Original Research Article

Effect of Drip FertigationLevels on Soil Fertility and Productivity of Cauliflower cv. PSBK- 1

ABSTRACT

Thefield experiment were conducted during 2013-14 and 2014-15 to study the effect of drip fertigation on nutrient availability, nutrient uptake, plant parameters and yield of cauliflower. The field experiments were laid out in randomized block design with four replications and six fertigation levels (100, 90, 80, 70, 60 and 110 per cent of recommended dose). Fertigation with recommended dose of fertilizer resulted in highest available N (365.3 kg ha^{-1}), P (95.8 kg ha^{-1}) and K (477.8 kg ha^{-1}). Drip fertigation with recommended dose also increased the available Zn, Cu, Fe and Mn content by 8, 29, 21 and 40 per cent, respectively over 60% RD treatment. The productivity of cauliflower was maximum with the application of 100 percent nutrients through drip irrigation and recorded an increase of 17.9 percent curd yield over 60 percent RD treatment. The study suggests that application of recommended dose of fertilizer through drip irrigation in 10 splits leads to higher and sustainable cauliflower production.

Key words: Fertigation, drip system, water soluble fertilizer, nutrient uptake, cauliflower yield.

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INTRODUCTION

The continuous improvement in productivity with optimum utilization of water, fertilizer and natural resources is essential for sustainability of any production system. Apart from the economic considerations, it is well established that the adverse effect of injudicious use of water and fertilizers can also have adverse implications on the environment. Hence, there is a need for technological interventions that will help in minimizing the use of precious resources (nutrient and water) and maximizing crop production without any detrimental effects on the environment. Among the various techniques of water and nutrient application, micro irrigation practices are very efficient and water conserving in nature. The drip or trickle irrigation is gaining much importance now a days due to the many unique advantages it provides like conservation of soil moisture, optimum utilization of water resources, lesser wastage of nutrient, proper and sustained water and nutrient availability to the crop. It delivers water and nutrients directly to the root zone of the crop and water is applied in precise amount which synchronizes with the requirement of the crop. The major advantages of fertigation are in saving of labour, appropriate timing of application of water and nutrients and their uniform distribution. Apart from other advantages like minimum leaching and voltalization losses, higher fertilizer use efficiency besides higher crop yields (Raina*et al.*, 2011).

Cauliflower is one of the important winter vegetable crop of mid hill region of Himachal Pradesh and is grown on an area of 79.5thousand hectare with production of 1521.1 thousand metric tonnes and productivity of 19.1MT/ha (NHB, 2013).The major constraints in cauliflower production include the traditional way of fertilizer application and lack of irrigation water. Drip irrigation is the most suitable method for uniform head size and high quality produce. Emphasis on the fertilizer application rate source, timing and nutrient balance is critical for achieving good productivity of this crop. Most of the work on fertigation has been carried out using conventional NPK fertilizer. The information, on use of water soluble fertilizers, which has recently been introduced in the country especially for fertigation, is scanty. In view of the aforestated facts, the present investigation was undertakento study the availability of nutrient elements applied through drip irrigation system, leaf nutrient content, nutrient uptake and yield of cauliflower.

MATERIALS AND METHODS

The experiment was conducted during two crop year (2013-2015) at the experimental farm of Department of Soil Science and Water Management, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP). The soil (Eutrochrept) was gravelly sandy loam in texture and neutral in reaction. The experiment was laid out with six treatments combinations replicated four times in RBD factorial design. The treatments comprised of six levels of nutrients through drip irrigation or fertigationviz. T_1 (100%of Recommended dose), T_2 (90% of Recommended dose), T_3 (80% of Recommended dose), T_4 (70% of Recommended dose), T_5 (60% of Recommended dose), T_6 (110% of Recommended dose). Cauliflower seeds of *PusaSnow Ball* K-1 variety were sown in well prepared raised nursery beds and one month old seedling were transplanted in the field at the spacing of 60 cm x 45 cm.Drip system comprised of five emitters in each row, placed at an angle of 180^o to each other and at a distance of 23cm. The trials were conducted during the month of December to March in 2013-14 and 2014-2015 under temperate and dry condition. Twenty four raised plots of dimension 5 m x 1.8 m were made. The whole dose of FYM was applied before start of experiment. Each plot had four rows accommodating 33 plants and total 792 seedlings were transplanted in 24 plots.Recommended doses of N, P and K are 125, 108 and 76kg/ha, respectively for cauliflower in Himachal Pradesh. Fertigation was done through venturi in 10 equal split applications at 10 days interval. The water soluble fertilizer (WSF-19:19:19) was used for fertigation. To meet the NPK requirement of different treatments, WSF was supplemented with urea and muriateof potash (MOP). After each fertigation, drip system was thoroughly flushed for 5 minutes. Different doses of fertilizers were applied by regulating the supply with the help of closing and opening knobs put at appropriate places.All the cultural operations were done as per package and practices and nutrients were applied as per the treatment details. Soil samples from 15 cm depth from each treatment/ plot were collected. The entire volume of soil was mixed thoroughly, air dried, sieved through 2mm sieve and stored in polythene bags for further analysis. The soil samples were analysed for pH, EC,Organic carbon (OC) available N, P, K, Ca and Mgfollowing standard methods. Micronutrient cationi.e Cu, Fe, Mn and Zn were determined by the method adopted by Lindsay and Norvell (1978), respectively.The physico-chemical properties of initial soil used in the present study are presented in Table-1. The observations were recorded on different quantitative characters of cauliflower, viz. stalk length, number of leaves, gross weight, curd weight and curd yield. Curd yield (qha^{-1}) was calculated from the weight of curds obtained per plot (kg). The data recordedfor various parameters under field experiments were subjected to statistical analysis using randomized block design (RBD)and treatment means were separated by critical difference at 5% level of significance (Gomez and Gomez 1984). The pooled data of chemical properties, nutrient status and plant parameters for two crop year have been presented.

RESULTS AND DISCUSSION

Chemical properties and nutrient status of soil

Irrespective of treatments, the mean pH, EC and organic carbon was not significantly influenced by various treatments in both the years presented in (Table 2). However, different fertigation treatments significantly influenced the availability of nutrients. In general, the decreasing level of nutrients significantly decreased the content of availablenutrients. The highest build up ofavailable nitrogen was recorded under 100% RD (365.3 kg ha^{-1}) which was statistically at par with T_6 (354.4 kg ha^{-1}) and T_2 (352.0 kg ha^{-1}). However, these treatmentsregistered significantly higher available nitrogen content over the application of nutrients to the tune of 80, 70 and 60 percent of recommended dose. Treatment comprising fertigation with 100% RD increased the soil available nitrogen status by 20 per cent over the initial value recorded before execution of trial. Such an increase under fertigation with 90 and 110 per cent of RD were recorded to be 15.7

and 4.3 respectively. Quntam of N being added in balance application have helped higher available nitrogen status with 100% RD level. These results are in consonance with those of Fanish and Muthukrishnan 2013, Janagarathinam 2007 andBehera*et al.* 2013.Similarly, available P contents were relatively greater(95.84kg ha^{-1}) under 100 percent fertigation treatment. However, differences in available P among 100, 110 and 90 percent of RD were not significant. Significantly higher available P under 100% RD treatment may be due to the complete solubility of phosphorus source and frequent and small application rates through drip system. The findings corroborates with the results reported by Rauschkolb*et al.* 1976 and Harjinder*et al.* 2004. It is also observed that effect of different levels of fertigation treatments on available K, closely followed available N and P in soil. Thehigh availability of potassium may be due to majority of applied K was held in the surface soil and the downward movement was slow resulting in very small movement to deeper layer. The results are in agreement with the findings of Fanish and Muthukrishnan 2013, Zeng et al. 2000, Mmolawa and Or 2000, Mishra *et al.* 2006 and Suganya 2007. The data presented in (Table 3) indicated that imposition of different treatment did not influenced the availability of calcium, magnesium and micronutrient content of soil. However, highercontent of availableCa(5.99 [cmol $(p^{+})kg^{-1}$]), Mg(2.01 [cmol $(p^{+})kg^{-1}$]), Zn (2.95 mg kg^{-1}), Cu (3.99mg kg^{-1}), Fe(26.69 mg kg^{-1}) and Mn (10.52kg ha^{-1}) were recorded under 100% RD (T_1) fertigation treatment.

Plant parameter and yield

The plant parameters of cauliflower i.e. number of leaves, gross weight, curd weight and yield was significantly influenced by different levels of fertigation (Table 4). The number of leaves among nutrient levels was significantly higher under T_1(19) which was at par with T_2,T_3 and T_6. The higher number of leaves with 100 percent RD treatment may be attributed to balanced nutrition, better water and nutrients utilization which results into more vegetative growth and higher photosynthetic rate. Similar findings on cauliflower crop have also been reported by Yanglem and Tumbare (2014). These results are also in consonance with those of Olsen and Grevsen (2000) and Kage*et al.* (2001) and Aladakatti*et al.* (2012). The increase in gross weight was noted to be 18.5 per cent higher under 100% RD compared to 60% RD. This could be due to high yield and vegetative growth becauseof balanced fertilization in fractionated supplies have met the nutrient requirement of cauliflower at different growth stages. The curd weight is an important parameter that determines the commercial viability and acceptability of a variety and is one of the most important traits attaining highest consideration in research programs. Application of recommended level of nutrients (T_1) produced maximum (873.8 g plant^{-1}) curd weight which was at par with T_6(844.4 g plant^{-1}). A comparision of data among different fertigation level reveals that T_1, T_2, T_3, T_4, T_5 and T_6 registered curd yield in the tune of 291.0, 274.5, 266.5, 254.3, 246.9 and 281.2q ha^{-1}, respectively. The increase in curd yield was noted to be 18 per cent higher under 100% RD treatment over to 60% RD treatment. These results suggested that increasing level of fertigation significantly improved the curd yield. Significantly higher yield under 100% RD treatment may be attributed to much better water and nutrient utilization as nutrients were applied in ten equal splits. These fractionated supplies in optimum nutrient concentration might have met the nutrient requirement of cauliflower at various growth stages thus leading to higher curd weight and yield. Kapoor*et al.* (2014), Sathya*et al.* (2008) and Brahma *et al.* (2010) observed significantly higher yield of tomato on fertigation. Similar observations were also made by Patel and Rajput (2003) in broccoli. Yanglem and Tumbare (2014) have also made the similar findings and attributed to such effect at higher fertigation level, crop meet out its nutritional requirement at respective growth stage which lead to luxurious growth and there by enhancement of yield in cauliflower.

Table 1. Some important physico- chemical properties of the experimental soil

Characteristics	Value	Methods/ References
pH (soil: water 1:2)	6.56	1:2 Soil : water suspension, measured with digital pH meter (Jackson, 2005)
EC (soil : water 1: 2)dSm^{-1}	0.18	1:2 Soil : water suspension, measured with digital EC meter (Jackson, 2005)
Textural class	Gravelly sandy loam	
Organic carbon (%)	1.00	Walkley and Black wet digestion method (Walkley and Black, 1934)
Available N (kg ha^{-1})	264.5	Alkaline potassium permanganate method (Subbiah and Asija, 1956)
Available P (kg ha^{-1})	42.5	Olsen's method (Olsen *et al.*, 1954)
Available K (kg ha^{-1})	377.3	Ammonium acetate method (Merwin and Peech, 1951)
Available Ca (cmol (p^{+}) kg^{-1})	4.31	Ammonium acetate method

		(Merwin and Peech, 1951)
Available Mg (cmol (p^+) kg^{-1})	1.41	Ammonium acetate method (Merwin and Peech, 1951)
DTPA Zn (mg kg^{-1})	2.58	DTPA extractant(Lindsay and Norvell,1978)
DTPA Cu (mg kg^{-1})	1.60	DTPA extractant(Lindsay and Norvell,1978)
DTPA Fe (mg kg^{-1})	20.76	DTPA extractant(Lindsay and Norvell,1978)
DTPA Mn (mg kg^{-1})	1.96	DTPA extractant(Lindsay and Norvell,1978)

Table 2.Effect of drip fertigation on chemical propertiesof soil

Treatments	**pH**	**EC (dS/ cm)**	**OC (%)**	**Macro nutrient (kgha^{-1})**		
				N	**P**	**K**
T_1	6.69	0.60	1.39	365.3	95.8	477.8
T_2	6.60	0.48	1.27	352.0	83.2	438.8
T_3	6.55	0.45	1.23	337.1	75.9	428.3
T_4	6.53	0.41	1.17	308.1	69.2	412.6
T_5	6.49	0.38	1.14	303.4	65.0	396.9
T_6	6.62	0.51	1.29	354.4	91.8	463.4
CD(0.05)	**NS**	**NS**	**NS**	**22.9**	**12.8**	**9.9**

Table 3.Effect of drip fertigation on the availability of secondary and micronutrients of soil.

Treatments	**Calcium (cmol(p^+)kg^{-1})**	**Magnesium (cmol(p^+)kg^{-1})**	**Zinc (mg kg^{-1})**	**Copper (mg kg^{-1})**	**Iron (mg kg^{-1})**	**Manganese (mg kg^{-1})**
T_1	5.99	2.01	2.95	3.99	26.69	10.52
T_2	5.84	2.00	2.85	3.72	26.39	9.27
T_3	5.77	1.98	2.83	3.65	25.99	8.76
T_4	5.62	1.98	2.77	3.38	25.21	8.31
T_5	5.42	1.98	2.63	3.32	24.68	8.27
T_6	5.92	1.99	2.88	3.93	26.61	9.61
CD(0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 4.Effect of drip fertigation on plant growth and yield of cauliflower.

Treatments	Stalk length (cm)	No. of leaves	Gross weight (g)	Curd weight (g plant^{-1})	Yield (q ha^{-1})
T_1	5.0	19	1281.0	873.8	291.0
T_2	4.7	18	1149.6	825.5	274.5
T_3	4.6	18	1123.1	800.3	266.5
T_4	4.3	17	1114.5	763.8	254.3
T_5	4.2	16	1080.8	741.4	246.9
T_6	4.8	18	1209.1	844.4	281.2
CD(0.05)	**NS**	**1.08**	**65.16**	**41.64**	**13.92**

CONCLUSION

The results revealed that application of 100% RD of nutrients in ten splits through drip irrigation was found better in soil fertility status, nutrient uptake, plant parameter and curd yield over rest of the fertigation treatments. Compared with other treatments, use of 100% RD through fertigation resulted in significantly greater availability of nutrients, as also nutrient uptake that contributed to higher yield of cauliflower. Therefore it may be concluded that better soil health, higher and sustainable cauliflower production could be realized by applying 100% of recommended NPK in splits through drip irrigation.

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