



Effect of FYM and sources of water on growth, yield and soil chemical properties after harvest of wheat (*Triticum aestivum* L) in salt affected soils

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Paper received: 13.06.2020

Revised received: 03.10.2020

Accepted: 30.10.2020

Abstract

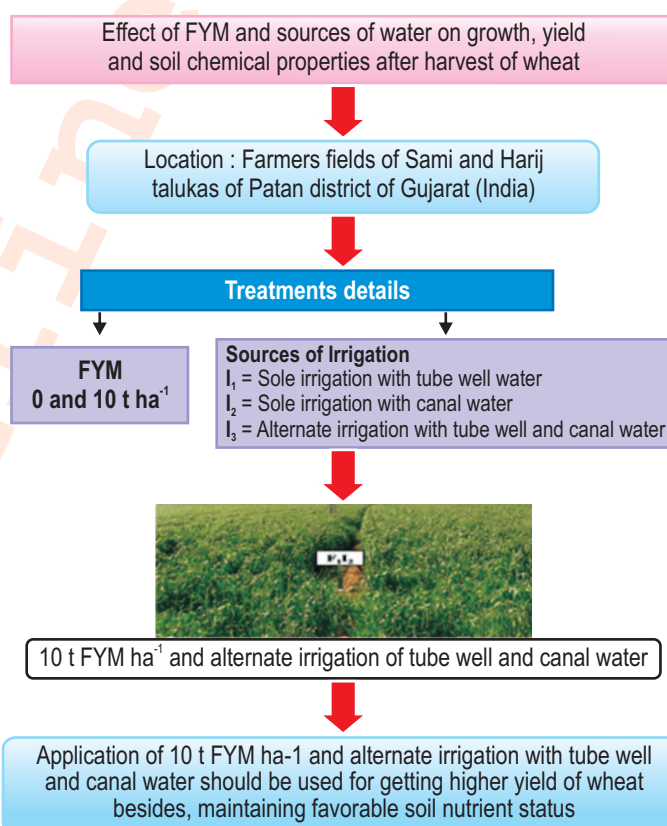
Aim: To study the effect of FYM and different sources of water on growth, yield and soil chemical properties after harvest of wheat (*Triticum aestivum* L) in salt affected soils of Gujarat.

Methodology: A field trial was conducted with two levels of FYM viz., F_0 : 0 t FYM ha⁻¹ and F_1 : 10.0 t FYM ha⁻¹ and three sources of irrigation viz., I_1 : Sole application of tube well water, I_2 : Sole application of canal water and I_3 : Alternate application of tube well and canal water which was replicated four times in factorial randomized block design on wheat variety Raj-3077.

Results: The treatment 10 t FYM ha⁻¹ achieved significantly superior grain (5130 kg ha⁻¹ Location-I and 4940 kg ha⁻¹ Location-II) and straw (6517 kg ha⁻¹ Location-I and 6252 kg ha⁻¹ Location-II) yields of wheat over no FYM use on pooled results. In contrast, the alternate application of tube well and canal water gave significantly higher grain yield (4458 kg ha⁻¹ Location-I and 4991 kg ha⁻¹ Location-II) of wheat over sole use of tube well as well as canal water on pooled basis.

Interpretation: Stand on this study it is accomplished that use of 10 t FYM ha⁻¹ and rotate application of tube well and canal water should be used for receiving superior yield and net income from wheat as well as maintaining encouraging soil nutrient status.

Key words: Canal water, Farm yard manure, Wheat



How to cite : Malav, J.K., R.P. Pavaya and S. Kumar: Effect of FYM and sources of water on growth, yield and soil chemical properties after harvest of wheat (*Triticum aestivum* L) in salt affected soils. *J. Environ. Biol.*, **41**, 1696-1702 (2020).

Introduction

Wheat is one of the most important staple food and generally cultured chief cereal crop equally in acreage and in production amidst the grain crops of the globe. In excess of one third of the human population is fed by wheat (Sajid *et al.*, 2017). In India, wheat is second crucial crop food crop, rice being the first. Wheat has a relatively high content of niacin and thiamine. Wheat proteins have meticulous significance besides, their consequence in nutrition. In India, the total cultivable area of wheat is 30.63 m ha⁻¹ with the production of 99.60 mt and average productivity of 3047 kg ha⁻¹ (Agricultural Statistics at a Glance, 2018). Low production of wheat in Gujarat in contrast to Punjab and Haryana is due to arid and semi-arid climate. Salt affected soils are of broad incidence in such regions of Gujarat. These soils are extremely awkward mostly due to their salt substances and low nutrient status. Gujarat constitutes 1.05 million hectares with a production of 3.13 million tones and efficiency of 2932 kg ha⁻¹ (Agricultural Statistics at a Glance, 2018). In Gujarat, wheat is being cultured beneath irrigated as well as rain fed situation. Gujarat stands 8th in area, 6th in production and 5th in terms of wheat yield per hectare in India. The majority wheat rising districts of are Banaskantha, Mehsana, Kheda, Ahmedabad, Junagadh, Rajkot, Bhavnagar and Sabarkantha.

In India, totally salt exaggerated area is 6.74 m ha out of which 3.79 and 2.95 m ha are of sodic and saline soils, respectively. Salinity is one of the critical abiotic stress factors, which reduces crop production in arid and semi-arid areas, as it contains sufficient salt in the root zone to change the growth of crops. In addition, low precipitation is insufficient for leaching, salt below root zone level (Zhao *et al.*, 2007). Extreme soluble salts in the root zone slow down plant roots from withdrawing water from adjacent soil even though sufficient plant available water is present in soil. In addition to this, soil salinity has the ability to change plant growth through advanced concentrations of toxic ions in the soil (Dikilitas, 2012). Indeed ion toxicities are caused by the accretion of sodium, chloride and boron in the tissue of transpiring leaves to destructive levels.

The underground water quality of North Gujarat Agro climatic Zone -IV (Patan, Banaskantha, Kutchh, Mehsana districts) is poor; more than 50 % samples showed higher salinity as compared to sodicity (C_sS₂ class). Using these waters for irrigation may lead to secondary salinization in the soil and ultimately affecting the productivity of soil in this region. The problem of soil salinization can only be solved by leaching off dissolved salts with good quality of irrigation water beyond the root zone, which is quite impossible as there is a limited supply good quality water as well as hardpan in sub-surface region, which restricts deep percolation of water and soluble salts. Hence, poor quality water can be managed by adding of farm yard manure (organic amendments) to the soil and conjunctive use of canal water with tube well water which limits soil salinization.

Considering the above facts, the effect of FYM and sources of water on growth, yield and soil chemical properties after harvest of wheat in salt affected soil was investigated in this study.

Materials and Methods

A field trial was carried out at Sami and Harij talukas of Patan district, Gujarat during rabi period of 2014-15, 2015-16, 2016-17 and 2017-18. The trial was carried out under the direction of Department of Agricultural Chemistry and Soil Science, C.P. College of Agriculture, S.D. Agricultural University, Sardarkrushinagar, Gujarat (India). The trial was taken with two levels of FYM viz., F₀: 0 t FYM ha⁻¹ and F₁: 10.0 t FYM ha⁻¹ and three sources of irrigation viz., I₁: Sole application of tube well water, I₂: Sole application of canal water and I₃: Alternate application of tube well and canal water which was simulated four times with randomized block design with factorial concept and wheat variety Raj-3077 was sown.

Geographically, Sami and Harij are located at 23.6851° N latitude, 71.7786° E longitudes at an elevation of 84 m. The climate of Sami-Harij region is semi-arid and sub-tropical with hot summer and cold winter. In this area, normally monsoon commences in the month of June and retreats in September. The majority of the rainfall is conventional on or after south-west monsoon currents. The total rainfall of region was ranged between 552-994 mm. Average minimum and maximum temperature of the year of study was 19.5°C and 32.5°C, respectively. Analytical data pertaining to initial soil fertility status, water quality and nutrient content in FYM are given in Table 1.

The nutrient eminence of soil, representative soil sample (0-15 cm depth) from three spots of every net plot after harvest of wheat crop were composed, composited and air dried. These samples were then grinded with wooden mortar and pestle and passed through 2.0 mm sieve and were investigated for EC, pH, organic carbon (%), available P₂O₅ and K₂O status in soil as per standard method. The soil of the trial field was loamy sand in texture, alkaline in nature and soluble salt content under limit. It was low in organic carbon, medium in available P₂O₅ and medium to high in available K₂O status. The yield attributes and yield parameters viz., seed yield, straw yield, no. of effective tillers/plant, plant height (cm), length of spike (cm) and no. of seed/spike recorded from net plot and changed on hectare basis. All the data for different parameters were statistically analyzed using Fishers' analysis of variance (ANOVA) method and the treatments were compared at 5% level of significance.

Results and Discussion

The perusal of data given in Table 2 and 3 revealed that application that application of FYM had a significant effect on grain and straw yield, no. of tillers, length of spike, number of seeds/spike and protein content of wheat during all the individual

Table 1 : Analytical data of initial soil fertility, water quality and nutrient content in FYM

A. Initial soil fertility status (Location-I) (Soil type: Loamy sand)						
	Nutrient	Methods of analysis and Reference(s)	2014-15	2015-16	2016-17	2017-18
1.	pH _(1:2.5)	Potentiometry Jackson (1973)	7.51	7.48	7.29	7.39
2.	EC _(1:2.5) (dSm ⁻¹)	Conductometry Jackson (1973)	2.65	2.48	2.54	2.39
3.	Organic Carbon (OC) %	Modified Walkley and Black method Walkley and Black (1934)	0.29	0.33	0.34	0.31
4.	Available P ₂ O ₅ (kg ha ⁻¹)	Olsen's method (0.5 M NaHCO ₃ , pH 8.5) Olsen <i>et al.</i> (1954)	43.25	40.25	43.65	38.98
5.	Available K ₂ O (kg ha ⁻¹)	Flame photometry method Jackson (1973)	271	265	259	270
B. Water quality analysis						
	Source	EC (µmhos cm⁻¹)	pH	SAR	Chloride (meq l⁻¹)	Class
1.	Tube well water	4900.0	7.50	9.08	29.10	C ₄ S ₁
2.	Canal water	230.0	7.95	1.36	1.10	C ₁ S ₁
C. Initial soil fertility status (Location-II) (Soil type: Loamy sand)						
	Nutrient	Methods of analysis and Reference(s)	2014-15	2015-16	2016-17	2017-18
1.	pH _(1:2.5)	Potentiometry Jackson (1973)	7.95	8.08	7.91	7.85
2.	EC _(1:2.5) (dSm ⁻¹)	Conductometry Jackson (1973)	1.39	1.28	1.31	1.24
3.	Organic Carbon %	Modified Walkley and Black method Walkley and Black (1934)	0.32	0.29	0.35	0.31
4.	Available P ₂ O ₅ (kg ha ⁻¹)	Olsen's method (0.5 M NaHCO ₃ , pH 8.5) Olsen <i>et al.</i> (1954)	36.25	40.65	37.25	41.35
5.	Available K ₂ O (kg ha ⁻¹)	Flame photometry method Jackson (1973)	275	251	265	271
D. Water quality analysis						
	Source	EC (µmhos cm⁻¹)	pH	SAR	Chloride (meq l⁻¹)	Class
1.	Tube well water	2950	8.45	13.34	40.10	C ₄ S ₂
2.	Canal water	230.0	7.95	1.36	1.10	C ₁ S ₁
Average nutrient content in FYM (%)						
	2014-15	2015-16	2016-17	2017-18		
Nitrogen	0.55	0.48	0.41	0.61		
P ₂ O ₅	0.17	0.22	0.19	0.18		

years as well as on pooled basis at both the locations. Application of 10 t FYM ha⁻¹ gave significantly higher yield of grain (5130 and 4940 kg ha⁻¹) and straw (6517 and 6252 kg ha⁻¹), no. of tillers (6.56 and 6.45), length of spike (7.51 and 7.83 cm), no. of seeds/spike (33.69 and 33.78) and protein content (13.24 and 13.02%) in wheat on pooled basis at both the locations. It is fairly apparent that the maximum grain and straw yield was recorded under at 10 t FYM ha⁻¹. Starting these results it may be subjective that the expensive effect of FYM is due to its association in supplying additional plant nutrients, enhancement of soil physical, chemical and biological progression in soil. Enhancement in the soil structure due to FYM application leads to enhanced environment for root development. Farm yard manure also advances soil water

holding ability. The fact that the use of organic fertilizers to get better soil structure, nutrient exchange and to maintain soil health has elevated advantage of organic farming. The use of FYM alone as an alternate for inorganic fertilizer is not sufficient to maintain the present levels of crop effectiveness of high yielding varieties. In common, the use of natural amendments such as crop residues and/or FYM significantly augments soil organic carbon (Yadav *et al.*, 2000). In diminutive, improved nutrient composition of wheat on applying FYM may be due to enhanced availability of nutrients under sufficient provider of available nutrients.

The statistics obtainable in Table 2 and Table 3 specify that different sources of irrigation had a significant effect on grain

Table 2 : Effect of different levels of FYM and sources of irrigation on yield and yield attributes of wheat (Pooled data of 4 years)

Treatments	Location-I						
	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	No. of effective tillers/plant	Plant height (cm)	Length of spike (cm)	No. of seed/ spike	Protein content (%)
Levels of FYM (t ha⁻¹)							
F ₀ : 0	4481	5723	6.13	69.75	7.13	31.31	12.58
F ₁ : 10	5130	6517	6.56	71.84	7.51	33.69	13.24
S. Em +	54	62	0.10	1.08	0.11	0.57	0.20
CD (0.05)	151	176	0.28	NS	0.32	1.61	0.56
Sources of irrigation							
I ₁	4015	5879	5.99	69.39	7.00	31.15	12.63
I ₂	4336	6169	6.42	71.01	7.37	32.88	12.96
I ₃	4458	6313	6.63	71.99	7.59	33.46	13.13
S. Em +	114	76	0.12	1.33	0.14	0.70	0.24
CD (0.05)	343	216	0.34	NS	0.39	NS	NS
CV %	7.53	7.06	10.65	10.60	10.58	12.17	10.58
Interactions							
FYM x Irrigation	NS	NS	NS	NS	NS	NS	NS
FYM x Year	NS	NS	NS	NS	NS	NS	NS
Irrigation x Year	NS	NS	NS	NS	NS	NS	NS
FYM x Irrigation x Year	NS	NS	NS	NS	NS	NS	NS

and straw yield, no. of effective tillers, no. of seeds/spike and length of spike of wheat on pooled basis at both sites. The rotate application of tube well and canal water gave significantly higher grain (4458 and 4991 kg ha⁻¹) and straw (6313 and 6254 kg ha⁻¹) yield, no. of effective tillers (6.63 and 6.35), length of spike (7.59 and 7.83 cm) and no. of seeds/spike (34.06 Location-II) of wheat over sole application of tube well water on pooled basis at both sites, but it was at par with the sole application of canal water in case of grain yield (4336 kg ha⁻¹) of wheat at Location-I. From the data presented in Table 2 and Table 3, it could be inferred that sources of irrigation did not show any significant change in plant height and total number of seeds per spike on pooled basis at both the locations. Yield components and grain yield were reduced significantly with the sole application of tube well water. Sole application of canal water did not show any significant effect of on growth as well as yield and yield attributes except grain yield of wheat at location-I. The results illustrate that use of alternate irrigation of tube well and canal water, the tube well water hold high quantity of mineral elements and unlike kind of salts and the supply of next irrigation through canal water dissolves all mineral and salts present in the soil. Therefore crop utilized all the essential elements mineral and salts, while other perilous salts were leached downward beneath the root zone. Extra salts are impulsive when less irrigation water was applied, particularly if accompanied by lack of rain.

Reduction in grain yield and yield components owed to salinity has also been pragmatic by Saqib *et al.* (2004) and Ghogdi *et al.* (2012). Amongst the morphological attributes,

utmost reduction was pragmatic in number of tillers per plant which may be due to incorporation of tremendous salts by the plants, which ultimately pretentious the plant growth expansively by declining the quantity of photosynthetic, water or supplementary growth factors (Khathar and Kuhad, 1999). Owing to higher concentrations of salts in the leaves, metabolic processes like photosynthesis and protein synthesis are unconstructively affected leading to condensed grain weight. A positive correlation exists between Na⁺ keeping out and salt accumulation in lots of crops together with wheat (Shafi *et al.*, 2010; Ghogdi *et al.*, 2012). Under saline conditions, there is unreceptive diffusion of Na⁺ ions during injured membranes and decreased effectiveness of prohibiting mechanism which results in elevated concentration of sodium in leaf sap (Leidi and Saiz, 1997). Potassium influx transporters arbitrate sodium influx into root cells (Rabhi *et al.*, 2007) under saline condition. There was encouraging association of grain yield and quality with the alternating application of canal water and tube well water in this study which shows that dissolved soluble salts and supply of plant nutrients to plant sustain constructive ionic composition helps to tolerate saline conditions.

The data presented in Table 4 and Table 5 reveal that individual effect of FYM and sources of irrigation was found to be non-significant in case of soil pH and available K₂O content in soil after harvest of wheat on pooled basis at both the locations, except available K₂O content at location II. The statistics (Table 4 and Table 5) illustrate that the application of 10 t FYM ha⁻¹ was found to be significant on electrical conductivity of soil after

Table 3 : Effect of different levels of FYM and sources of irrigation on yield and yield attributes of wheat (Pooled data of 4 years)

Treatments	Location-II						
	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	No. of effective tillers/plant	Plant height (cm)	Length of spike (cm)	No. of seed/ spike	Protein content (%)
Levels of FYM (t ha⁻¹)							
F ₀ : 0	4310	5422	5.84	67.79	7.19	31.49	12.28
F ₁ : 10	4940	6252	6.45	70.70	7.83	33.78	13.02
S. Em +	66	106	0.09	1.09	0.13	0.57	0.20
CD (0.05)	188	299	0.25	NS	0.37	1.62	0.58
Sources of irrigation							
I ₁	4231	5430	5.94	68.09	7.22	31.72	12.47
I ₂	4653	5827	6.15	69.37	7.48	32.12	12.62
I ₃	4991	6254	6.35	70.29	7.83	34.06	12.85
S. Em +	81	129	0.11	1.34	0.16	0.70	0.25
CD (0.05)	230	366	0.30	NS	0.45	1.98	NS
CV %	9.96	12.54	9.84	10.95	11.98	12.13	11.23
Interactions							
FYM x Irrigation	NS	NS	NS	NS	NS	NS	NS
FYM x Year	NS	NS	NS	NS	NS	NS	NS
Irrigation x Year	NS	NS	NS	NS	NS	NS	NS
FYM x Irrigation x Year	NS	NS	NS	NS	NS	NS	NS

Table 4: Effect of different levels of FYM and sources of irrigation on the nutrient status after harvest of crop (Pooled data of 4 years)

Treatments	Location-I				
	pH	EC(dSm ⁻¹)	OC(%)	Available P ₂ O ₅ (kg ha ⁻¹)	Available K ₂ O (kg ha ⁻¹)
Levels of FYM (t ha⁻¹)					
F ₀ : 0	7.44	1.61	0.32	38.92	261
F ₁ : 10	7.26	1.46	0.37	44.72	273
S. Em +	0.08	0.02	0.01	0.79	4
CD (0.05)	NS	0.06	0.02	2.25	NS
Sources of irrigation					
I ₁ : Sole irrigation with tube well water	7.51	2.60	0.32	39.86	263
I ₂ : Sole irrigation with canal water	7.26	0.67	0.35	42.43	268
I ₃ : Alternate irrigation with tube well and canal water	7.29	1.34	0.36	43.18	270
S. Em +	0.10	0.02	0.01	0.97	5
CD (0.05)	NS	0.07	0.02	2.75	NS
CV %	7.50	9.06	12.87	13.17	11.34
CD (Y x T)	NS	NS	NS	NS	NS

harvest of wheat on pooled basis at both the locations. Significantly lowest electrical conductivity (1.46 dSm⁻¹ and 0.75 dSm⁻¹) was observed with the application of 10 t FYM ha⁻¹ in soil after harvest of wheat on pooled basis at both the locations. The data presented in Table 4 and Table 5 reveal that application of FYM either alone or in combination with NPK resulted in considerable changes of soil organic carbon content in the surface soil layer (0–15 cm) than that of unfertilized control as well as NPK treated plots. The plots that received 10 t FYM ha⁻¹ registered significantly higher (0.34% to 0.37%) build-up in soil organic carbon over unfertilized control plots in the surface soil

on pooled basis at both sites. The data presented in Table 4 and Table 5 reveal that the application of 10 t FYM ha⁻¹ gave significantly higher available P₂O₅ content (44.72 kg ha⁻¹ and 40.84 kg ha⁻¹) in soil after harvest of crop over control on pooled basis at both the locations. The data obtainable in Table 5 revealed that the application of 10 t FYM ha⁻¹ gave significantly higher available K₂O content (273 kg ha⁻¹) in soil after harvest of crop over control on pooled basis at site II. The reduction in soil pH in the FYM applied soil might have resulted due to liberated organic acids and carbon dioxide (CO₂) into the soil through the decay of the manure. Invention of aliphatic and aromatic hydroxyl

Table 5 : Effect of different levels of FYM and sources of irrigation on the nutrient status after harvest of crop (Pooled data of 4 years)

Treatments	Location-II				
	pH	EC(dSm ⁻¹)	OC(%)	AvailableP ₂ O ₅ (kg ha ⁻¹)	AvailableK ₂ O (kg ha ⁻¹)
Levels of FYM (t/ha)					
F ₀ : 0	7.81	0.88	0.31	35.44	257
F ₁ : 10	7.66	0.75	0.34	40.84	273
S. Em +	0.13	0.01	0.01	0.63	4
CD (0.05)	NS	0.03	0.02	1.79	12.18
Sources of irrigation					
I ₁ : Sole irrigation with tube well water	8.03	1.21	0.31	36.87	260
I ₂ : Sole irrigation with canal water	7.47	0.51	0.33	38.04	264
I ₃ : Alternate irrigation with tube well and canal water	7.70	0.72	0.35	39.49	271
S. Em +	0.15	0.01	0.01	0.77	5
CD (0.05)	NS	0.04	0.02	NS	NS
CV %	11.33	8.97	12.1	11.48	11.26
CD (Y x T)	NS	NS	NS	NS	NS

acids as a consequence of putrefaction of FYM can also result in complexing of free and exchangeable aluminum ions, thus decreasing the pH (Grewal *et al.*, 1981). Results of 25 years of nonstop cropping in long term fertilizer trial also revealed that integrated use of NPK and FYM in soybean–wheat system, significantly improved soil organic carbon content in a Haplustalf and Chromustert. Likewise Aoyama *et al.* (1999b) accounted that after 18 years; manure enlarged the organic matter of whole soil and privileged structure of slaking-resistant macro-aggregates (250–1000 mm). Aoyama *et al.* (1999b) observed that organic carbon addition through manure led to higher absorption of total carbon in dry sieved macro-aggregates than in micro aggregates.

Continuous application of FYM also condenses the movement of polyvalent cations such as Ca, Fe and Al due to chelation which, in turn, is considered accountable for decrease in P-fixation (Gupta *et al.*, 1988). Application of FYM augmented Olsen-P since of its P content and perhaps by increasing maintenance of P in soil. An optimistic result of FYM on P accessibility was also pragmatic by Roy *et al.* (2001). Improved soil physical environment attached with competence of water and nutrients helped in superior uptake of water and nutrients resulting in higher yield of wheat in FYM treated plots as compared to that in control plots.

The data presented in Table 4 and Table 5 indicates that the effect of sources of irrigation on electrical conductivity was found significant on pooled basis at both the locations. The results reveal that significantly lowest electrical conductivity (0.67 and 0.51 dSm⁻¹) was observed with the sole application of canal water on pooled basis at both the locations. The data presented in Table 4 and Table 5 reveal that application of alternate irrigation with canal and tube well water significantly increased the organic carbon content (0.36% and 0.35%) in soil after harvest of wheat

on pooled basis at both the locations; but it was at par with the sole application of canal water at both the locations on pooled basis. The results showed that use of alternate irrigation of tube well and canal water, the tube well water contains high amount of mineral elements and different types of salts and the supply of next irrigation through canal water dissolved all the mineral and salts in the soil hence, crop utilized all the essential elements mineral and salts while, other hazardous salts are leached down below the root zone. More salts are precipitated when less irrigation water was applied, especially if accompanied by a lack of rain conditions. The data obtainable in Table 4 and Table 5, disclose that different sources of irrigation water did not show any significant change in case of soil pH and available K₂O content in soil after harvest of wheat crop on pooled basis at both sites. The application of alternate irrigation with tube well and canal water significantly increased the available P₂O₅ content in soil after harvest of wheat at location-I on pooled basis; but it was statistically at par with the sole irrigation with canal water. The interaction effect between different levels of FYM and sources of irrigation on grain and straw yield, total numbers of effective tillers, length of spike and total number of seeds per spike and physico-chemical properties of soil were found non-significant on pooled basis at both the locations.

Based on this investigation, it is concluded that application of 10 t FYM ha⁻¹ and alternate application of tube well and canal water should be used for higher yield of wheat besides, maintaining favorable soil nutrients status.

Acknowledgment

The authors are grateful to the Department of Agriculture Chemistry and Soil Science, C.P. College, S.D. Agricultural University, Sardarkrushinagar for providing necessary facilities for research work.

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