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Performance of Different Varieties of Groundnut Under Surface and Subsurface Drip Irrigation Using Saline and Good Quality Waters

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Abstract

A study was conducted on the performance of different varieties of groundnut under surface and subsurface drip irrigation using saline and good quality waters at Swami Keshwanand Rajasthan Agricultural University, Bikaner during 2016-2018 on loamy sand soil. The experiment comprised of two levels of irrigation water salinity viz., EC 0.25 (BAW) and 2.8 dS m^{-1}, two drip system (surface and subsurface) and three varieties (HNG-10, HNG-123 and Mallika) of groundnut under Randomized Block Design (RBD) with three replications. Application of best available water gave significantly higher yield (28.03 q ha^{-1}) with the tune of 30.2 per cent over saline water and subsurface irrigation yielded (25.57 q ha^{-1}) significantly higher over surface drip irrigation method. Among the varieties, HNG 123 performed well with significantly higher yield (26.99 q ha^{-1}) over both the varieties. BAW fetched the higher net return (₹ 68220) and B:C ratio (1.95) and in case of drip irrigation systems, subsurface irrigation brought in higher net return and B:C ratio. Variety HNG-123 found superior with maximum net return (₹ 62704) and B:C ratio (1.88) followed by Mallika.

Key words: Irrigation water quality, Saline water, Groundnut varieties, Surface and subsurface drip irrigation, Water use efficiency, B:C ratio

Introduction

Groundnut is one of the most important food crops of the world, grown in 26.4 million ha with a total production of 36.1 million metric tons and an average productivity of 1.4 Mg ha^{-1} (FAO, 2008-09). India has the largest area under groundnut with the lowest productivity in the world (FAO STAT, 2002). Gujarat, Andhra Pradesh and Rajasthan are the leading states of India in production of groundnut. In Rajasthan it is cultivated in area of 6.40 lakh ha area (Indiastat, 2019). Bikaner is the pioneer district in groundnut production, where it is grown as an irrigated crop. Judicious use of saline ground water in dry areas with scarcity of irrigation water for crop production has been found quite feasible (Dagar *et al*., 2019). Ground water quality of Bikaner district is not good and has the problem of salinity. Overhead sprinklers are used for irrigation resulting in low water use efficiency (WUE) with depletion of ground water reservoir in this arid region. Drip irrigation is the right option in this situation which not only enhances WUE but ensures safe use of poor-quality water with minimum hazard on soil and plant. Drip irrigation system for saline water is considered the most suitable technology as leaching of salts takes at low leaching fraction. Thus, drip system not only saves irrigation water but also does not permit salt accumulation in vicinity of root zone. Drip irrigation system has been found to be quite effective under limited water availability not only in achieving higher productivity but also economizing other inputs such as fertilizers, pesticides, labor etc. Drip irrigation system is a

conventional and effective means of supplying water directly to soil and nearer to the plant without much loss of water resulting in higher water productivity (Banyopadhyay *et al.*, 2005). Groundnut is an important crop with respect to use of limited water with minimum harmful effect of poor quality water as point application of irrigation water is easy in drip irrigation and there is no need to apply irrigation water on whole field. Secondly, leaching of salts takes place away from actual root zone. Further, subsurface drip irrigation is a slight variation of the conventional surface drip irrigation and lateral lines are installed below ground surface reducing soil evaporation losses. The laterals are buried at a depth of 30 cm below the soil surface depending mostly on the tillage practice and the crop to be irrigated (Sakellariou-Makrantonaki *et al.*, 2002). Performance of groundnut varieties varies with the quality of irrigation water which may be due to differences in their salt tolerance limits. Keeping all these aspects under consideration the present study was under taken to find out most suitable groundnut variety under different quality of irrigation water and mode of irrigation water application under drip systems.

Material and Methods

The field experiment was conducted at Precision Farming Development Centre, Agricultural Research Station, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India (28°01′N latitude and 73°22′E longitude at an altitude of 234.70 m above mean sea level) during *kharif* seasons of 2016, 2017 and 2018. The soil of experimental field was loamy-sand, alkaline in reaction (pH 8.2) having 120 kg ha^{-1} available N (Alkaline permanganate method), low level of available phosphorus (15.1 kg ha^{-1}, Olsen's method) and medium in available potassium (173.7 kg ha^{-1}, Flame photometric method) in 0-15 cm soil depth at the start of the experiment.

The experiment was planned to study the performance evaluation of different varieties of groundnut under surface and subsurface drip irrigation system using saline water. The treatments comprised of two levels of irrigation water salinity (BAW- best available water, EC 0.25 dS m^{-1}; and saline water EC 2.8 dS m^{-1}), two drip systems (surface and subsurface) and three varieties (HNG-10, HNG-123 and Mallika) under Randomized Block Design (RBD) with three replications. Groundnut was grown as per standard agronomic practices. Irrigation was applied through in-line drip with discharge rate of 4 litre per hour per emitter. Irrigations were scheduled on alternate day basis and fertilizers were applied through drip. The yield attributes and yields were recorded and data were statistically analyzed for estimation of analysis of variance as per method suggested by (Panse and Sukhatme, 1985). The critical differences between the observed values under different treatment combinations were also estimated to understand the significant effects of different saline waters, varieties and irrigation system.

Results and Discussion

Impact of irrigation water quality on yield attributes and yield of groundnut

Pooled data of 3 years revealed that quality of irrigation water had profound effect on all yield attributes (Table 1). Yield attributes viz., number of pods per plant, 100-seed weight and shelling percentage decreased with use of saline water. The significantly higher value of their yield attributes was obtained with use of BAW over saline water. Pod and straw yields were also found significantly superior with BAW with the tune of 30.2 per cent and 27.9 per cent, respectively over saline water. The reduction in yield parameters might be due to harmful effect of salts in physiological processes. Photosynthesis, nutrient absorption and uptake decrease and photorespiration increases which results in lower photosynthate assimilation and ultimately leads to poor yields. Contrary to this the experimental results at the Bikaner centre indicated that groundnut crop could tolerate irrigation water salinity up to 4 dS m^{-1} without any significant reduction in yield under surface drip system (AICRP SAS & USW, 2019).

Impact of irrigation systems

Drip irrigation systems showed a marginal variation in yield attributes. The yield attributes *viz.*, pods per plant, seeds per pod, 100-seed weight

Table 1. Effect of different water quality, methods of irrigation and variety on yield attributes, yield and water use efficiency of groundnut (Pooled data of 3 years)

Treatments	No. of pods plant^{-1}	No. of seeds pod^{-1}	100- seed weight (g)	Shelling (%)	Yield (q ha^{-1})		WUE (kg ha-mm^{-1})
					Pod yield	Straw yield	
Saline (EC 2.8 dS m^{-1})	16.46	1.81	46.82	64.34	21.53	36.17	4.47
B A W	19.23	1.93	53.18	68.18	28.03	46.25	5.82
S.Em±	0.66	0.05	1.02	1.00	0.23	0.37	
LSD (p≤0.05)	2.08	NS	3.22	3.14	0.66	1.16	
Surface drip	17.02	1.84	49.24	65.45	23.99	39.34	4.98
Sub surface drip	18.67	1.90	50.74	66.26	25.57	41.42	5.30
S.Em±	0.66	0.05	1.02	1.00	0.23	0.37	
LSD (p≤0.05)	NS	NS	NS	NS	0.66	1.16	
HNG 10	20.42	1.84	38.46	68.73	22.72	37.72	4.71
HNG 123	19.14	1.92	47.62	65.84	26.99	43.99	5.60
Mallika	13.98	1.81	63.91	64.21	24.62	40.38	5.11
S.Em±	0.81	0.06	1.26	1.23	0.31	0.46	
LSD (p≤0.05)	2.56	NS	3.96	3.86	0.98	1.45	

BAW= best available water with EC 0.25 dS m^{-1}; q (quantile) =100 kg

and shelling percentage exhibited the marginal superiority with use of subsurface irrigation system over surface drip irrigation system, though, the differences were non-significant. However, the differences in yields (pod and straw yield) were found significant. Subsurface drip irrigation system produced significantly higher seed and straw yield with the tune of 6.59 and 9.50 per cent over surface drip irrigation, which might be due to less salt accumulation in rhizosphere under subsurface drip irrigation than surface drip irrigation system.

Yield attributes and yield of different varieties under different systems of irrigation

Groundnut varieties varied significantly with respect to yield attributes and yield (Table 1). Variety HNG 10 produced significantly higher number of pods per plant as compared to Mallika. Varieties were found on a par with respect to seeds per pod. In case of seeds per pod, HNG 123 showed numerical superiority. Mallika produced bold seed with significantly higher 100-seed weight followed by HNG 123. With respect to pod and straw yield, variety HNG 123 found superior over rest both the varieties. HNG 123 produced the highest pod (26.99 q ha^{-1}) and straw (44.14 q ha^{-1}) yields followed by Mallika. HNG 123 yielded 4.27 and 2.37 q ha^{-1} higher pod yield over HNG 10 and Mallika, respectively. The differences in yields in these varieties are due to the differences in the genetic constitution, growth habit of these varieties and salt-tolerance (DoR, 2005, 2009; Gochar, 2011).

Combined effects of treatments were also found significant (Table 2). The interaction effect between quality of water and drip irrigation system was found significant. Use of BAW under subsurface drip system produced significantly

Table 2. Interaction effects between water quality and drip system and varieties of groundnut for pod yield (q ha^{-1})

Water quality	Drip system		Varieties		
	Surface drip	Sub surface drip	HNG 10	HNG 123	Mallika
Saline water	22.31	20.75	19.71	23.51	21.36
BAW	25.67	30.40	25.74	30.48	27.88
S.Em±	0.32		0.04		
LSD (p≤0.05)	0.93		0.12		

Salinity of water as in Table 1.

Table 3. Effect of water quality, irrigation method and varieties on economics of groundnut cultivation

Treatment	Cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
Water quality				
Saline water	71650	107822	36172	1.50
BAW	71650	139870	68220	1.95
Drip system				
Surface	70400	119564	49164	1.70
Sub-surface	72900	127132	54232	1.74
Varieties				
HNG 10	71650	113512	41862	1.58
HNG 123	71650	134354	62704	1.88
Mallika	71650	122708	51058	1.71

Sale price of groundnut seed @ ₹ 4000 per q and straw @ ₹ 600 per q; q=100 kg
Salinity of water as in Table 1

higher pod yield (30.40 q ha^{-1}) over rest of the interactions. Likewise, other varieties also responded differentially with quality of irrigation water. Variety HNG 123 produced significantly higher yield (30.48 q ha^{-1}) when it was irrigated with good quality water.

Water use efficiency

During the three years of the experimentation, the average water applied was 482 mm and by using it the water use efficiency of the treatments was also computed (Table 1). Higher water use efficiency was obtained with good-quality water (BAW) (5.82 kg per ha-mm) and in case of irrigation systems subsurface drip system was found better with high water use efficiency (5.30 kg per ha-mm). Among the varieties tested, the highest water use efficiency (5.6 kg per ha-mm) was recorded in variety HNG 123 followed by Mallika. The higher water use efficiency of these treatments is due to their resultant effect in terms of higher yields, as WUE is the function of pod yield and water used by the crop.

Economics

To find out the economic viability of the treatments, economics of the treatments were calculated. Application of good quality water (BAW) fetched the higher grass return (₹ 1,39,870), net return (₹ 68,220) and B:C ratio (1.95). Out of two drip irrigation systems, subsurface drip irrigation was found economically superior with higher gross return (₹ 1,27,132), net return (₹ 54,232) and B:C ratio (1.74). Among the varieties tested, variety HNG-123 fetched the maximum gross return (₹ 1,34,354), net return (₹ 62,704) and B:C ratio (1.88).

Conclusions

Groundnut is an important cash crop in the arid region of Rajasthan. However, low water use efficiency of over-head sprinklers might result in depletion of limited ground water resource of arid region. Further, leaching of salts is not possible in case of sprinkler due to low application rates. The drip has advantages that whole field surface is not to be provided with irrigation water and leaching of salts can take place even at low application rates. Thus, salts are pushed towards periphery of wetted soil mass reducing effect of salinity on the root-zone of the crop. Among surface and subsurface drip, subsurface drip has been found more effective for yield and water productivity, probably due to low soil evaporation and less accumulation of salts in root zone. With respect to pod and straw yield, variety HNG 123 found superior over rest two varieties tested. HNG 123 produced the highest pod (26.99 q ha^{-1}) and straw (44.14 q ha^{-1}) yields followed by Mallika. Variety HNG 123 yielded 4.27 and 2.37 q ha^{-1} higher pod yield over HNG 10 and Mallika, respectively.

Economic analysis suggested that subsurface drip irrigation gave B:C ratio (1.74) while among

the varieties tested, variety HNG-123 gave B:C ratio (1.88). Thus, groundnut crop can be grown economically by drip system, preferably by subsurface drip system, using saline water having salinity up to 4.0 dS m^{-1}.

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