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NUTRIENT CONTENT AND NUTRIENT USE EFFICIENCY AS INFLUENCED BY DRIP FERTIGATION IN CAULIFLOWER (*Brassica oleracea var. botrytis*)

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ABSTRACT

A present investigation was conducted at Horticulture Farm, Rajasthan College of Agriculture, Udaipur, during *rabi* season in 2013-14 and 2014-15. The experiments was laid out in split plot design with 15 treatment combinations replicated three times in which included 3 levels of irrigation *viz*., 80%, 60% and 40% PE through drip irrigation and five levels of fertigation *viz*., 100% RDF, 75% RDF, 50% RDF, 75% RDF + 2 foliar spray of 1% urea phosphate, and 50% RDF + 2 foliar spray of 1% urea phosphate through fertigation. The results revealed that drip irrigation at 80% PE produced the highest curd yield (236.82 q ha^{-1}), nutrients content in plant & curd and nutrient use efficiency as compared to drip irrigation at 40 % PE. The highest yield (244.02 q ha^{-1}) was found with 75% RDF through fertigation + 2 foliar spray of 1% urea phosphate as compared to 50 per cent RDF through fertigation. The maximum NPK content in curd and plant were obtained with 100 % RDF through fertigation as other fertigation levels, while the highest nutrient use efficiency was recorded with 50 % RDF through fertigation + 2 foliar spray of 1% urea phosphate than other treatments.

KEYWORDS- Fetigation, yield, NPK content and nutrient use efficiency.

INTRODUCTION

Water and nutrient management are the key factors for successful cultivation of vegetable crops, which responds well to nutrient and irrigation regime. In crop intensive agriculture, both fertilizer and irrigation management have contributed immensely in increasing the yield and quality of crops. The method of fertilizer and irrigation application affects the efficiency of these inputs in arid and semi- arid regions. Under adverse conditions fertilizer and irrigation use is very low therefore it improve use efficiency of these are flood irrigation as the conventional method is being widely used to irrigate most of the vegetable crops grown in India. However, higher application efficiency of drip-irrigation over conventional (surface) method of irrigation has been reported by optimizing the use of limited water. Drip irrigation is the concept where water is applied at low rate frequently near the root zone of the plant. Drip irrigation is one such technology which can help to increase the irrigation potential by optimizing the use of available irrigation water. Hence, an attempt was made to generate the information on water requirement through drip method for one of the common commercial vegetable crops. Fertigation is such innovative technology of applying water soluble fertilizers through drip irrigation. Drip irrigation is one of the latest and efficient methods of irrigation having about 90% irrigation efficiency. This method increases the crop yield in general to the tune of 25-30 % with saving of irrigation water to the extent of 50 to 60 %, when compared to conventional irrigation method (Yadav *et al.,* 1993). Fertigation saves fertilizers up to 25% (Vaishnava *et al.,* 1995), thus fertigation results in appropriate and efficient use of precious commodities such as water and fertilizer. As the water soluble fertilizers are very costly inputs, therefore the efforts are made by various researchers to reduce the quantity of water soluble fertilizers (Nitrogen and Potassium) in conjunction with straight fertilizer (Single super phosphate) to enhance the yield potential of cauliflower and fertilizer use efficiency. In the view of above mentioned considerations, this study was carried out to investigate the response of cauliflower for varying irrigation regimes and fertigation levels with modification in curd yield, nutrient content and nutrient use efficiency.

MATERIALS & METHODS

The experiment was conducted at Horticulture Farm, Rajasthan College of Agriculture, MPUAT Udaipur during *rabi* season in 2013-14 and 2014-15.The site was situated at 24^{o}.35' N latitude, 74^{o}.42' E longitude and an altitude of 579.5 m above mean sea level. The region falls under agro-climatic zone IVA (Sub-Humid Southern Plain and Aravalli Hills) of Rajasthan. The soil was Haplustepts, clay loam in texture having pH 8.15, EC 0.67 dS m^{-1}, Organic carbon 0.71%, available nitrogen 296.45 kg ha^{-1}, available phosphorus 23.76 kg ha^{-1}and available potassium 318.65 kg ha^{-1}. The experiment was laid out in split plot design with 15 treatment combinations which consisted of 3 levels of drip irrigation (80%, 60% and 40% PE) and 5 levels of fertigation (100% RDF, 75% RDF, 50% RDF, 75% RDF + 2 foliar spray 1% urea phosphate, and 50% RDF +2 foliar spray 1% urea phosphate through fertigation) were replicated three times. Four water old seedling of cauliflower variety Pusa Snowbal K-1 was transplanted during third week of November and harvested in the third week of February. The water soluble fertilizers (urea, urea phosphate and potassium nitrate) were used in experiment through drip irrigation. The fertilizers were applied at fifteen days interval in 6 equal splits starting from 15 days after transplanting through drip irrigation according to fertilizer schedules. The fertilizer schedules was developed according to RDF (120-80-60 NPK kg ha^{-1}) for cauliflower crop. In drip irrigation scheduling was done based on pan evaporation and application of water three days interval according to requirement of the crop. Representative plant and curd samples were collected from each plot after harvest crop and analyzed using standard methods. Nitrogen content in curd and plant was estimated by Nessler's reagent, spectrophotometrically (Snell and Snell, 1959), phosphorus by Vanadomolybdate phosphoric acid yellow colour method (Jackson, 1967) and potassium by Flame photometer method (Jackson, 1967). The nutrient use efficiency was computed by dividing yield (q ha^{-1}) with total quantity of nutrient applied –

$$NUE = \frac{Yield(kg/ha)}{Total\ quantity\ of\ nutrient\ applied\ (Kg/ha)}$$

RESULTS

Yield

The data presented in Table -4 showed that drip irrigation at 80% PE, irrespective of fertigation levels recorded significantly the highest curd yield ha^{-1} (236.82q) as compared to 40% PE. This might be due that, the optimum moisture in the vicinity of root zone throughout the crop growth period which enhance the vegetative growth of the crop thereby increase the photosynthesis and efficient translocation of photosynthesis towards the reproductive organ i.e., curd, which increases the length, width and weight of curd finally resulted in increased curd yield of cauliflower (Table 1). These results are in agreement with Al-Mohammadi and Al-Zu'bi (2011). Similarly, application of 75% RDF through fertigation + 2 foliar spray of 1 % urea phosphate registered significantly increase curd yield ha^{-1} (244.02q) of cauliflower than rest of the other treatments (Table-4). Increase in the yield and yield attributed parameter with 75% RDF fertigation + 2 foliar spray of 1% urea phosphate might be due to the uniform distribution and adequate availability of nutrients and moisture in the root zone of the crop. Similar findings were also like Ayyadurai and Manickasundaram (2014) and Yanglem and Tumbare (2014) *etc*.

TABLE 1. Effect of drip irrigation and fertigation levels on N, P and K content in curd after harvest of cauliflower

Treatments	N content in curd (%)			P content in curd (%)			K content in curd (%)		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
Irrigation levels									
Drip at 80% PE	2.556	2.592	2.574	0.610	0.633	0.621	2.719	2.798	2.759
Drip at 60 % PE	2.432	2.523	2.477	0.575	0.590	0.582	2.667	2.725	2.696
Drip at 40% PE	2.411	2.472	2.442	0.537	0.570	0.553	2.592	2.649	2.620
SEm ±	0.035	0.031	0.024	0.010	0.014	0.009	0.029	0.025	0.019
CD (P = 0.05)	0.098	0.087	0.055	0.028	0.039	0.020	0.081	0.068	0.044
Fertigation levels									
100% RDF	2.576	2.599	2.588	0.627	0.644	0.635	2.782	2.832	2.807
75% RDF	2.448	2.521	2.484	0.563	0.597	0.580	2.686	2.715	2.701
50% RDF	2.359	2.468	2.414	0.520	0.541	0.530	2.510	2.620	2.565
75% RDF + 2 foliar spray	2.496	2.569	2.532	0.617	0.634	0.626	2.776	2.799	2.788
50% RDF + 2 foliar spray	2.453	2.489	2.471	0.543	0.572	0.558	2.542	2.653	2.597
SEm ±	0.041	0.040	0.029	0.013	0.010	0.008	0.031	0.023	0.019
CD (P = 0.05)	0.085	0.082	0.058	0.027	0.022	0.017	0.064	0.048	0.039

TABLE 2: Effect of drip irrigation and fertigation levels on N, P and K content in plant after harvest of cauliflower

Treatments	N content in plant (%)			P content in plant (%)			K content in plant (%)		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
Irrigation levels									
Drip at 80% PE	1.889	1.950	1.920	0.422	0.455	0.438	1.948	1.978	1.963
Drip at 60 % PE	1.814	1.910	1.862	0.394	0.425	0.409	1.880	1.904	1.892
Drip at 40% PE	1.770	1.850	1.810	0.359	0.379	0.369	1.818	1.860	1.839
SEm ±	0.018	0.025	0.015	0.007	0.009	0.006	0.021	0.026	0.017
CD (P = 0.05)	0.051	0.068	0.035	0.021	0.026	0.014	0.059	0.073	0.039
Fertigation levels									
100% RDF	1.915	1.964	1.940	0.435	0.457	0.446	1.960	1.999	1.979
75% RDF	1.808	1.895	1.851	0.383	0.412	0.398	1.882	1.917	1.899
50% RDF	1.754	1.832	1.793	0.347	0.376	0.361	1.772	1.829	1.801
75% RDF + 2 foliar spray	1.843	1.946	1.894	0.427	0.456	0.442	1.968	1.963	1.966
50% RDF + 2 foliar spray	1.803	1.879	1.841	0.366	0.396	0.381	1.828	1.861	1.845
SEm ±	0.022	0.029	0.018	0.009	0.010	0.007	0.023	0.031	0.019
CD (P = 0.05)	0.046	0.059	0.036	0.019	0.020	0.013	0.047	0.065	0.039

Nutrient Content

Effect of drip irrigation: Application of different levels of drip irrigation brought about significant improvement in nitrogen, phosphorus and potassium content in curd and plant of cauliflower during both the years of study (Table 1 and 2). The maximum improvement in nitrogen, phosphorus and potassium content in cauliflower curd and plant was recorded with higher level of drip irrigation which could be ascribed to better and timely availability of water and nutrients. Due to this, the force exerted by the plants to extract water and nutrients would be less and this might have enabled the crop to put forth better nutrient content in curd and plant Al-Mohammadi and Al-Zu'bi (2011) and Kohire and Das (2015) etc.

Effect of Fertigation

Significant and higher values of nitrogen, phosphorus and potassium content in curd and plant of cauliflower under 100 % drip fertigation were observed as compared to low level of fertigation (Table 1 and 2). It can be attributed to favourable nutrient-water interaction in the root zone, which in turn resulted in increased nutrient use efficiency and there by improved nutrient status of cauliflower. These results are in agreement with the finding such as Selim *et al.*(2010), Vazquez *et al.* (2010) and singh *et al.* (2013) *etc.*

Nutrients use efficiency

Effect of drip irrigation

Nitrogen, phosphorus, potassium and total nutrient use efficiency of cauliflower crop as influenced by different irrigation levels had been summarized in (Table 3 and 4). The highest nutrient use efficiency was observed with drip irrigation at 80 % PE followed by 60% PE and 40 % PE. The highest total nutrient use efficiency could be ascribed to better and timely availability of moisture and plant nutrients in adequate qantity through out the growth stages in drip fertigation system leading to better uptake of nutrient and production of cauliflower. Similar findings were also reported like as Kadam *et al.,* 2006 and Badr *et al.,* 2007.

TABLE 3. Effect of drip irrigation and fertigation levels on NUE, PUE and KUE in soil after harvest of cauliflower

Treatments	NUE (kg kg^{-1})			PUE (kg kg^{-1})			KUE (kg kg^{-1})		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
Irrigation levels									
Drip at 80% PE	299.54	289.35	294.44	449.31	434.02	441.66	599.07	578.69	588.88
Drip at 60 % PE	268.33	261.54	264.94	402.50	392.31	397.41	536.67	523.09	529.88
Drip at 40% PE	236.73	225.73	231.23	355.09	338.59	346.84	473.46	451.46	462.46
SEm ±	9.910	8.735	6.605	14.866	13.100	9.908	19.821	17.470	13.211
CD (P = 0.05)	27.516	24.253	15.232	41.273	36.380	22.848	55.031	48.510	30.464
Fertigation levels									
100% RDF	195.83	190.43	193.13	293.75	285.65	289.70	391.67	380.86	386.27
75% RDF	244.86	235.80	240.33	367.28	353.70	360.49	489.71	471.60	480.66
50% RDF	300.31	288.83	294.57	450.46	433.24	441.85	600.62	577.65	589.14
75% RDF + 2 foliar spray	276.54	265.72	271.13	414.81	398.58	406.70	553.09	531.44	542.26
50% RDF + 2 foliar spray	323.46	313.58	318.52	485.19	470.37	477.78	646.91	627.16	637.04
SEm ±	8.354	8.652	6.013	12.531	12.978	9.020	16.709	17.304	12.027
CD (P = 0.05)	17.242	17.856	12.091	25.864	26.785	18.136	34.485	35.713	24.182

TABLE 4: Effect of drip irrigation and fertigation levels on total NUE and WUE in soil after harvest of cauliflower

Treatments	Total NUE (Kg Kg^{-1})			Curd yield (q ha^{-1})		
	013-14	2014-15	Pooled	2013-14	2014-15	Pooled
Irrigation levels						
Drip at 80% PE	138.25	133.54	135.90	241.00	232.64	236.82
Drip at 60 % PE	123.85	120.71	122.28	217.78	212.44	215.11
Drip at 40% PE	109.26	104.18	106.72	188.33	179.71	184.02
SEm ±	4.574	4.030	3.049	7.679	6.520	5.036
CD (P = 0.05)	12.700	11.190	7.030	21.321	18.100	11.614
Fertigation levels						
100% RDF	90.38	87.89	89.14	235.00	228.52	231.76
75% RDF	113.01	108.83	110.92	220.37	212.22	216.30
50% RDF	138.60	133.30	135.95	180.19	173.30	176.74
75% RDF + 2 foliar spray	127.64	122.64	125.14	248.89	239.15	244.02
50% RDF + 2 foliar spray	149.29	144.73	147.01	194.07	188.15	191.11
SEm ±	3.856	3.993	2.775	6.561	6.458	4.603
CD (P = 0.05)	7.958	8.241	5.580	13.541	13.329	9.255

Effect of fertigation

The Maximum Nitrogen, phosphorus, potassium and total nutrient use efficiency were observed under 50% RDF fertigation + 2 foliar spray of 1% urea phosphate and minimum with 100% RDF fertigation (Table 3 and 4). Higher values of nutrient use efficiency under lower levels of fertigation can be attributed to favourable nutrient-water interaction in the root zone, which in turn resulted in increased nutrient use efficiency. These results are in agreement with the Vijayakumar *et al.* (2010).

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