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Response of FYM and gypsum on seed yield and quality of radish under high RSC water

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Abstract

The study was conducted to assess the effect of FYM and gypsum on seed quality of radish under high RSC water. The three levels of farmyard manure (0, 10 and 20 t/ha) and three levels of gypsum (0, 5 and 10 t/ha) were laid out in randomized block design (factorial) with four replications. The application of farmyard manure and gypsum individually and in combination significantly influenced the seed yield, seed quality and economics of radish crop. Application of farmyard manure @ 20 t/ha in combination with 100% neutralization of RSC through gypsum (10 t/ha) were recorded significantly maximum seed yield (6.62 q/ha), test weight (10.96 g), standard germination percentage (76.57%), seedling length (36.97 cm), seedling dry weight (11.56 mg), vigour index-I (2832.5), vigour index-II (885.39), net returns (Rs. 92451/-) and benefit to cost ratio (1.87) as compared to control where no FYM and gypsum was applied during both the years of study. Hence, combined application of FYM and gypsum minimize the harmful effect of sodic water and maximize the yield and quality of seed in radish.

Keywords: Economics, FYM, gypsum, radish, seed quality, sodic water

Introduction

Radish (*Raphanus sativus* L.) $2n=2x=18$, is an important root vegetable crop belongs to Brassicaceae family. It is extensively grown in tropical, sub-tropical and temperate regions of the country. The edible part of radish is modified root (fusiform), which develops as primary root from hypocotyl. Radish is annual for its swollen taproot, which can be globular, tapering, or cylindrical and biennial for its seed production. It is cool season vegetable. Radish plays a vital role in the health and nutritional security of human beings in addition to improve the economy of the people of the country. It is used beneficial to controls damage to red blood cells, safeguards liver, gall bladder, increases appetite, prevents constipation, piles patients, liver trouble, jaundice, gall bladder and urinary disorders (Shrestha and Thapa, 2018) [1].

In Haryana, the area under vegetable crop is 4.46 lac ha with an annual production of 71.51 lac tonnes, whereas, the area under radish is 33056 ha with a production of 531511 tonnes during 2017-18 (Anonymous, 2018) [2]. Currently, India's share in the world's total vegetable production is 13.6% and demand for vegetables is projected to rise to 170 million tonnes by the year 2025 (Anonymous, 2011) [1]. The area and production of vegetables may be increased with proper management practices such as management of poor quality water and condition of soil. As poor quality water is one of the main constraint of any crop as well as in vegetable production, to overcome this some amendments like gypsum, phosphogypsum and farmyard manure can be used. But these amendments increase the cost of cultivation to the farmer. In this research, appropriate dose of various amendments were taken to get more and better quality yield under sodic irrigation water. Good quality water is the most critical and scarce resource for drinking, agriculture and industry, more so in arid and semi-arid regions. The continuous increase in the human and animal population has resulted in increased demand of water for domestic, industrial and agriculture needs. Presently, about 15% of India's water resources are consumed to meet out the domestic and industrial requirements and share of these two sectors will grow to about 30% by 2050 (Minhas and Samra, 2004) [8]. In the arid and semi-arid tracts of Haryana on an average about 37% ground water is good, 8% is marginal and 55% is poor in quality. Out of poor quality water, 11%, 18% and 26% are sodic, saline and saline-sodic, respectively (Singh *et al.*, 2004) [12]. The continuous and indiscriminate use of sodic water for irrigation as such causes soil sodicity and at the same time

adversely affects the growth quality, seed yield and economics of crops under most situations.

The vegetable crops are more remunerative, thus the area under vegetable crops is increasing every year. The productivity of radish in India is very less which may be due to unavailability of quality water in arid and semi-arid regions of the country. Good quality seed is also one of the important means to increase productivity in any seed crop (Verma and Phogat, 1994) [14]. Therefore, the present experiment was undertaken to study the quality and economics of radish under efficient management of FYM and gypsum irrigated with sodic water.

Materials and Methods

The present experiment was carried out during 2017-18 & 2018-19 at Vegetable Research Farm of the Department of Vegetable Science, CCS HAU, Hisar (Haryana) situated at 29°10' North latitude and 75°46' E longitude at mean elevation of 215.2 meter above mean sea level. The soil of the experimental field was sandy loam with 19.6% clay and cation exchange capacity 9.3 C mol/kg in 0-30 cm depth, soil field capacity 16.88%, permanent wilting point 7.98%, bulk density 1.57 g/cc and electrical conductivity 0.48 dSm⁻¹. The soil was low in organic carbon (0.42%), available nitrogen (125 kg ha⁻¹) and medium in available phosphorus (16 kg ha⁻¹).

The experiment was laid out in a randomized block design (factorial) replicated four times with treatments comprising of three levels of farmyard manure (0, 10 and 20 t/ha) and three levels of gypsum (0, 50 and 100% neutralization of RSC water with gypsum). For neutralization of 50% of RSC of irrigation water 5.0 t/ha gypsum and for 100% neutralization 10.0 t/ha gypsum was applied. The ionic composition and quality parameter of irrigation water used for raising the crop was CO₃²⁻ : 0.7 me/litre, HCO₃⁻ : 13.8 me/litre, Ca²⁺ : 0.5 me/litre, Mg²⁺ : 1.5 me/litre, Na⁺ : 15.8 me/litre and RSC: 12.5 me/litre. Carbonate and bicarbonate ions in irrigation water were determined by titration with standard H₂SO₄ using phenolphthalein and methyl orange as indicators. Sodium and potassium ions were estimated with the help of flame photometer, whereas, Versenate (EDTA) method of Cheng

and Bray (1951) [4] was followed for the determination of calcium and magnesium.

The 45 day old stecklings of radish cultivar Punjab Safed were planted in the last week of December month at a spacing of 60 cm row to row and 45 cm plant to plant in 3.0 x 3.0 m sized plots accommodating 33 plants per plot. The stecklings were prepared by cutting lower 2/3rd portion of root and trimming of the tops in the same proportion. Stecklings were dipped in 0.2% solution of carbendazim for 10 minutes. Since the weather components during the season greatly influence the growth, development, seed yield and quality of the crop considerably, therefore, the data recorded on various meteorological aspects during the course of experimentation from the Agro-Meteorological station located at Research Farm of the Department of Agro-Meteorology are presented in Figure 1 & 2.

The data were recorded during both the years of study for seed yield (q/ha), test weight (thousand seed weight in gram), standard germination percentage, seedling length (cm), seedling dry weight (mg), vigour index-I and vigour index-II in the department of Seed Science & Technology, CCSHAU, Hisar. Net returns were counted with the following formula as gross return-cost of cultivation and the benefit to cost ratio (B: C) was calculated as gross return divided by cost of cultivation. Taking the current sale price of radish seed (Rs. 300/kg) as well as expenditure on farmyard manure (Rs. 1000/t) and gypsum (Rs. 2664/t) in to consideration, the economics of each treatment was worked out.

The statistical analysis of data collected during the study was done by applying the technique of analysis of variance (ANOVA) as suggested by Gomez and Gomez (1984) [5] and Panse and Sukhatme (1961) [10]. All the statistical analysis was carried out by using OPSTAT statistical software. The critical difference for all the characters was calculated to compare the means of two treatments with the help of standard error for the differences of two treatments mean and tabulated value of 't' at 5 per cent level of significance and at error degree of freedom. The critical difference was calculated by multiplying SE d with t value at 5% error degree of freedom.

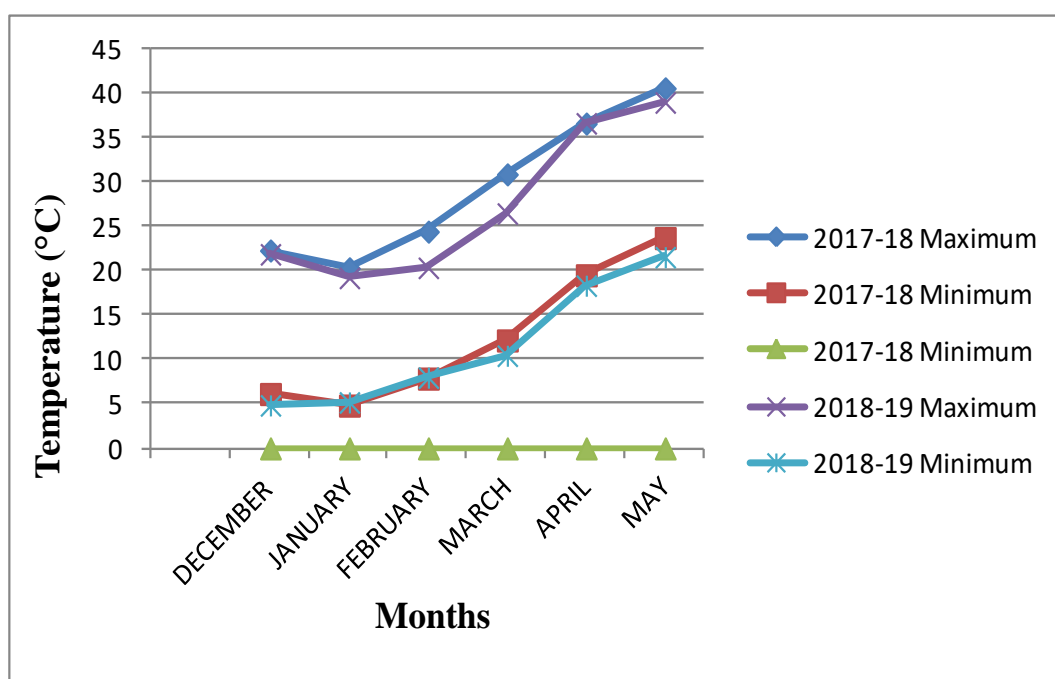


Fig 1: Monthly temperature (°C) in cropping season during 2017-18 & 2018-19

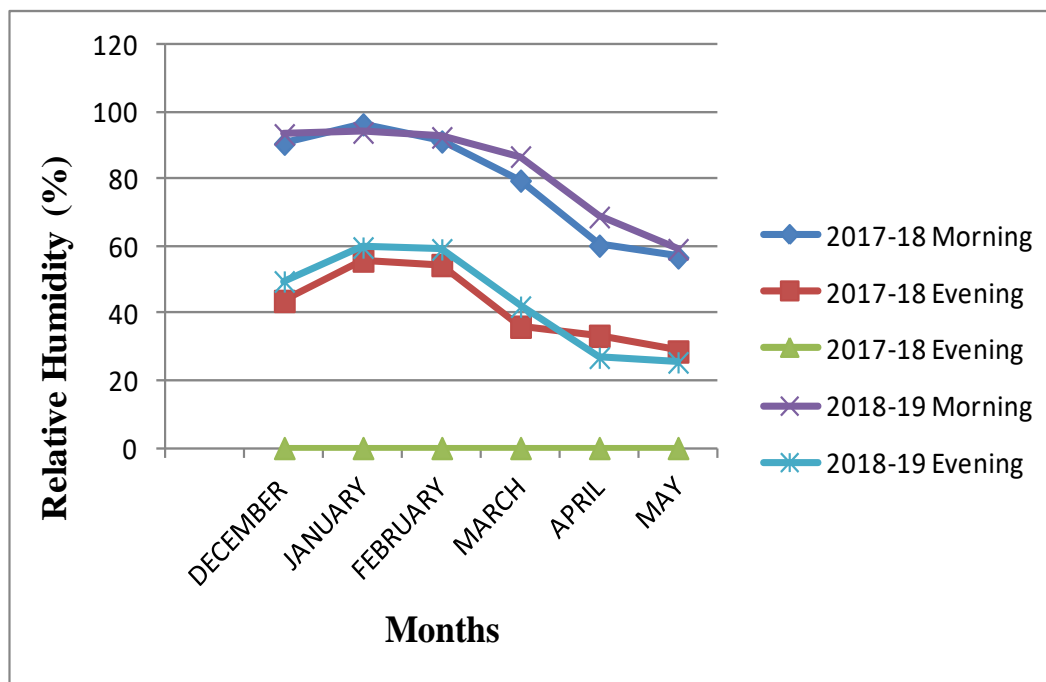


Fig 2: Monthly relative humidity (%) in cropping season during 2017-18 & 2018-19

Results and Discussion

Seed Yield: The radish seed yield (q/ha) in relation to farmyard manure (FYM) and gypsum application irrigated with sodic water is presented in Table 1. Among the FYM levels, highest seed yield (4.99 q/ha) was obtained under the treatment in which FYM was applied 20 t/ha and minimum (2.40 q/ha) in treatment where no FYM was applied. Among the gypsum levels, significantly maximum seed yield (4.85 q/ha) was obtained under the treatment in which 100% neutralization of RSC of irrigation water by gypsum applied at the rate of 10.0 t/ha and minimum seed yield (2.06 q/ha) in treatment in which no gypsum was applied to neutralize RSC of irrigation water. Among the interaction combinations of FYM and gypsum, the significantly maximum seed yield (6.62 q/ha) was obtained under the treatment where farmyard manure was applied at the rate of 20 t/ha with 100% neutralization of RSC of irrigation water by gypsum and minimum (1.32 q/ha) in control treatment where no farmyard manure and gypsum was applied. The increase in yield was more with gypsum and farmyard manure application. This showed the addition of farmyard manure alone is not sufficient to mitigate the harmful effect of sodicity. But in conjunction of gypsum with farmyard manure played a crucial role. This might be due to the fact that gypsum neutralized the sodicity effect of water and farmyard manure in general improved the physical properties of soil. The results are same findings of Kumar *et al.* (2017)^[7] and Kumar *et al.* (2019)^[6].

Seed Quality: The seed quality in relation to FYM and gypsum application irrigated with sodic water is presented in Table 1. Among the FYM levels, significantly maximum test weight (9.44 g), standard germination percentage (69.76%), seedling length (33.02 cm), seedling dry weight (11.03 mg),

vigour index-I (2341.0) and vigour index-II (779.49) were recorded under the treatment in which FYM was applied 20 t/ha and minimum in treatment where no FYM was applied. Whereas, among the gypsum levels, significantly highest test weight (9.22 g), maximum standard germination percentage (70.03%), seedling length (31.84 cm), seedling dry weight (11.09 mg), vigour index-I (2252.8) and vigour index-II (779.26) were recorded under the treatment 100% neutralization of RSC of irrigation water by gypsum at the rate of 10 t/ha and minimum in treatment in which no gypsum was applied to neutralize RSC of irrigation water.

Among the interaction combinations of farmyard manure and gypsum at different levels had significant effect on the maximum test weight (10.96 g), standard germination percentage (76.57%), seedling length (36.97 cm), seedling dry weight (11.56 mg), vigour index-I (2832.5) and vigour index-II (885.39) were noticed under the treatment F₂G₂ where farmyard manure was applied at the rate of 20 t/ha in combination with 100% neutralization of RSC by gypsum and minimum in control treatment where no farmyard manure and gypsum was applied. This might be due to the fact that farmyard manure and gypsum improved vegetative and reproductive growth of radish seedling under sodic water conditions. With improvement in vegetative growth, the photosynthetic process could have been improved, which resulted in heavier seeds. The standard germination percentage increased with the increase in levels of farmyard manure and gypsum since the neutralized water enhanced the plant growth parameters and also important constituents of seed quality, ultimately enhanced the seed vigour. In this respect, the present results conform to the findings of Bilekudari *et al.* (2005), Noreen and Ashraf (2008) and Tripathi *et al.* (2013)^[3, 9, 13].

Table 1: Effect of FYM and gypsum on seed yield and seed quality traits of radish (pooled data of 2017-18 & 2018-19)

Treatments	Seed yield (q/ha)	Test weight (g)	Standard germination (%)	Seedling length (cm)	Seedling dry weight (mg)	Vigour index-I	Vigour index-II
Farmyard manure							
F ₀	2.40	6.92	58.08	26.14	9.75	1526.2	570.91
F ₁	3.57	8.32	65.44	28.91	10.63	1905.5	699.02
F ₂	4.99	9.44	69.76	33.02	11.03	2341.0	779.49
SEm±	0.010	0.04	0.05	0.27	0.05	19.94	2.97
CD (p=0.05)	0.029	0.11	0.15	0.81	0.16	59.79	8.91
Gypsum							
G ₀	2.06	6.78	55.61	25.77	9.57	1437.7	534.61
G ₁	4.04	8.67	67.63	30.46	10.75	2082.1	735.55
G ₂	4.85	9.22	70.03	31.84	11.09	2252.8	779.26
SEm±	0.010	0.04	0.05	0.27	0.05	19.94	2.97
CD (p=0.05)	0.029	0.11	0.15	0.81	0.16	59.79	8.91
Interaction of FYM and gypsum							
F ₀ G ₀	1.32	6.21	52.17	23.97	8.39	1252.5	438.21
F ₀ G ₁	2.61	7.03	59.70	26.70	10.24	1595.3	611.65
F ₀ G ₂	3.26	7.51	62.37	27.73	10.62	1730.8	662.88
F ₁ G ₀	2.17	6.90	56.47	26.37	9.98	1490.1	564.13
F ₁ G ₁	3.86	8.84	68.70	29.53	10.82	2031.0	743.40
F ₁ G ₂	4.68	9.21	71.17	30.83	11.09	2195.2	789.52
F ₂ G ₀	2.69	7.23	58.20	26.97	10.33	1570.6	601.48
F ₂ G ₁	5.66	10.13	74.50	35.13	11.20	2619.9	851.60
F ₂ G ₂	6.62	10.96	76.57	36.97	11.56	2832.5	885.39
SEm±	0.017	0.07	0.09	0.47	0.09	34.54	5.15
CD (p=0.05)	0.050	0.20	0.26	1.40	0.27	103.55	15.43

Note: F₀= No farmyard manure, F₁= 10 t/ha farmyard manure, F₂= 20 t/ha farmyard manure; G₀= No gypsum, G₁= 50% of gypsum requirement, G₂= 100% of gypsum requirement

Economics: Economics of radish seed crop showed that among the different treatments, gypsum with farmyard manure recorded highest net returns and profitability of crops as presented in Table 2. The maximum net return (Rs. 92451 ha⁻¹) and benefit to cost ratio (1.87) obtained in the treatment combination of farmyard manure 20 t/ha with 100% neutralization of RSC by gypsum followed by treatment with farmyard manure 20 t/ha with 50% neutralization of RSC, whereas, lowest net return (Rs. -19885 ha⁻¹) and benefit cost ratio (0.67) recorded in the control treatment where no FYM and gypsum was applied. This might be due the hazards

caused by sodicity, which resulted in lower plant population and poor plant growth, ultimately resulting in very lower seed yield. The results are similar to the findings of Tripathi *et al.* (2013) and Kumar *et al.* (2017) [13, 6].

Conclusion

Based on two years study it can be concluded that the combined application of farmyard manure and gypsum minimizes the adverse effect of sodic water and also improve the seed yield and seed quality of radish.

Table 2: Economics of radish seed crop during 2017-18 & 2018-19 (Pooled data)

Treatment	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	Benefit cost ratio
F ₀ G ₀	59485	39600	-19885	0.67
F ₀ G ₁	72805	78300	5495	1.08
F ₀ G ₂	86149	97800	11651	1.14
F ₁ G ₀	69485	65100	-4385	0.94
F ₁ G ₁	82805	115800	32995	1.40
F ₁ G ₂	96149	140400	44251	1.46
F ₂ G ₀	79485	80700	1215	1.02
F ₂ G ₁	92805	169800	76995	1.83
F ₂ G ₂	106149	198600	92451	1.87

Note: F₀= No farmyard manure, F₁= 10 t/ha farmyard manure, F₂= 20 t/ha farmyard manure; G₀= No gypsum, G₁= 50% of gypsum requirement, G₂= 100% of gypsum requirement

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