

Vegetative Growth, Seed Yield and Seed Quality of Radish as Influenced by Farmyard Manure and Gypsum

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ABSTRACT: A field study was conducted at Research Farm of the Department of Vegetable Science and laboratory studies were conducted in the Department of Seed Science and Technology, CCS Haryana Agricultural University, Hisar. The three levels of farmyard manure 0, 10 and 20 t/ha and 0, 50 and 100% neutralization of sodic water by gypsum were laid out in factorial RBD with three replications. Individually and combination of FYM and gypsum significantly influenced the vegetative growth, seed yield and seed quality in radish. Among the interaction combinations, the plant height at 80 DAP (120.56, 124.9 & 122.76cm), number of leaves per plant at 80 DAP (23.93, 26.07 & 25.0), number of primary branches per plant (7.73, 9.0 & 8.37), number of seeds per pod (5.80, 6.60 & 6.20), seed yield (643.33, 681.11 & 662.22kg/ha), test weight (10.31, 11.61 & 10.96g), seed germination (74.87, 78.27 & 76.57%) and vigour index-I (2711, 2953.9 & 2832.5) were recorded significantly maximum in F₂G₂ treatment where 20 t/ha farmyard manure along with 100% neutralization of sodic irrigation water through gypsum. However, the earliest days to 50% flowering (58.33, 59 & 58.67) and maturity in days (123.67, 124.33 & 124) were recorded in F₀G₀ treatment combination where no FYM and gypsum was applied during 2017-18 and 2018-19 and pooled data, respectively.

Keywords: FYM, Gypsum, Sodic water, Seed quality, Seed yield, Vegetative growth.

INTRODUCTION

Radish (*Raphanus sativus* L.) is a popular root crop of Cruciferae family that is believed to be originated from central or western China and Indo-Pak subcontinent. It is a favourite crop of kitchen garden because of its short duration and easy to grow. It is grown for its fleshy edible roots, which are eaten raw as salad or cooked as vegetable. Radish is a good source of vitamin C, vitamin A, minerals and also considered as good appetizer (Hamid *et al.*, 2002). It is widely grown in tropical, sub-tropical and temperate regions of the country.

Radish is the most important seed crop in terms of high demand of quality commercial seed. For seed production, the winter cultivars require low temperature for flowering and seed setting at higher altitudes/ hills. However, some cultivars produce seed in plains also (HVAP 2011). Root to seed and seed to seed methods are used for seed production in radish. The steckling size affects the morphological characteristics of radish that ultimately affect the seed yield (Ahmed *et al.*, 1999). Productivity of radish in India is very less which may be due to absence of quality water in arid and semi-arid regions. The ground water is either saline or alkaline and almost 60% of it as such is not suitable for irrigation. Simultaneously, vegetables production is being threatened by increasing soil salinity or alkalinity particularly in irrigated areas, which provide 40% of the world food (FAO, 2001). Addition of organic

amendments to soil compaction, soil properties, increase microbial, improves aeration, supply of essential nutrients and organic matters which is highly accepted by the farmers (Prapagar *et al.*, 2012). Gypsum is the most commonly used amendment as it is availability at low cost. Joachim *et al.* (2007) reported the beneficial effect of combined use of farmyard manure and gypsum on the reclamation of sodic soils. Sodic water having low EC (<4 dSm⁻¹), high SAR (>10 mmol/litre) and high RSC (>2.5 me/litre), which may constitute most important source of supplemental irrigation provided so its use judiciously and carefully (Minhas, 2010). The poor-quality water 18, 11 and 26% are saline, sodic and saline-sodic, respectively (Singh *et al.*, 2004). Continuous use of sodic water for irrigation may cause soil salinization and sodification; it has adverse-effect on vegetative growth, seed yield and quality of crops (Satyavan *et al.*, 2006). The present experiment shows the effects of farmyard manure and gypsum on vegetative growth, seed yield and seed quality of radish crop.

MATERIALS AND METHODS

The experiment was laid out with treatments 0, 10 and 20 t/ha farmyard manure and 0, 50 and 100% neutralization of RSC by gypsum in factorial RBD with three replications. Punjab Safed cultivar was planted through stecklings in the December month at 60 × 45 cm spacing in 3.0×3.0 m sized plots. The stecklings

were prepared by cutting lower 2/3rd portion of root and top portion. The 45 days old seedlings were dipped in 0.2% carbendazim for 10 minutes before planted.

The data were noted from five randomly selected plants from each treatment of each replication for plant height (cm) and number of leaves/plant at 80 DAP, number of primary branches/plant, days to 50% flowering, maturity in days, number of seeds per pod, seed yield (kg/ha), test weight (g), seed germination (%) and vigour index-I. The field and laboratory observations were recorded during 2017-18 & 2018-19 years of experiment and their averaged on per plant basis. Statistically analyzed as per Gomez & Gomez (1984) and Panse & Sukhatme (1961) using programme developed by O.P. Sheoran. The seed germination percentage, vigour index-I and critical difference were calculated using formula given below:

$$\text{Seed germination (\%)} = \frac{\text{No. of seeds germinated}}{\text{Total no. of seeds sown}}$$

$$\text{Vigour index-I} = \text{Standard germination (\%)} \times \text{mean seedling length (cm)}$$

$$\text{Critical difference (CD)} = \text{SE d} \times \text{t value at 5\% error degree of freedom.}$$

RESULTS

The performance of 0, 10 and 20 t/ha of farmyard manure and 0, 50 and 100% neutralization of sodic water by gypsum was calculated to know the vegetative growth, seed yield and seed quality of radish. The results are presented in Table 1&2 for individual and interaction.

A. Vegetative growth

Plant height at 80 DAP (114.50, 118.71 & 116.60cm), number of leaves per plant at 80 DAP (21.36, 23.27 & 22.31) and number of primary branches per plant (6.98, 8.13 & 7.56) was found significantly maximum in the treatment in which 20 t/ha FYM was applied and minimum in control treatment where no FYM was applied. Among the gypsum levels, plant height at 80 DAP (113.42, 117.3 & 115.37cm), number of leaves per plant at 80 DAP (20.78, 22.53 & 21.66) and number of primary branches per plant (7.04, 8.29 & 7.67) was recorded maximum under the treatment in which 100% neutralization of RSC of irrigation water by gypsum applied at the rate of 10 t/ha and minimum where no gypsum was used during 2017-18, 2018-19 and pooled data, respectively.

Amongst the interaction combinations of FYM and gypsum, plant height at 80 DAP (120.56, 124.9 & 122.76 cm), number of leaves per plant at 80 DAP (23.93, 26.07 & 25.0) and number of primary branches per plant (7.73, 9.0 & 8.37) was found significantly maximum in the treatment where farmyard manure was applied 20 t/ha with 100% neutralization of sodic irrigation water by gypsum and minimum in control where no farmyard manure and gypsum was applied during both the year of study.

B. Phenological traits

Days to 50% flowering (45.44, 46.33 & 45.89) and days to maturity (109.22, 109.89 & 109.56) was exhibited significantly minimum in control treatment

where no farmyard manure was applied and maximum days was exhibited in the treatment where 20 t/ha FYM was used. Between the gypsum levels, days to 50% flowering (44.67, 45.11 & 44.89) and days to maturity (108.67, 109.44 & 109.06) was recorded significant minimum in the control treatment where farmyard manure was not applied and the maximum days was recorded in 20 t/ha FYM was used during both the years of research.

Interaction effect of FYM and gypsum, days to 50% flowering (42.33, 41.67 & 42.0) and days to maturity (104.67, 102.67 & 103.67) was recorded significantly least in the control treatment where no farmyard manure and gypsum (F₀G₀) and supreme days was recorded in the treatment combinations where 20 t/ha FYM with 100% neutralization of sodic water by gypsum during 2017-18, 2018-19 and pooled analysis, respectively.

C. Seed yield

Farmyard manure levels, number of seeds per pod (5.33, 6.04 & 5.69) and seed yield (483.83, 514.32 & 499.07 kg/ha) was obtained significantly higher in the treatment in which 20 t/ha FYM was applied and the lowest in control treatment where FYM was not functional. In the gypsum points, number of seeds per pod (5.36, 5.93 & 5.64) and seed yield (467.41, 503.46 & 485.43 kg/ha) was obtained significantly higher under 10 t/ha gypsum for 100% neutralization of sodic water and the least in where gypsum was not used during both years.

The interaction of FYM and gypsum, number of seeds per pod (5.80, 6.60 & 6.20) and seed yield (643.33, 681.11 & 662.22 kg/ha) was obtained significantly maximum under farmyard manure 20 t/ha along with 10 t/ha gypsum to 100% neutralization sodic water (F₂G₂) and the minimum in control treatment where farmyard manure and gypsum (F₀G₀) was not applied during 2017-18, 2018-19 and pooled analyzed, respectively.

D. Seed quality

The FYM stages, test weight (8.82, 10.05 & 9.44 g), seed germination (67.84, 71.67 & 69.76%) and vigour index-I (2224.8, 2457.2 & 2341) was observed statistically significant maximum in F₂ treatment where 20 t/ha FYM applied and the minimum in control treatment (F₀) where FYM was not used. In case of gypsum levels, test weight (8.71, 9.74 & 9.22g), seed germination (68.27, 71.80 & 70.03%) and vigour index-I (2152.8, 2352.8 & 2252.8) was exhibited significantly maximum in G₂ treatment where gypsum 10 t/ha applied while minimum in where gypsum was not used in experimentation during both the years.

Interactive result of FYM and gypsum, test weight (10.31, 11.61 & 10.96g), seed germination (74.87, 78.27 & 76.57%) and vigour index-I (2711, 2953.9 & 2832.5) was recorded significantly supreme in the 20 t/ha farmyard manure with 10 t/ha gypsum for 100% neutralization of sodic water and minimum found in control treatment where FYM and gypsum was not applied during 2017-18, 2018-19 and pooled data, respectively.

DISCUSSION

In the present studies, vegetative growth, phenological attributes, seed yield and seed quality of radish field

were noticed better during the second year than in first year of research, which might be due to more favourable weather conditions during second year of research has in 2018-19 (Table 1 & 2).

Table 1: Vegetative growth and phenological attributes of radish as influenced by farmyard manure and gypsum.

Treatment	Plant height (cm)			Number of leaves/plant			No. of primary branches/plant			Days to 50% flowering			Maturity in days		
	80 DAP			80 DAP											
FYM	2017-18	2018-19	pooled	2017-18	2018-19	pooled	2017-18	2018-19	pooled	2017-18	2018-19	pooled	2017-18	2018-19	pooled
F ₀	99.20	103.73	101.46	16.11	17.36	16.73	5.22	6.24	5.73	45.44	46.33	45.89	109.22	109.89	109.56
F ₁	106.42	111.07	108.75	18.29	19.80	19.04	6.24	7.33	6.79	49.67	50.56	50.11	115.89	117.56	116.72
F ₂	114.50	118.71	116.60	21.36	23.27	22.31	6.98	8.13	7.56	54.22	55.11	54.67	118.78	120.11	119.44
SEm±	0.25	0.34	0.24	0.14	0.05	0.08	0.03	0.07	0.04	0.26	0.26	0.25	0.21	0.20	0.18
CD (p=0.05)	0.76	1.03	0.73	0.42	0.14	0.23	0.09	0.21	0.13	0.78	0.79	0.76	0.63	0.59	0.55
Gypsum															
G ₀	97.18	101.76	99.47	15.58	16.82	16.20	4.89	5.76	5.32	44.67	45.11	44.89	108.67	109.44	109.06
G ₁	109.52	114.42	111.97	19.40	21.07	20.23	6.51	7.67	7.09	51.33	52.56	51.94	115.89	117.33	116.61
G ₂	113.42	117.3	115.37	20.78	22.53	21.66	7.04	8.29	7.67	53.33	54.33	53.83	119.33	120.78	120.06
SEm±	0.25	0.34	0.24	0.14	0.05	0.08	0.03	0.07	0.04	0.26	0.26	0.25	0.21	0.20	0.18
CD (p=0.05)	0.76	1.03	0.73	0.42	0.14	0.23	0.09	0.21	0.13	0.78	0.79	0.76	0.63	0.59	0.55
Interaction of FYM & Gypsum															
F ₀ G ₀	89.93	93.85	91.89	13.20	13.93	13.57	4.20	4.73	4.47	42.33	41.67	42.0	104.67	102.67	103.67
F ₀ G ₁	101.78	106.99	104.39	16.80	18.27	17.53	5.20	6.40	5.80	46.0	47.67	46.83	108.33	110.0	109.17
F ₀ G ₂	105.89	110.3	108.11	18.33	19.87	19.10	6.27	7.60	6.93	48.0	49.67	48.83	114.67	117.0	115.83
F ₁ G ₀	96.99	103.02	100.0	15.73	17.27	16.50	4.73	5.80	5.27	44.0	45.0	44.50	110.0	112.33	111.17
F ₁ G ₁	108.48	113.50	110.99	19.07	20.47	19.77	6.87	7.93	7.40	51.33	52.33	51.83	118.0	119.33	118.67
F ₁ G ₂	113.81	116.7	115.25	20.07	21.67	20.87	7.13	8.27	7.70	53.67	54.33	54.0	119.67	121.0	120.33
F ₂ G ₀	104.6	108.41	106.5	17.80	19.27	18.53	5.73	6.73	6.23	47.67	48.67	48.17	111.33	113.33	112.33
F ₂ G ₁	118.29	122.76	120.53	22.33	24.47	23.40	7.47	8.67	8.07	56.67	57.67	57.17	121.33	122.67	122.0
F ₂ G ₂	120.56	124.9	122.76	23.93	26.07	25.0	7.73	9.00	8.37	58.33	59.0	58.67	123.67	124.33	124.0
SEm±	0.44	0.59	0.42	0.24	0.08	0.13	0.05	0.12	0.07	0.45	0.46	0.44	0.36	0.34	0.32
CD (p=0.05)	1.32	1.78	1.27	0.72	0.24	0.40	0.16	0.37	0.22	1.35	1.37	1.32	1.09	1.01	0.95

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

Table 2: Seed yield and seed quality of radish as influenced by farmyard manure and gypsum.

Treatment	Number of seeds per pod			Seed yield (kg/ha)			Test weight (g)			Seed germination percentage			Vigour index-I		
	2017-18	2018-19	pooled	2017-18	2018-19	pooled	2017-18	2018-19	pooled	2017-18	2018-19	pooled	2017-18	2018-19	pooled
F ₀	4.22	4.64	4.43	231.11	248.64	239.88	6.42	7.41	6.92	56.27	59.89	58.08	1438.9	1613.4	1526.2
F ₁	4.84	5.27	5.06	344.57	369.46	357.01	7.89	8.74	8.32	63.60	67.29	65.44	1813.2	1997.7	1905.5
F ₂	5.33	6.04	5.69	483.83	514.32	499.07	8.82	10.05	9.44	67.84	71.67	69.76	2224.8	2457.2	2341.0
SEm±	0.03	0.03	0.02	1.21	1.32	0.97	0.07	0.07	0.04	0.05	0.08	0.05	22.09	19.97	19.94
CD (p=0.05)	0.08	0.09	0.06	3.64	3.94	2.91	0.20	0.21	0.11	0.15	0.25	0.15	66.22	59.86	59.79
Gypsum															
G ₀	4.02	4.44	4.23	201.36	210.99	206.17	6.32	7.24	6.78	53.78	57.44	55.61	1351.6	1523.9	1437.7
G ₁	5.02	5.58	5.30	390.74	417.98	404.36	8.11	9.22	8.67	65.67	69.60	67.63	1972.6	2191.5	2082.1
G ₂	5.36	5.93	5.64	467.41	503.46	485.43	8.71	9.74	9.22	68.27	71.80	70.03	2152.8	2352.8	2252.8
SEm±	0.03	0.03	0.02	1.21	1.32	0.97	0.07	0.07	0.04	0.05	0.08	0.05	22.09	19.97	19.94
CD (p=0.05)	0.08	0.09	0.06	3.64	3.94	2.91	0.20	0.21	0.11	0.15	0.25	0.15	66.22	59.86	59.79
Interaction of FYM & Gypsum															
F ₀ G ₀	3.40	3.73	3.57	129.63	134.07	131.85	5.85	6.57	6.21	50.47	53.87	52.17	1171.7	1333.2	1252.5
F ₀ G ₁	4.33	4.80	4.57	249.63	272.96	261.30	6.46	7.60	7.03	57.67	61.73	59.70	1503.2	1687.3	1595.3
F ₀ G ₂	4.93	5.40	5.17	314.07	338.89	326.48	6.96	8.05	7.51	60.67	64.07	62.37	1642.1	1819.5	1730.8
F ₁ G ₀	4.07	4.40	4.23	214.81	220.00	217.41	6.35	7.44	6.90	54.67	58.27	56.47	1403.2	1577.0	1490.1
F ₁ G ₁	5.13	5.60	5.37	374.07	398.00	386.04	8.46	9.23	8.84	66.87	70.53	68.70	1931.1	2131.0	2031.0
F ₁ G ₂	5.33	5.80	5.57	444.81	490.37	467.59	8.85	9.57	9.21	69.27	73.07	71.17	2105.3	2285.1	2195.2
F ₂ G ₀	4.60	5.20	4.90	259.63	278.89	269.26	6.74	7.71	7.23	56.20	60.20	58.20	1479.8	1661.4	1570.6
F ₂ G ₁	5.60	6.33	5.97	548.52	582.96	565.74	9.42	10.84	10.13	72.47	76.53	74.50	2483.6	2756.3	2619.9
F ₂ G ₂	5.80	6.60	6.20	643.33	681.11	662.22	10.31	11.61	10.96	74.87	78.27	76.57	2711.0	2953.9	2832.5
SEm±	0.05	0.05	0.04	2.10	2.28	1.68	0.11	0.12	0.07	0.09	0.14	0.09	38.26	34.59	34.54
CD (p=0.05)	0.14	0.15	0.11	6.30	6.83	5.04	0.34	0.37	0.20	0.27	0.43	0.26	114.69	103.69	103.55

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

A. Vegetative growth

The plant height at 80 DAP, number of leaves per plant at 80 DAP and number of primary branches per plant was recorded maximum individual and combined application of 20 t/ha farmyard manure and 100% neutralization of sodic water by gypsum (F₂G₂), which minimized the harmful effect of sodicity and increased

the availability of nutrients. The results are in conformation with the findings of Monika, (2012); Kaswan *et al.* (2017).

B. Phenological attributes

The minimum number of days to 50% flowering and maturity was recorded under control treatment where

no farmyard manure and gypsum was applied. The earliness of crop might be due to the stress conditions in control treatment. The results of present research are similar to the findings of Tripathi *et al.* (2013); Kumar *et al.* (2019).

C. Seed yield

Application of farmyard manure and gypsum individually and in combination significantly maximum obtained the number of seeds per pod and seed yield per hectare. This might be due to the fact that gypsum neutralized the sodicity effect of water and farmyard manure in general improved the physical properties like structure of soil. The results are same as findings of Khoja (2004); Bilekudari *et al.* (2005).

D. Seed quality

Farmyard manure and gypsum application individually and in interaction significantly affect the test weight, seed germination percentage and vigour index-I, which were recorded maximum in treatment where farmyard manure was used 20 t/ha along with 10 t/ha gypsum for 100% neutralization of RSC of water. This might be due to the fact that FYM and gypsum improved vegetative and reproductive growth and the photosynthetic process could have been improved, which resulted in heavier seeds. The standard germination percentage increased with increase in levels of FYM and gypsum since the neutralized water enhanced the plant growth parameters and important constituents of seed quality, ultimately enhanced seed vigour. Similar findings were observed by Noreen and Ashraf, (2008); Tripathi *et al.* (2013).

CONCLUSION

Thus, it is concluded that the F2G2 (20 t/ha FYM + 10 t/ha gypsum for 100% neutralization of sodic water) is effective in increasing the vegetative growth, seed yield and seed quality of radish crop.

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