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Effect of FYM and gypsum with high RSC water application on growth and phenological characters of radish (*Raphanus sativus* L.)

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Abstract

The experiment was conducted at Research Farm of the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar (Haryana) to find out the effect of high RSC water, farmyard manure and gypsum on growth and phenological parameters in radish field during the year 2017-18 & 2018-19. The 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) were laid out in a randomized block design (factorial) with thrice replication keeping a net plot size of 3.0x3.0 m and Punjab Safed cultivar was used for this study. The application of farmyard manure individually and in combination of farmyard manure and gypsum significantly influenced the vegetative growth and phenological parameters in radish crop under semi-arid conditions of Hisar. Among the interaction combinations, the plant height at 80 days after planting (cm) and at harvest (cm), number of leaves per plant at 80 days after planting, number of primary and secondary branches per plant at harvest were recorded significantly maximum in F_2G_2 treatment where farmyard manure was applied at the rate of 20 t/ha in combination with 100% neutralization of RSC by gypsum. However, minimum days to 50% flowering, days to 50% pod formation and days to maturity were recorded in F_0G_0 treatment combination where no farmyard manure and gypsum was applied during 2017-18 and 2018-19.

Key words: Radish, growth, phenological, FYM, gypsum and RSC water

Introduction

Radish (*Raphanus sativus* L.) is an important root vegetable crop widely grown in tropical, subtropical and temperate regions of India (Singh et al. 2018). In tropical regions, it is cultivated round the year, in subtropical regions during winters and in temperate regions during spring-summer. West Bengal, Haryana, Assam, Bihar, Chhattisgarh, Odisha, Jammu and Kashmir, Uttar Pradesh and Karnataka are the major growing states. 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. Further, the ground water is either saline or alkaline and almost 60% of it as such is not suitable for irrigation. Simultaneously, vegetable production including radish is being threatened by increasing soil salinity or alkalinity particularly in irrigated areas, which provide 40% of the world food (FAO 2001). Water used for irrigation varies greatly in quality depending upon type and quantity of salts dissolved in relatively small or significant amount. Marginally saline water can also be used for crop production successfully without any hazardous effect on soil and plant if sodium absorption ratio (SAR) is less since water with high SAR is out-rightly unfit for irrigation. Sodic water is characterized by its low EC (<4 dSm^{-1}), high SAR (>10 $mmol/L^{1/2}$) and high RSC (>2.5 me/L), which may constitute most important source of supplemental irrigation provided it is used judiciously and carefully. Such type of water is found in areas of Rewari, Jhajjar, Bhiwani, Mahendergarh, Gurugram, Sirsa, Kaithal, Fatehabad and Hisar districts of Haryana where on an average, about 37% groundwater is good, 8% is marginal and 55% is poor in quality. Out of poor-quality water, 18, 11 and 26% are saline, sodic and saline-sodic, respectively (Singh et al., 2004).

The continuous use of sodic water for irrigation as such causes soil salinization and sodification and at the same time, it adversely affects the growth and yield of crops under most of the situations. Their repeated applications over the years enhance calcium deficiency and deteriorate soil physical condition due to the presence of sodium and magnesium in excess quantity (Satyavan et al., 2006). Although, during emergency such water could be used with special management practices depending upon the rainfall, crop to be grown and soil type. Keeping in view,

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the present investigation has been conducted to study the effect of FYM and gypsum with high RSC water application on growth and phenological characters of seed crop of radish.

Materials and Methods

The present study was carried out at Vegetable Research Farm of the Department of Vegetable Science, CCS HAU, Hisar situated at situated 29°10'North latitude and 75°46' longitude at mean elevation of 215.2 meter above mean sea level during period of 2017-18 and 2018-19. 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 layer. The experiment was laid out 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) in a randomized block design (factorial) replicated thrice. The 45-day old stecklings of Punjab Safed cultivar of radish were planted in the month of December at a spacing of 60 cm (RxR) x 45 cm (PxP) in 3.0x3.0 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.

The data were recorded from five randomly selected plants from each treatment of each replication for plant height (cm) at 40, 80 days after planting and at harvest, number of leaves per plant at 40, 80 days after planting and at harvest, number of primary and secondary branches per plant at harvest, days to 50% flowering, days to 50% pod formation and days to maturity. The observations recorded were during both of the years of study (2017-18 & 2018-19) and averaged for computation on per plant basis and statistically analysed as per Gomez and Gomez (1984) and Panse and Sukhatme (1961) using the statistical programme developed by O.P. Sheoran.

Results and Discussion

The effect of three levels of farmyard manure (0, 10 and 20 t/ha) and three levels of gypsum (0, 50 and 100% neutralization of RSC) was studied to understand the growth and phenological characters of radish. The results obtained are presented in Table 1, 2 & 3 for individual effect and interaction, respectively.

Effect of farmyard manure: Among three levels of farmyard manure studied, varied differences in all the growth and phenological traits were found to be statistically significant (Table 1). Based on pooled data the growth rate revealed that maximum plant height was recorded under 20 t/ha farmyard manure (F_2) at 40, 80 DAP and at harvest *i.e.* 32.65 cm, 116.60 cm and 135.39 cm, respectively which was statistically superior to 10 t/ha farmyard manure (F_1) and control treatment (F_0). Maximum number of leaves per plant was noted in 20 t/ha farmyard manure (F_2) at 40 DAP (5.23), 80 DAP (22.31) and at harvest (2.66) which was significantly higher followed by 10 t/ha farmyard manure (F_1) and control (F_0). Significantly superior number of primary branches per plant (7.56) and number of secondary branches per plant (19.30) were registered with 20 t/ha farmyard manure (F_2) over 10 t/ha farmyard manure (F_1) and control treatment (F_0). This is might be due to application of farmyard manure which minimized the harmful effect of sodicity and increased the availability of nutrients. Similar trends were found during both the years of study. The results are in confirmation with the findings of Monika (2012), Upad--hyay et al. (2012) and Kumar et al. (2019). Based on pooled data results obtained and presented in Table 2, phenological traits revealed that minimum days to 50% flowering (45.89), days to 50% pod formation (70.94) and days to maturity (109.56) was recorded under the control (F_0) which was statistically superior as compared to10 t/ha farmyard

Table 1: Effect of different levels of FYM and gypsum on growth traits of radish (pooled data)

Treatments	Plant height (cm)			Number of leaves/plant			Number of primary branches/plant	Number of secondary branches/plant
	40 DAP	80 DAP	At harvest	40 DAP	80 DAP	At harvest		
Farmyard manure								
F_0	26.03	101.46	122.47	4.14	16.73	1.93	5.73	15.28
F_1	29.91	108.75	129.50	4.67	19.04	2.31	6.79	17.10
F_2	32.65	116.60	135.39	5.23	22.31	2.66	7.56	19.30
SEm±	0.20	0.24	0.12	0.03	0.08	0.04	0.04	0.05
CD (*p*=0.05)	0.61	0.73	0.36	0.10	0.23	0.11	0.13	0.15
Gypsum								
G_0	25.19	99.47	121.36	3.97	16.20	1.78	5.32	14.51
G_1	30.87	111.97	131.91	4.87	20.23	2.46	7.09	18.07
G_2	32.52	115.37	134.08	5.21	21.66	2.67	7.67	19.10
SEm±	0.20	0.24	0.12	0.03	0.08	0.04	0.04	0.05
CD (*p*=0.05)	0.61	0.73	0.36	0.10	0.23	0.11	0.13	0.15

Note: F_0= No farmyard manure, F_1= 10 t/ha, F_2= 20 t/ha; G_0= No gypsum, G_1= 50% of gypsum requirement, G_2= 100% of gypsum requirement

Table 2: Effect of different levels of FYM and gypsum on phenological traits of radish (pooled data)

Treatments	Days to 50% flowering	Days to 50% pod formation	Days to maturity
Farmyard manure			
F_0	45.89	70.94	109.56
F_1	50.11	73.50	116.72
F_2	54.67	76.28	119.44
SEm±	0.25	0.22	0.18
CD (p=0.05)	0.76	0.66	0.55
Gypsum			
G_0	44.89	70.06	109.06
G_1	51.94	74.50	116.61
G_2	53.83	76.17	120.06
SEm±	0.25	0.22	0.18
CD (p=0.05)	0.76	0.66	0.55

Note: F_0= No farmyard manure, F_1= 10 t/ha, F_2= 20 t/ha; G_0= No gypsum, G_1= 50% of gypsum requirement, G_2= 100% of gypsum requirement

manure (F_1) and 20 t/ha farmyard manure (F_2). The earliness of crop might be due to the stress conditions in control treatment. The results of present study are in close conformity to the findings of Tripathi et al. (2013) and Kumar et al. (2019).

Effect of gypsum: The application of different levels of gypsum had significant effect on growth and phenological traits of radish (Table 1). All the levels of gypsum increased the plant height as compared to control. Based on pooled data the growth rate revealed that maximum plant height was recorded under 100% neutralization of RSC (G_2) at 40, 80 DAP and at harvest *i.e.* 32.52 cm, 115.37 cm and 134.08 cm, respectively which was significantly superior to 50% neutralization of RSC (G_1) and control treatment (G_0). Maximum number of leaves per plant was noticed in 100% neutralization of RSC (G_2) treatment at 40 DAP (5.21), 80 DAP (21.66) and at harvest (2.67) which was significantly greater followed by 50% neutralization of RSC (G_1) and control (G_0). The significantly superior number of primary (7.67) and secondary branches per plant (19.10) were observed in 100% neutralization of RSC (G_2), while minimum fewer than 50% neutralization of RSC (G_1) and control (G_0). This might be due to the fact that gypsum neutralized the sodicity effect of water. Parallel trends were found during both the years of study. The similar effects of gypsum have been reported by Kaswan et al. (2017) and Kumar et al. (2017). Based on pooled data results presented in Table 2, phenological traits exposed that days to 50% flowering (44.89), days to 50% pod formation (70.06) and days to maturity (109.06) was recorded minimum in control treatment (G_0) which was statistically superior as compared to 50% neutralization of RSC (G_1) and 100% neutralization of RSC (G_2). It might be due to stress conditions the days came earlier in control and fewer than 100% neutralization of RSC (G_2) treatment came later due to neutralization of RSC, the plants showed full vegetative and reproductive phase. The results are in accordance with those of Tripathi et al. (2013) and Upadhyay et al. (2012).

Interaction effect: Among the interaction combinations farmyard manure and gypsum at different levels had significant effect on the plant height at 80 days after planting and at harvest, number of leaves per plant at 80 days after planting, number of primary and secondary branches per plant, days to 50% flowering, days to 50% pod formation, days to maturity of radish (Table 3). The maximum plant height at 80 days after planting (122.76) and at harvest (141.12), number of leaves per plant at 80 days after planting (25.0), number of primary (8.37) and secondary branches per plant (21.13) were recorded under combined application of farmyard manure at the rate of 20 t/ha and 100% neutralization of RSC by gypsum (F_2G_2), which minimized the harmful effect of sodicity and increased the availability of nutrients. Similar trends were found during both the

Table 3: Interaction effect between FYM and gypsum on growth and phenological characters of radish (pooled data)

Treatments	Plant height (cm)			Number of leaves/plant			Number of primary branches/plant	Number of secondary branches/plant	Days to 50% flowering	Days to 50% pod formation	Days to maturity
	40 DAP	80 DAP	At harvest	40 DAP	80 DAP	At harvest					
F_0G_0	21.28	91.89	115.45	3.40	13.57	1.47	4.47	11.80	42.0	67.33	103.67
F_0G_1	27.57	104.39	124.60	4.32	17.53	2.00	5.80	16.50	46.83	71.50	109.17
F_0G_2	29.25	108.11	127.36	4.72	19.10	2.33	6.93	17.53	48.83	74.0	115.83
F_1G_0	25.73	100.0	123.05	3.98	16.50	1.67	5.27	14.63	44.50	69.83	111.17
F_1G_1	31.17	110.99	131.68	4.92	19.77	2.53	7.40	18.03	51.83	74.67	118.67
F_1G_2	32.82	115.25	133.76	5.12	20.87	2.73	7.70	18.63	54.0	76.0	120.33
F_2G_0	28.56	106.5	125.58	4.52	18.53	2.20	6.23	17.10	48.17	73.0	112.33
F_2G_1	33.88	120.53	139.47	5.38	23.40	2.83	8.07	19.67	57.17	77.33	122.0
F_2G_2	35.50	122.76	141.12	5.80	25.0	2.93	8.37	21.13	58.67	78.50	124.0
SEm±	0.35	0.42	0.21	0.06	0.13	0.07	0.07	0.09	0.44	0.38	0.32
CD (p=0.05)	NS	1.27	0.63	NS	0.40	NS	0.22	0.26	1.32	1.14	0.95

Note: F_0= No farmyard manure, F_1= 10 t/ha, F_2= 20 t/ha, G_0= No gypsum, G_1= 50% of gypsum requirement, G_2= 100% of gypsum requirement, NS= Non-significant

years of study. The results are in conformation with the findings of Monika (2012), Upad--hyay et al. (2012), Kaswan et al. (2017), Kumar et al. (2017) and Kumar et al. (2019).

The minimum days to 50% flowering (42.0), days to 50% pod formation (67.33) and days to maturity (103.67) were noted in F_0G_0 treatment combination where no farmyard manure and gypsum was applied. ***It clearly indicated that under nutrient deficient environment, radish plants tried to complete the life cycle early as compared to normal conditions. This was due to the fact that d***ays taken to flowering are decided by C: N ratio. The plants tend to flower earlier with higher C: N ratio. Higher nutrients availability significantly delayed the flowering in radish crop. The results are in confirmation with the findings of Tripathi et al. (2013), Bhardwaj and Kumar (2016) and Kumar et al. (2019). From the above findings, it is concluded that the application 20 t/ha farmyard manure individually and in combination of 20 t/ha farmyard manure and 100% neutralization of RSC by gypsum was found effective for raising a successful seed crop of radish since both improved the vegetative growth, phenological characters, seed yield, seed quality attributes and chemical properties of soil during both years of study.

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मूली की वृद्धि और ऋतु जैविकी मापदंडों पर उच्च आरएससी जल, गोबर की खाद और जिप्सम के विभिन्न स्तरों वाले प्रयोग के प्रभाव को ज्ञात करने के लिए सब्जी विज्ञान विभाग, चौधरी चरण सिंह हरियाणा कृषि विश्वविद्यालय, हिसार (हरियाणा) के अनुसंधान प्रक्षेत्र पर वर्ष 2017–18 और 2018–19 के दौरान परीक्षण किया गया। गोबर के खाद के तीन स्तरों (0, 10 और 20 टन/हेक्टेयर) और जिप्सम के तीन स्तरों (0, 50 और 100 प्रतिशत आरएससी के बेअसर) का अध्ययन रैण्डोमाइज्ड ब्लॉक डिजाइन (फैक्टोरियल) में तीन प्रतिकृतियों में किया गया। अध्ययन के लिए भूखण्ड का आकार 3 × 3 मीटर और मूली की किस्म पंजाब सफेद का उपयोग किया गया। गोबर की खाद एकल तथा गोबर की खाद व जिप्सम के संयोजन ने मूली की फसल में वानस्पतिक वृद्धि और ऋतु जैविकी मापदण्डों को सार्थक रूप से हिसार की अर्द्ध शुष्क परिस्थिति में प्रभावित किया। परस्पर संयोजन के बीच, बीज बुवाई के 80 दिनों उपरान्त पौध की ऊँचाई (सेन्टी मीटर) और कटाई के समय ऊँचाई (सेन्टी मीटर), रोपड़ के 80 दिनों बाद प्रति पौध पत्तियों की संख्या, कटाई के समय प्राथमिक तथा माध्यामिक शाखाओं की संख्या प्रति पौध एफ–2 जी–2 में अधिकतम पायी गई जबकि जिप्सम द्वारा आरएससी के 100 प्रतिशत निराकरण के साथ संयोजन में 20 टन प्रति हेक्टेयर की दर से गोबर की खाद प्रयोग किया गया। हांलाकि, न्यूनतम दिनों में 50 प्रतिशत पुष्पन, 50 प्रतिशत फली बनने और परिपक्वता के दिन एफ–0 जी–0 उपचार संयोजन में दर्ज किया गया जो वर्ष 2017–18, 2018–19 के दौरान गोबर की खाद और जिप्सम का प्रयोग नहीं किया गया था।

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