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Conjunctive Use Of Alkali Water/ Tube Well Water On The Yield And Yield Attributes Of Onion (*Allium Cepa*) In Semi-Arid Conditions Of Western Part Of U.P.

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Abstract

A field experiment was conducted to study the effect of quality of irrigation water on yield of onion during 2011-12 to 2013-14 at Bichpuri Agra. The results revealed that the bulb yield of onion was highest in with tube well water (24.58 t ha^{-1}) and lowest with alkali water (10.2 t ha^{-1}).The different irrigation mode of tube well water and alkali water also differ significantly with all tube well water treatments. Amongst the different tube well: alkali waters modes highest yield was recorded in 1TW: 1AW with 98% relative yield. The modes 2TW: 2AW and 4AW: 2TW and blending (1TW:2AW) produced significantly lower yield compared with 2TW:2AW treatment. The water use and water use efficiency was higher in TW treatment and lowest in all AW treatments. The A grade onion bulbs were produced in all TW irrigated treatment and C grade in maximum in all AW irrigated treatments. The keeping quality of onion bulbs (% weight loss) was maximum in AW (34.6%) treatment and lowest in all AW treatments (25.2%).

Key words : *Conjuctive use, alkali water, tubewell water, Onion yield.*

Introduction

Degradation of soils with the use of alkali ground waters constitutes a major threat to irrigated agriculture in semi-arid parts especially south Asia[1]. High incidence (30-50%) of these waters in found in semiarid parts (annual rainfall 500-700mm), which are the most intensively cultivated areas in the Indo-Gangetic plains. Irrigation with alkali waters results in a rise in soil alkalinity and sodicity thus adversely affecting the soil's physical behavior in terms of crusting, hard-setting and low intake rates. This not only decreases the crop yields but also limits the choice of crops that can be grown on these soils[1,7]. Specialized soil-crop-irrigation management practices, which help to maintain the sodicity in the root zone within permissible limits, are therefore advocated for sustained irrigation with alkali waters. In addition to the appropriate selection of crops and improvement in water management, application of amendments in required to maintain soil structure/permeability and thus sustain irrigation with alkali waters.

Material and Methods

The experiment was conducted at the experimental farm of AICRP- Management of Salt Affected Soils and Use of Saline Water in Agriculture, Raja Balwant Singh College of Agriculture, Bichpuri, Agra, Uttar Pradesh (27.2^0 N and 77.9^0 E). The climate at the site is semi-arid with average rainfall of 650 mm, about 80% of which is received during July-September. The soil at the site was a well-drained (water level below 14.2 m) sandy loam soil with an electrical conductivity of saturation paste extract (ECe) of 2.7 dS/m, pH of the saturation paste (pHs) of 8.0, exchangeable sodium percentage (ESP)of 5.4, organic matter content of 2.9 g/kg soil and clay content of 14%.. Treatments consisted of combinations of irrigation with an alkali water (AW, ECaw 3.2 dS/m, residual sodium

carbonate (RSC) 15.2 me/l, sodium adsorption ratio (SAR) 12.6) and a good quality tube well water (TW, ECtw 3.2 dS/m, RSC nil, SAR 11.8) applied either alone, as blends or in cyclic (i.e. alternate) application. Specifically, these treatments were:

(1) Irrigation with good quality tube well water alone (TW, for reference)
(2) Alternating irrigations with TW and AW, with TW to start with (1TW:1AW)
(3) Alternating two irrigations each with TW and AW and applying TW to start with (2TW:2AW)
(4) Alternating two irrigations each with TW and AW and applying AW to start with (2AW:2CW)
(5) Four irrigations with AW to start with and followed by two with TW (4TW:2CW)
(6) Blending in the ratio of 2:1 (2TW:1AW)
(7) Blending in the ratio of 1:2 (1TW:2AW).
(8) Irrigation with alkali water alone (AW)

The experiment was conducted during 3 years. Treatments were imposed in a randomized block design with four replications. The plot size was 16 m^2 (4 m x 4 m) and to control lateral fluxes of salt and water, each plot was lined with polyethylene sheet down to a depth of 0.9 m. Alkali water was synthesized by dissolving the required quantities of sodium bicarbonate in canal water. Local agronomic practices in terms of inter/intra-row spacing, seed rates, fertilizers, irrigation schedules and other cultural practices were followed for each crop. Onion (Nasik Red) was planted during the end of December and harvested during the end of March or second week of April. The open pan evaporation, rainfall and irrigation water was applied was recorded and display in (Table 1).The bulb yield recorded grade wise i.e. A grade (<60 gm), B grade (40 gm) and C grade (> 40 gm) in all treatments. The keeping quality of onion bulbs in the form of weight loss (%) was observed in all the treatments. This study purpose one kg of onion bulbs in all three grade collect and store in aired plastic basket and stored in room temperature. The 30 days inter well weight of the onion bulbs observed this process continued in 120 days. Soil samples were also taken to a depth of 0.9 m at planting and at harvest of the crop and soil water storage (SWS) was determined thermo-gravi-meterically. The quantity of water used (WU) was calculated as difference in soil storage during the season (SWS) plus irrigation (IW) and rainfall (RW). The water use efficiency (WUE, kg/ha-cm) was then calculated as the ratio of yield (kg/ha) to WU (cm).

Table 1 Rainfall (mm), US Open pan evaporation (OPE, mm), irrigation water applied (mm) to onion crop

Crop	Parameters	2011-12	2012-13	2013-14	Mean
Onion	OPE	227	248	265	247
	Rainfall	33.5	57.7	124.8	72.0
	Irrigation(mm)	350	350	280	327

Results and discussion

Crop performance

Irrigation with alkali water (AW) significantly reduced the average yields over a period of three years of onion (59%) ,though the reduction in yields were comparatively lower in the first year (56%), than subsequent years (Table 2). Onion has been rated as moderately sensitive crop. The significant reduction in crop yields can be ascribed to bicarbonate toxicity and build up of alkalinity and sodicity in soils leading to structural deterioration and poor permeability problems. These factors ultimately result in nutritional imbalances. The restricted movement of water in soils irrigated with alkali water may also result in the retention of salts in surface layers,

which simultaneously induces salinity stresses affecting crop growth[6]. The salinity (2.9-4.9 dS/m) during the crop growth period, though not high, was beyond the threshold values reported for the crops under consideration.

The overall growth of onion monitored in terms of plant height and number of leaves/plant was markedly affected with the use of different alkalinity waters (Table 2). The impact of poor growth also reflected in yield attributing parameters like diameter of bulb, fresh weight and volume of bulbs under the various treatments. Significant reduction in these parameters was observed at use of more quantity of alkali water but the relative impact was severe on the bulb size. The significantly higher plant height of onion crop was observed in tube well water irrigation treatment (43.2 cm) and minimum alkali water irrigation treatment (25.5 cm). The number of leaves /plant, bulb volume and bulb weight was significantly higher in tube well water irrigated treatments and lost in alkali water irrigated treatments [4,5].

Table 2 Effect of modes of irrigation with alkali and tube well water on yield attributing characters of onion

Mode of irrigation	Plant height (cm)	Leaves plant^{-1}	Bulb volume (cm^{-3})	Bulb weight (gm)
TW	43.2	9.43	70.73	83.57
1TW:1AW	41.97	9.33	70.03	81.73
2TW:2AW	40.93	9.07	69.17	80.93
2AW:2TW	37.43	8.40	58.13	61.87
4AW:2TW	39.97	7.77	48.40	57.77
Mixing (1TW:2AW)	38.20	8.97	65.93	79.70
Mixing (2TW:1AW)	40.10	9.17	69.53	81.03
AW	25.50	7.23	31.13	32.02
CD at 5%	1.89	0.42	3.05	5.69

The yields of onion crop (Table 3) improved under the various combinations of tube well water (TW) and alkali water (AW) usage compared with alkali water alone. The crops tended to perform better with yearly water use compared to blending. When averaged over the 3-years, the relative yield (RY) of onion was 98, 97, 89, 85 and 48% under the cyclic 1TW:1AW, 2TW:1AW, 2AW:2TW, 4AW:2TW respectively while the RY was 93 and 95% for waters blended in the ratio 2TW:1AW and 1TW:2AW, respectively. Thus, the results of the present study further corroborate that the same also holds for the combined use of alkali and good quality waters when the good quality water is applied initially. It can be concluded that the combined use of alkali and good quality canal waters can maintain the soil sodium saturation at relatively low levels depending upon the proportion of the two waters. Amongst the various treatment options, the cyclic use should be preferred especially when canal waters are utilized for initial irrigations since it would have both operational and performance advantages over the blending of the water supplies. The use of AW should be avoided during the initial stages of crop growth[2,3].

Table 3 Effect of modes of irrigation with alkali and tubewell water on bulb yield of onion

Mode of Irrigation	Yield (t/ha) during the year				
	2011-12	2012-13	2013-14	Mean	RY (%)
TW	244.3	247.0	246.3	245.8	100
1TW:1AW	240.3	242.6	240.2	240.0	98
2TW:2AW	238.7	239.6	236.7	238.3	97
2AW:2TW	222.1	224.0	219.2	221.8	89
4AW:2TW	214.9	216.3	212.3	214.5	85
Mixing (1TW:2AW)	230.6	232.5	227.8	230.3	93
Mixing (2TW:1AW)	235.7	237.1	230.2	234.3	95
AW	105.9	102.5	97.6	102.0	41
CD at 5%	10.2	7.1	8.6	-	-

Table 4 Effect of various treatments on quality parameters and water use and water use efficiency (Av. 3 years)

Mode of water use	Tuber yield grade wise (t ha^{-1})			Weight loss (%)	Water use (cm)	Water use efficiency kg/ha-cm
	'A' >60 gm	'B' 40 gm	'C' <40 gm			
TW	108.2	80.3	58.4	25.2	43.8	561.3
1TW:1AW	102.7	76.5	63.2	26.8	42.7	562.1
2TW:2AW	97.7	78.8	63.3	59.9	43.2	551.7
2AW:2TW	92.2	75.7	55.9	28.7	42.7	519.4
4AW:2TW	82.7	68.1	65.5	30.1	43.1	497.7
Mixing (1TW:2AW)	95.8	73.8	63.2	27.1	42.7	539.3
Mixing (2TW:1AW)	98.2	71.5	67.9	25.7	43.2	542.4
AW	24.5	32.4	45.3	34.6	42.8	238.3
CD at 5%	5.9	3.6	2.9	3.4	-	-

Quality of Produce

The effect of sodicity build up in the soil profile due to combined use of alkali and tube well water under different treatments were evaluated in terms of quality of onion bulb . The quality of onion bulb was measured in terms of the bulb grade (A>60g, B 40-60g and C < 40g) and keeping quality (percentage weight loss in storage) and is shown in (Table 4).In general, it was observed that the lower grade bulbs (C grade), increased with decline in yield under different treatments respectively[3]. Storage quality also deteriorated with AW irrigation (e.g. the onion bulb shriveled with two-third-weight loss on storage for 120 days under AW treatments where as the weight loss was just about two-fifth under TW). (Table 4).

The water use efficiency (WUE) was declined with reduced yields and sodicity development under various treatments (Table 4). For different treatments of TW and AW, WUE was estimated between 238.3-562.1 kg/ha-cm. The highest WUE was estimated for all TW whereas the lowest for all AW. Among different modes of combined use of alkali and tube well waters, WUE was estimated highest in case of blending of tube well and alkali waters in ratio of 2TW:1AW (542.4kg/ha-cm) in potato crop.

Change in soil properties

The salt build up in the surface soil layer (0-0.30 cm), where most dense crop roots are confined and has high potential for clay dispersion, surface crusting thus low infiltration rate, is most influenced by irrigation water quality. The effects of various modes of irrigation on the properties, though monitored up to 90 cm in the effective root zone depth, is presented limited to agriculturally important soil layer. Continuous irrigation with alkali water (AW) significantly increased salt built up in soil profile as compared to continuous use of tube well water (TW). The average values of pH, ECe, SARe and ESP at the harvest of onion crop ranged between 7.6-8.4, 3.2- 4.8 dS/m, 3.4-15.6 and 9.7-22.1, respectively (Table 5).

Table 5 Soil analysis (0-30 cm depth) in different irrigation modes (Av. 3years)

Treatments	At sowing				At harvest			
	ECe	SAR	pH	ESP	ECe	SAR	pH	ESP
TW	2.8	2.9	7.5	8.8	3.2	3.4	7.6	9.7
1TW:1AW	3.1	6.7	7.8	12.7	3.6	8.2	8.0	14.3
2TW:2AW	3.3	6.5	7.8	13.2	3.5	8.7	8.1	13.8
2AW:2TW	3.3	8.9	7.6	14.1	3.3	8.8	8.0	14.9
4AW:2TW	3.4	8.3	7.8	14.9	3.4	9.2	8.0	15.2
Mixing (1TW:2AW)	3.3	7.9	8.2	14.8	3.5	8.6	8.1	15.9
Mixing (2TW:1AW)	3.3	6.5	8.1	13.7	3.5	8.2	8.0	14.8
AW	3.4	12.8	8.2	16.8	4.8	15.6	8.4	22.1

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