. Though, the irrigation water in such areas is poor in quality but it is inescapable as there is no alternative source of irrigation in such areas. Rapeseed and mustard is one of the important edible oilseed crops of India next to groundnut and soyabean. It alone accounts for about one-third of the total oilseeds production in the country. India ranked second during 2008-09 both in terms of production and area under rapeseed and mustard in the world with 17.4 per cent of production and 25.6 per cent of area. India produced 7.36 million tones of rapeseed and mustard from 6.0 million hectares of area with an average yield of 1145 kg ha<sup>-1</sup> during 2016-17. Green stems and leaves are a good source of green fodder for cattle. The fresh leaves of young plants are used as green vegetable which serve as a good source of sulphur and minerals in the human diet. In the industry, mustard oil is used for softening the leather. Besides, the production of rapeseed and mustard provides substantial jobs to the working force in the primary, secondary and tertiary sectors of the economy.

**Introduction**

The ground water of north-western Rajasthan is typical water with problem of high salinity flanked with high chloride and sulphates. Such water is continuously in use for agriculture depending on the extent of hazardous constituents. Moreover, several farmers have discontinued their source of underground irrigation on account of soil deterioration leading to drastic reduction in yield of crops. Though, the irrigation water in such areas is poor in quality but it is inescapable as there is no alternative source of irrigation in such areas.

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Rajasthan is one of the major rapeseed and mustard producing states of India. It ranked first both in terms of area and production of rapeseed and mustard. It produced 3.71 million tones of rapeseed and mustard during 2016-17. The major rapeseed and mustard producing districts of the state are Bharatpur, Alwar, SawaiMadhopur, Tonk, Sri Ganganagar, Jhunjhunu, Hanumangarh, Dholpur, Baran and Nagaur.

**Importance of Research Work**

Efficient and sustainable management of natural resources especially soil and water, is basic to agricultural growth and national economy in India. In this, context, soil productivity plays a vital role in enhancing agricultural growth. In quest for augmenting agricultural production for meeting the varied soaring demands of the swelling population and unscientific management of soil and water

resource without any perspective of long term sustainability have not only caused adverse impact on productivity growth rate in agriculture but also resulted in market resource degradation along with serious environmental concerns. Over exploitation and unscientific management of limited resources without regard to long term sustainability have resulted in different kinds of soil degradation posing threat to soil productivity and food security.

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### **Objectives**

1. To determine the effect of organic manures and soil moisture regimes on soil physico chemical properties and nutrient availability in soil under irrigation with saline water.
2. To evaluate the effect of organic manures and soil moisture regimes on yield and quality of mustard under irrigation with saline water.
3. To study the effect of organic manures and moisture regimes on dynamics of soil microbial biomass and soil enzyme activities under irrigation with saline water.

### **Methodology**

The field experiment entitled “**Effect of organic manures and soil moisture regimes on nutrient availability and yield of mustard irrigated with different saline water**”

was conducted during rabi season of the year 2015-16 and 2016-17. The experimental materials and the criteria used for treatment evaluation during the entire course of investigation are being presented in this thesis under the following heads.

### **Experimental site**

Sri Ganganagar District is located between Latitude 28.4 to 30.6 and Longitude 72.2 to 75.3. The total area of Sri Ganganagar is 11,154.66km<sup>2</sup> or 1,115,466 hectares. It is surrounded on the east by Hanumangarh District on the south by Bikaner District, and on the west by Bahawalnagar district of the Pakistani Punjab and on the north by the Punjab. In Rajasthan, this region falls under agro-climatic zone I-b (Irrigated North-Western Plain).

### **Physico-chemical properties**

#### **Bulk density**

Bulk density of soil was determined for undisturbed soil by core sampler method in situ (Blake and Hartge, 1986).

#### **Saturated hydraulic conductivity**

Saturated hydraulic conductivity of soil was determined by undisturbed soil by constant head method (Klute and Dirksen, 1986).

#### **Moisture retention and available water**

Soil moisture retention at 33 kPa and 1500 kPa tensions was determined on pressure plate apparatus as described by Gardner, (1986) and available water was calculated as moisture retention at 33 kPa minus moisture retention at 1500 kPa.

#### **pH**

Soil pH was determined by electronic method with Systronics pH meter model 322-1 glass electrode assembly in soil saturation paste (Richards, 1954).

#### **Electrical conductivity (ECe)**

ECe of soil samples was measured on Solubridge in soil saturation extract (Richards, 1954).

#### **CEC**

CEC of soil was determined by method No. 19 of USDA Handbook No. 60. by using neutral normal ammonium acetate solution (Richards, 1954).

#### **Water expense efficiency**

Water expense efficiency is the ratio between the produce (seed) and the water spent in

obtaining that produce rather than the water used consumptively by the crop (Prihar et al., 1976) and computed by the following formula:

Water Expense efficiency (kg/ha-cm) =

$$\frac{\text{Seed yield (kg ha}^{-1}\text{)}}{\text{Total Water expense}}$$

Total water expense of the crop was computed as the sum of irrigation water, rainfall during the crop growing season and profile water depletion (difference in soil water storage of 100 cm profile at the time of sowing to at harvest). The total soil water storage in 100 cm soil profile was calculated by this way.

Water content in ithlayer (%) x depth of ithlayer

$$\text{Storage (cm m}^{-1}\text{)} = \sum_{i=1}^n \frac{\text{Total soil water (cm) x B.D. of } i^{\text{th}} \text{ layer (Mg m}^{-3}\text{)}}{100}$$

### Nutrient availability

#### Total N

Total N in the soil was determined by macrokjeldahl method. The soil samples were acid (H<sub>2</sub>SO<sub>4</sub>) digested with K<sub>2</sub>SO<sub>4</sub>-catalyst mixture (Bremner and Mulvaney, 1982). The clear digested samples were mixed with strong alkali solution (NaOH) and steam distilled in macrokjeldahls. The ammonia so liberated was trapped in boric acid and titrated against 0.01N H<sub>2</sub>SO<sub>4</sub> using mixed indicator.

#### Total P

Total soil P was determined after HClO<sub>4</sub> digestion (Jackson, 1973). After digestion and volume make up, the aliquot was used for analysis by the Olsen's method.

#### Available N

Soil samples were analyzed for available N using alkaline potassium permanganate, which oxidized and hydrolyzed the organic matter present in the soil (Subbiah and Asija, 1956).

#### Available P

Available phosphorus was determined colorimetrically by extracting the soil with 0.5N NaHCO<sub>3</sub> at pH 8.5 (Olsen et al., 1954) and measuring the intensity of blue colour developed by ammonium molybdate – stannous chloride.

#### NH<sub>4</sub><sup>+</sup>-N and NO<sub>3</sub><sup>-</sup>-N

Soil was extracted with 100 ml of 0.5 M K<sub>2</sub>SO<sub>4</sub> (shaking for 1 hr) and the amount of NH<sub>4</sub><sup>+</sup> and NO<sub>3</sub><sup>-</sup> nitrogen was determined by steam distillation method (Keeney and Nelson, 1982).

#### Organic carbon

Organic carbon in the soil was estimated by Walkley and Black (1934) method. This method involved oxidation of organic matter with chromic acid and the undecomposed potassium dichromate was back titrated against ferrous ammonium sulphate.

#### Soil microbial biomass and enzymes activities

Microbial biomass C, N and P were analysed following chloroform fumigation method, fifty g soil was fumigated for 24 h under vacuum in a vacuum desiccator using ethanol-free chloroform. Non-fumigated (50 g) and fumigated soils were extracted using 200 ml of 0.5 m K<sub>2</sub>SO<sub>4</sub> and extracts were used for determining carbon (Vence et al. 1987), nitrogen (Brookes et al. 1985) and phosphorus (Brookes et al. 1982). Soil samples were conditioned by maintaining moisture to 40 % water holding capacity to measure microbial biomass C, N and P. All results were expressed on an oven dry soil (105<sup>o</sup>C, 24 hr) basis.

#### Statistical analysis

##### Analysis of variance and test of significance

In order to test the significance of variation in experimental data obtained for various treatment effects, the data were statistically analysed as described by Fisher (1950). The critical differences were calculated to assess the significance of treatment mean wherever the 'F' test was found significant at 5 per cent level of probability. To elucidate the nature and magnitude of treatment effects, summary tables along with SEM ± and CD (P=0.05) were prepared and are given in the text of the chapter "Experimental results" and their analyses of variance are given in Appendices at the end.

#### Correlation studies

To assess inter-relationship between soil Cmic, Nmic and Pmic (build up) and other soil properties, multiple regression equation were worked out. All these statistical estimates were done by standard procedure of Gomez and Gomez (1984).

#### EFFECT OF ORGANIC MANURES

Application of chemical fertilizers applied even in balanced amounts are generally unable to

sustain productivity under continuous cropping and irrigation with poor quality waters. This negative effect is overcome by inclusion of organic materials known to improve soil properties mediated through formation of organic acids on decomposition of organic matter (Kumar and Tripathi, 1990). Thus, organic matter is a substance that has many desirable characteristics which influences the soil physico-chemical properties associated with the plant growth and development and increase availability of nutrients.

#### **Soil physico-chemical properties**

The significant decrease in bulk density and increase in saturated hydraulic conductivity and moisture retention of soil at crop harvesting due to application of organic manures compared to control (no organic manure) was observed.

The role of organic matter in improving the physical properties is well known. Soil organic matter imparts desirable physical environment to soils by favorably affecting soil structure expressed through soil porosity, aggregation, bulk density and water storage capacity (Benbi et al., 1998). Decomposition of organic matter improved soil permeability and increased water stable aggregates as a result of complex series of polysaccharides synthesized by the soil microbes flourishing in decomposing organic matter and by their secretory products which acted as soil building materials. Thus, the increase in aggregation and improvement in soil structure brought significant reduction in bulk density with the application of organic manures could be attributed to the fixing of low density material with dense mineral fraction of the soil. The findings corroborate with the result of Maheswarappa et al. (1999), Srikant et al. (2000), Prakash et al. (2002) Selvi et al. (2005) and Singh et al. (2012) who observed a decrease in bulk density with increase in organic matter content in soil.

Effect of different organic manures on bulk density was well reflected on hydraulic conductivity and water retention. Incorporation of organic manures significantly increased the hydraulic conductivity and water retention of soil over control (no manures) and it might be due to reduction in bulk density and increase in soil aggregation which in turn increased the hydraulic conductivity of soil (Selvi et

al., 2005). The results provide further evidence that hydraulic conductivity correlated positively with organic carbon content ( $r = 0.450^*$ ) of soil in present study. The increase in water retention as a result of organic manure is expected from the aggregation resulting in favourable pore geometry of the soil (Acharya et al., 1988). The existence of positive correlation between organic carbon and available water content ( $r = 0.853^*$ ) and hydraulic conductivity of soil ( $r = 0.450^{**}$ ) further evidenced these view in present study. Similar results have also been reported by a number of workers viz. Bellakki and Badanur (1997), Laddha and Totawat (1998), Bajpai et al. (2006), Tripathi and Tiwari (2006) Ghuman and Sur (2006).

#### **Nutrient availability**

Addition of organic manures to soil had beneficial effect on the nutrient availability. All the treatments resulted in increasing the total and available nutrients in soil over control. Vermicompost showed the highest increase in total and available nutrients. The same treatment resulted maximum decrease in soil pH explaining the increase in total and available nutrients in soil.

#### **Water expense components**

A perusal of data indicated that profile water depletion and total water expense decreased significantly, whereas, water expense efficiency increased significantly with the addition of organic manures during both the years and in pooled mean analysis. Reduction in profile water depletion and total water expense under FYM and vermicompost treated plots may be a direct consequence of the reduced water losses under these plots, more specifically, the percolation + seepage losses. Reduction in percolation + seepage by incorporation of lantana has been observed to reduce total water use (Bhagat et al., 1999 and Bhagat et al., 2003) which in turn developed denser rooting and high dry matter yield result in higher water expense efficiency (Arora et al., 1993).

### **EFFECT OF MOISTURE REGIMES**

#### **Soil physico-chemical properties**

Data presented revealed that effect of application of irrigation water at different moisture regimes on bulk density of soil was found non-

significant during both the years, however, the saturated hydraulic conductivity of soil decreased significantly with the increasing level of irrigation during both the years and in pooled analysis. The decrease in saturated hydraulic conductivity at higher moisture regimes might be to change in porosity as porosity of rhizosphere positively related to hydraulic conductivity of soil. The increase in moisture content at 1500 kPa and 33 kPa owing to decrease in profile water depletion and water expense efficacy at more frequent irrigation might be the cause of decrease in saturated hydraulic conductivity. (Abu and Malgwi, 2012). The increase in organic carbon with the increasing frequency of irrigation in present study might also be the cause of higher moisture retention of soil. The EC of soil increased, while, pH decreased significantly with increasing frequency of irrigation water and this may be attributed to lower proportion of Na in total salt concentration of soil solution and neutral nature of electrolytes. The increase in EC and decrease in pH of soil with increasing frequency of irrigation water was also reported by Agrawal *et al.* (2002) and Singh *et al.* (2009).

## EFFECT OF SALINITY

### Soil physico-chemical properties

Data revealed that the effect of application of saline water on bulk density of soil was found non significant during both the years as well as in pooled analysis. However, the saturated hydraulic conductivity of soil increased significantly with increasing levels of salinity during both the years as well as in pooled.

An increase in saturated hydraulic conductivity with the increasing levels of salinity could be attributed to structural changes and positively related to changes in porosity of rhizosphere. It corroborates the results of Lal and Singh (1974) and Agrawal *et al.* (2002).

### Water expense component

Profile water depletion and total water expense decreased at both salinity levels, while, water expense efficiency increased at 6 dSm<sup>-1</sup> EC level, thereafter decreased significantly over to control in pooled mean analysis. This indicates that decrease in yield was of greater magnitude than that of total water expense at higher salinity level (12

dSm<sup>-1</sup>). Agrawal *et al.* (2002) reported increase in water use efficiency with increase in salinity in wheat. The differences in water depletion may be attributed to reduced evaporation from salinized soil due to lower vapour potential of soil solution and the difference in total water expense was possibly due to less utilization of available water by poorly grown plants at higher salinity. Minhas *et al.* (1990) also reported decrease in evapo-transpiration with increasing salinity levels.

## CONCLUSION

On the basis of the results obtained from the investigation, the following conclusion can be drawn

1. Application of organic manures alongwith more frequent irrigation by keeping the soil at a higher moisture content, prevents high salt concentration in the soil solution and tends to minimize the harmful effects of a given level of salinity. Hence, vermicompost @ 5 t ha<sup>-1</sup> under 0.8 IW/CPE moisture regime is a better choice for mitigating adverse effects of saline water properties and mustard yield.
2. Physico-chemical properties of soil, nutrient availability, soil microbial biomass and enzymes activities, incorporation of organic manure and maintenance of higher soil moisture regime has been found a viable soil management option for enhancing productivity and fertility of soil under irrigation with high saline water.

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