

## Performance of oat (*Avena sativa*) genotypes under alkali soil irrigated with sodic water\*

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Oat (*Avena sativa* L.) is an important winter (*rabi*) season cereal fodder crop of northern and central India. It has been recorded that oat is more suitable than the other fodder crops under moderately alkaline soil and sodic water irrigation (Ashok Kumar 2002). However, the range of variability amongst different genotypes of oat under moderate alkali soils irrigated with alkali waters has not been exploited to the desired levels. The present investigation shows the variability amongst 5 different oat genotypes under moderate alkali soils irrigated with alkali waters.

A field experiment was conducted at the farmer's field at Bhaini-Majra village in Kaithal District during winter (*rabi*) season 2003–04 to study the effect of gypsum application on 5 oat varieties ('JHO 99-2', 'JHO 2000-5', 'JHO 2000-6', 'JHO 822' and 'JHO 99-1') in a moderately alkaline soil. The initial pH of the soil (0–15 cm) was 9.3. Gypsum @ 2 and 4 tonnes/ha was mixed into shallow soil depth after giving pre-sowing irrigation with alkali water besides a control treatment in which gypsum was not added. These gypsum treatments of the addition of 2 and 4 tonnes/ha reduced the soil pH (0–15 cm) to 9.16 and 9.04 respectively. Oat varieties were sown on 11 November 2003 and harvested on 4 March 2004.

The crop was sown in rows 25 cm apart with 100 kg/ha seed rate and fertilized with 80 kg/ha N, 40 kg/ha P<sub>2</sub>O<sub>5</sub> and 40 kg/ha K<sub>2</sub>O. The tube well water used for irrigation had EC<sub>w</sub> 1.8 dS/m, RSC 9.4 me/litre, SAR 9.5 (mmol/litre)<sup>1/2</sup> and Ca+Mg 5.2 me/litre. Only 1 harvest was made on all the oat varieties when the crop attained approximately 50% bloom stage.

Soil samples were taken at sowing and harvest time for measuring electrical conductivity and pH. Electrical conductivity and pH from the soil samples were determined in 1:2 soil water suspension. Nitrogen in the plant samples was estimated by microkjeldhal method and crude protein was computed by multiplying with conversion factor 6.25. For remaining chemical analysis of plant samples, wet digestion (Jackson 1978) method was followed. Na and K were analyzed on flame photometer, whereas Ca, Mg and P were analyzed on

atomic absorption spectrophotometer.

Application of gypsum (2 and 4 tonnes/ha) to the alkali soil (pH 9.30) did not affect the green forage yield of oat significantly (Table 1). However, 5 oat genotypes tested on alkali soil and irrigated with sodic water showed significant differences for green forage yield. Among different genotypes 'JHO 99-2' gave significantly lower green forage yield (47.50 tonnes/ha) compared with the other genotypes. 'JHO 2000-6' recorded highest green forage yield (60.17 tonnes/ha) followed by 'JHO 99-1' (58.67 tonnes/ha) and 'JHO 2000-5' (58.08 tonnes/ha). Earlier, Ayers and Westcoat (1985) have also suggested that oat is moderately tolerant to exchangeable sodium. Ashok Kumar (2004) found that at the highest pH of 9.6, oat, barley (*Hordeum vulgare* L., s.l.) and Persian clover (*Trifolium resupinatum* L.) showed less yield reduction than the Egyptian clover (*Trifolium alexandrinum* L.) and Indian mustard (*Brassica juncea* (L.) Czernj & Cosson). Oat and barley also showed more root length and weight compared with the remaining forage crops. Ashok Kumar and Sharma (1995) reported oat to be the tolerant crop even under saline water irrigation among the 5 forage crops and found the relative tolerance to salinity in the order of oat (*Avena sativa* L.) > Chinese cabbage (*Brassica pekinensis* (Lour) Rupr.) > lucerne (*Medicago sativa* L.) > berseem (*Trifolium alexandrinum* L.) > shaftal (*Trifolium resupinatum* L.). It was also shown that oat requires less water compared to other crops tested, therefore, it should be given preference in salt-affected soils. Yadav *et al.* (2004) examined the effect of saline drainage water (EC 3.6–7.4) on 5 winter forage crops in an alluvial loam saline soil and noticed that rye grass (*Lolium rigidum*) and oat are comparatively more tolerant to salinity build up thus should be given preference under saline conditions.

Further, gypsum application did not influence the dry matter biomass as well as the dry matter percentage of the 5 oat genotypes. However, 5 oat genotypes showed significant differences for dry matter yield and dry matter percentage in alkali soil. 'JHO 2000-6' recorded maximum dry matter yield (9.6 tonnes/ha) and dry matter percentage (16.05) which was also significantly higher compared with the other varieties evaluated under alkali soil amended with different gypsum levels. The other 4 varieties showed statistically similar dry

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Table 1 Effect of gypsum levels on soil pH, EC, plant growth and green forage yield of different oat genotypes under sodic water irrigation

| Treatment                 | Green forage yield (tonnes/ha) | Dry matter yield (tonnes/ha) | Dry matter (%) | Soil pH |          | Soil ECe |          |
|---------------------------|--------------------------------|------------------------------|----------------|---------|----------|----------|----------|
|                           |                                |                              |                | 0-15 cm | 15-30 cm | 0-15 cm  | 15-30 cm |
| <i>Gypsum (tonnes/ha)</i> |                                |                              |                |         |          |          |          |
| 0                         | 52.90                          | 7.99                         | 15.45          | 9.29    | 9.30     | 1.47     | 1.41     |
| 2                         | 58.65                          | 8.85                         | 15.11          | 9.16    | 9.26     | 1.48     | 1.42     |
| 4                         | 56.85                          | 8.59                         | 14.64          | 9.04    | 9.20     | 1.46     | 1.42     |
| CD ( $P=0.05$ )           | NS                             | NS                           | NS             | 0.06    | 0.07     | NS       | NS       |
| <i>Varieties</i>          |                                |                              |                |         |          |          |          |
| 'JHO 99-2'                | 47.50                          | 6.96                         | 14.54          | 9.16    | 9.22     | 1.44     | 1.47     |
| 'JHO 2000-5'              | 58.08                          | 8.60                         | 14.84          | 9.18    | 9.25     | 1.50     | 1.41     |
| 'JHO 2000-6'              | 60.17                          | 9.60                         | 16.05          | 9.17    | 9.32     | 1.45     | 1.39     |
| 'JHO 822'                 | 56.25                          | 8.49                         | 15.06          | 9.16    | 9.24     | 1.50     | 1.45     |
| 'JHO 99-1'                | 58.67                          | 8.74                         | 14.85          | 9.13    | 9.22     | 1.47     | 1.37     |
| CD ( $P=0.05$ )           | 2.31                           | 0.68                         | 0.85           | NS      | NS       | NS       | NS       |

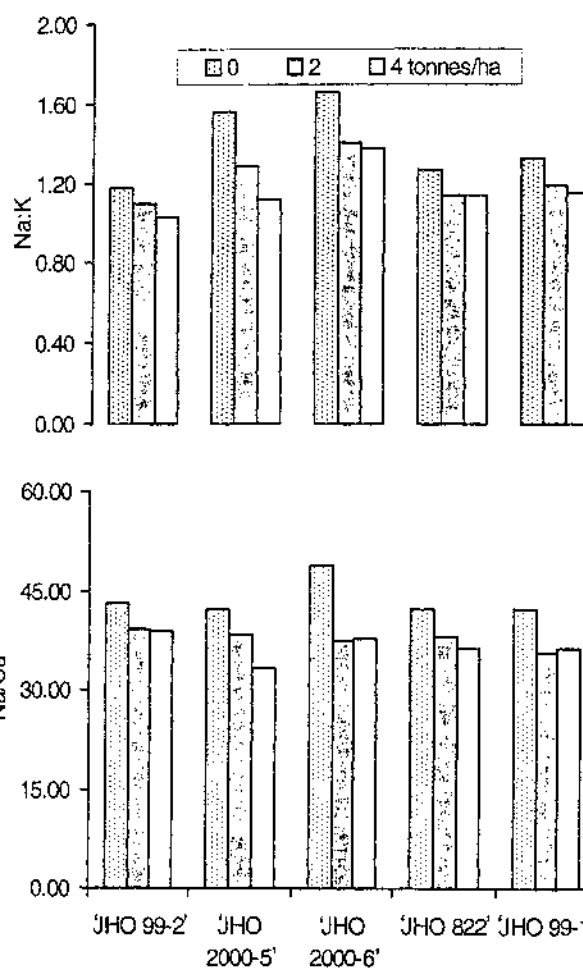
Table 2 Effect of gypsum levels on the chemical composition of different oat genotypes under sodic water irrigation

| Treatment                 | Na (%) | K (%) | Ca (%) | Mg (%) | Crude protein |
|---------------------------|--------|-------|--------|--------|---------------|
| <i>Gypsum (tonnes/ha)</i> |        |       |        |        |               |
| 0                         | 2.56   | 1.86  | 0.06   | 0.46   | 11.6          |
| 2                         | 2.38   | 1.97  | 0.06   | 0.45   | 11.7          |
| 4                         | 2.33   | 2.02  | 0.06   | 0.42   | 11.3          |
| CD ( $P=0.05$ )           | NS     | NS    | NS     | NS     | NS            |
| <i>Varieties</i>          |        |       |        |        |               |
| 'JHO 99-2'                | 2.40   | 2.19  | 0.06   | 0.43   | 12.3          |
| 'JHO 2000-5'              | 2.36   | 1.81  | 0.06   | 0.44   | 11.9          |
| 'JHO 2000-6'              | 2.53   | 1.71  | 0.06   | 0.46   | 11.0          |
| 'JHO 822'                 | 2.36   | 2.00  | 0.06   | 0.45   | 11.7          |
| 'JHO 99-1'                | 2.48   | 2.04  | 0.07   | 0.45   | 10.8          |
| CD ( $P=0.05$ )           | NS     | 0.25  | NS     | NS     | 0.2           |

matter yield and dry matter percentage. Among the 5 oat genotypes minimum dry matter yield (6.96 tonnes/ha) and dry matter percentage (14.54) was noticed in 'JHO 99-2' (Table 1).

Application of gypsum at 2 and 4 tonnes/ha significantly decreased the soil pH of 0-15 cm soil layer. Further, in 15-30 cm soil depth only 4 tonnes/ha gypsum application decreased the soil pH significantly over the no gypsum application. Different oat varieties did not play any significant role in improving the soil pH. Further, electrical conductivity (ECe) of the alkali soil was not affected significantly either by gypsum application or by the 5 oat varieties evaluated both in 0-15 and 15-30 cm soil depth.

The decline in soil pH (0-15 cm soil layer) from 9.3 to 9.04 owing to the application of gypsum (4 tonnes/ha) which did not significantly affect sodium percentage of oat (Table 2). Even the 5 oat genotypes did not show any significant variation in their sodium percentage. Further, the application of gypsum did not significantly influence the potassium content of oat. However, the 5 oat genotypes showed significant differences in their potassium content. Though 'JHO 99-2' was the lowest



content in different oat genotypes under sodic water irrigation

yielder amongst the 5 oat genotypes it showed highest potassium accumulation. Further, minimum potassium accumulation was recorded in 'JHO 2000-6' the highest yielder amongst the 5 oat genotypes. Significantly higher potassium

content was noticed in 'JHO 99-2', 'JHO 99-1' and 'JHO 822' compared to 'JHO 2000-6'. However, 'JHO 2000-5' and 'JHO 2000-6' were at par statistically with respect to potassium accumulation. Further, the calcium and magnesium content of oat was neither affected by gypsum application nor by the different varieties. Amongst the 5 genotypes tested, 'JHO 99-2' also showed lowest Na:K ratio (Fig 1). The highest Na:K ratio was recorded in 'JHO 2000-6' which also showed highest green forage yield amongst 5 varieties. The differences in potassium accumulation have caused variation in Na:K ratio as non-significant differences were recorded for Na accumulation in the 5 oat genotypes. 'JHO 2000-6' also showed highest Na:Ca under control conditions and highest decline in Na:Ca (23%) under declining pH levels, compared to other genotypes evaluated (Fig 1). This indicates the better adaptability of 'JHO 2000-6' under alkali stress situations.

Crude protein content was also not affected significantly by gypsum application. However, the 5 oat genotypes showed variations in their crude protein content. Amongst the 5 oat genotypes maximum crude protein content was observed in 'JHO 99-2' (12.3%), whereas 'JHO 99-1' showed the minimum (10.8%). 'JHO 2000-6' and 'JHO 99-1' were at par with each other statistically. Similarly, there was no significant difference between 'JHO 2000-5' and 'JHO 822'. It is concluded that 'JHO 2000-6' performed better under alkali soil irrigated with sodic water amongst the 5 oat genotypes evaluated.

#### SUMMARY

A field experiment was conducted at the farmer's field

during winter (*rabi*) 2003–04 to study the effect of gypsum application (2 and 4 tonnes/ha) on 5 oat varieties in a moderately alkali soil (pH 9.3) irrigated with alkali water. **Gypsum application did not significantly influence the green forage yield and crude protein content of 5 oat genotypes.** Amongst the 5 genotypes, 'JHO 2000-6' performed better under alkali soil irrigated with alkali water by recording highest green forage yield besides highest Na:K and lowest K accumulation.

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