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Influence of fertigation levels and intervals on plant and soil nutrient status in bittergourd

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Abstract
A field experiment was conducted during *kharif* (2018-2019) and summer (2019-2020) to standardize the fertigation levels and intervals for assessing plant and soil nutrient status *viz*., total nutrient uptake of N, P and K plant and available nutrient status. The experiment was laid out in Split Plot Design with two replications. The main plot treatment consist of five fertigation levels (F) *viz.*, F_1- 100% of RDF through soil as a straight fertilizer, F_2- 120% of RDF through water soluble fertilizer, F_3- 100% of RDF through water soluble fertilizer, F_4 - 80% of RDF through water soluble fertilizer, and F_5- 60% of RDF through water soluble fertilizer and sub plot treatment included three fertigation intervals (S) *viz*.,S_1- at 4 days interval, S_2- at 8 days interval and S_3- at 12 days interval. The F_2S_1 (120% of RDF through water soluble fertilizer (Fertigation) with 4 days intervals) provided significantly higher biomass and fruit yield of bitter gourd which was reflected in significantly higher total nutrient uptake of nitrogen (99.85 and 102.10 kg/ha), phosphorus (28.34 and 29.76 kg/ha) and potassium during summer season (114 kg/ha). Fertigation with 120% RDF with 4 days interval was found to record maximum available soil nutrients like nitrogen (268.62 and 270.51 kg/ha), phosphorus (17.90 and 19.72 kg/ha) and potassium (382.91 and 385.06 kg/ha) both the season.

Keywords: Bittergourd, fertigation, nutrient, uptake and soil

Introduction
Bitter gourd (*Momordica charantia* L.) is one of the most important vegetable of Cucurbitaceae family grown for its immature tuberculate fruits which have unique bitter taste. The area and production of bitter gourd in India is around 97 thousand hectors and 1137 thousand metric tons. Nutrients play very important role in growth and development of bitter gourd. Nutrient is also one of the main factors which govern the yield and quality of fruit of bitter gourd. Among them, N is the first limiting factor required to promote growth and to increase the size of the fruit. Phosphorus (P) is a structural element of certain coenzyme, which is involved in energy transfer thus, improves photosynthetic process and increased the growth of the crop. (Kacha *et al.*, 2017) [1]. Phosphorus also plays an important role in energy transformation and metabolic process of plant and stimulates early root formation and growth, gives a rapid and vigorous growth to plants. The role of potassium in plant metabolism, growth, and development and its significance in production of marketable fruit and on fruit firmness, quality and visual appearance are published and well known (Al-Moshileh *et al*., 2005) [2]. It plays a major role in the production of fruits. Hence, it is necessary for enhancing the fruit yield and yield attributes (Siva *et al*., 2018) [3].
The traditional fertilizers when applied in bulk, lot of fertilizers go waste due to leaching, evaporation and fixation in the soil. Moreover these fertilizers get transmitted to area beyond the active root zone and are no longer useful to the plants. The effective utilization by the plant in many cases is less than 50% of the fertilizers applied (Shirgure *et al*., 1999) [4]. Hence fertigation is used as one of the most effective and convenient method of supplying nutrient and water according to the specific requirements of the crop to maintain optimum soil fertility and better quality produce. Careful regulation and monitoring of nutrient supply is possible by even distribution of nutrients throughout the root zone. Split application can be an important part of a successful nutrient management program and can help growers achieve right source, right rate, right time and right place. Dividing total nutrient application into two or more treatments can help growers enhance nutrient efficiency, promote optimum yields and mitigate the loss of nutrients.

Material And Methods

A field experiment with bittergourd veriety 'Phule Green Gold' was conducted during *kharif* 2018-2019 and summer 2019-2020 at the Chilli and Vegetable Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was conducted in Split Plot Design with two replications. The main plot treatment including five fertigation levels (F) *viz.*, F_1- 100% of RDF (100:50:50kg/ha NPK) through soil as a straight fertilizer, F_2- 120% of RDF (120:60:60kg/ha NPK) through water soluble fertilizer, F_3- 100% of RDF(100:50:50kg/ha NPK) through water soluble fertilizer, F_4 - 80% of RDF(80:40:40kg/ha NPK) through water soluble fertilizer, and F_5- 60% of RDF (60:30:30kg/ha NPK) through water soluble fertilizer and sub plot treatment included three Fertigation intervals (S) *viz.*,S_1- at 4 days interval, S_2- at 8 days interval and S_3- at 12 days interval. The RDF (100:50:50 kg/ha NPK) through soil as a straight fertilizer used urea, muriate of potash and single super phosphate, where as water soluble fertilizer *viz.*, urea and 19:19:19 were used to provide the major nutrient requirement for the crop through fertigation. After sowing, the crop was irrigated with drip system according to crop requirement in respective season. Bower system was established with plastic net and vines were trailed on this. Online dripper (1 dripper plant $^{-1}$) with discharge rate of 4 L hr^{-1} was used. The data relating to growth attributes were statistically analysed by applying the technique of analysis of variance (ANOVA) for split plot design and the significance was tested by F test (Panse and Sukhatme, 1967) [5]. In cases where F values were found significant, critical differences (CD) were calculated.

Result And Discussion

Fertigation levels

The data presented in table 1 reveled that during *kharif* season and summer season, the maximum total nitrogen, phosphorus and potassium uptake was observed in F_2 i.e. 120% RDF through fertigation (83.31 and 87.62 kg/ha nitrogen respectively) and it was at par with the treatment F_3 i.e. 100% RDF through fertigation (78.44 kg/ha) during *kharif* season, (22.05 and 24.51 kg/ha phosphorus respectively) and it was at par with the treatment F_3 i.e. 100% RDF through fertigation (20.38 kg/ha) during *kharif* season and (90.85 and 97.68 kg/ha potassium respectively) and it was at par with the treatment F_3 i.e. 100% RDF through fertigation (84.31 kg/ha) during *kharif* season. The frequent application of nutrients to the root zone through fertigation coupled with better root activity increases the uptake per plant due to the better availability of nutrients. Also in drip fertigation the leaching loss of nutrients was lower as compared to soil application of fertilizers. Similar observations of increased uptake as a result of fertigation have also been reported by Vasane *et al.* (1996) [6], Hebbar *et al.* (2004) [7] and Lakshmi (1997) [8].

Fertigation intervals

The treatment S_1 i.e. fertigation at 4 days interval recorded maximum total nitrogen, phosphorus and potassium uptake (80.32 and 81.83 kg/ha nitrogen respectively); (20.19 and 22.56 kg/ha phosphorus respectively) and (86.90 and 91.67 kg/ha potassium respectively) and it was significantly superior over rest of the treatments during both the seasons. The recommended dose of nitrogen and potassium was applied in more number of splits along with irrigation water create favourable conditions for uptake of nutrients by the plant as reported by Kendule (2013) [9].

Interaction effects

The maximum total nitrogen, phosphorus and potassium uptake was observed in treatment F_2S_1 i.e. 120% RDF through fertigation with 4 days interval (99.85 and 102.10 kg/ha nitrogen respectively), (28.34 and 29.76 kg/ha phosphorus respectively) during both the seasons whereas treatment of F_3S_1 i.e. 100% RDF through fertigation with 4 days interval was at par during kharif season for total nitrogen uptake (93.26 kg). During *kharif* season, maximum total potassium uptake was observed in treatment F_2S_1 i.e. 120% RDF through fertigation with 4 days interval (114 kg/ha).

Available nitrogen, phosphorus and potassium of soil

The data presented in Table 2 revealed that, the available nitrogen, phosphorus and potassium of soil was found maximum in treatment F_2S_1 i.e. 120% RDF through fertigation with 4 days intervals during both the seasons (268.62 and 270.51 kg/ha nitrogen respectively); (17.90 and 19.72 kg/ha phosphorus respectively) and (382.91 and 385.06 kg/ha potassium respectively).

Table 1: Effect of fertigation levels and intervals on total uptake of nitrogen, phosphorus and potassium *kharif* and summer season

Treatments	Total nitrogen uptake (kg/ha)		Total phosphorus uptake (kg/ha)		Total Potassium uptake (kg/ha)	
	Kharif	**Summer**	***Kharif***	**Summer**	***Kharif***	**Summer**
Ferigation Levels (F)						
F_1	62.01	59.97	12.36	13.95	74.98	67.81
F_2	83.31	87.62	22.05	24.51	90.85	97.68
F_3	78.44	81.37	20.38	22.48	84.31	90.97
F_4	73.13	76.81	18.17	20.94	77.28	85.95
F_5	50.10	58.57	8.26	13.71	53.93	65.72
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	1.33	0.48	0.58	0.17	2.05	0.46
CD 5%	5.21	1.89	2.27	0.68	8.06	1.82
Fertigation Intervals (S)						
S_1	80.32	81.83	20.19	22.56	86.90	91.67
S_2	68.16	72.36	15.86	18.93	75.50	81.05
S_3	59.72	64.40	12.69	15.86	66.41	72.16
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.99	0.26	0.26	0.10	1.23	0.35
CD 5%	3.12	0.82	0.82	0.30	3.89	1.10
Interaction effects (F X S)						
F_1S_1	67.70	60.74	13.37	14.64	83.11	68.75

F_1S_2	59.62	59.95	12.26	13.70	71.81	67.79
F_1S_3	58.72	59.21	11.46	13.51	70.02	66.90
F_2S_1	99.85	102.10	28.34	29.76	106.30	114.00
F_2S_2	81.49	87.76	21.52	24.57	90.04	97.67
F_2S_3	68.60	73.00	16.27	19.21	76.22	81.37
F_3S_1	93.26	93.73	26.10	27.25	96.98	104.70
F_3S_2	77.17	79.86	19.66	22.10	84.31	89.29
F_3S_3	64.88	70.51	15.40	18.08	71.63	78.91
F_4S_1	86.53	91.33	23.43	26.31	89.55	102.27
F_4S_2	72.51	75.22	17.50	20.51	77.73	84.10
F_4S_3	60.35	63.88	13.58	16.00	64.57	71.48
F_5S_1	54.24	61.27	9.70	14.84	58.54	68.63
F_5S_2	50.01	59.03	8.35	13.76	53.60	66.39
F_5S_3	46.06	55.41	6.74	12.51	49.64	62.13
F test	Sig.	Sig.	Sig.	Sig.	NS	Sig.
SE(m) ±	2.22	0.58	0.58	0.21	2.76	0.78
CD 5%	6.98	1.83	1.83	0.67	-	2.46

Table 2: Effect of fertigation levels and intervals on available nitrogen, phosphorus and potassium of soil

Treatment	Available nutrient (Kg/ha)					
	Nitrogen		**Phosphorus**		**Potassium**	
	Kharif	**Summer**	***Kharif***	**Summer**	***Kharif***	**Summer**
F_1 S_1	257.72	262.42	16.37	18.33	378.29	382.50
F_1 S_2	256.91	261.79	16.66	18.03	378.43	382.99
F_1 S_3	257.11	262.20	16.50	17.22	376.54	382.54
F_2 S_1	268.62	270.51	17.90	19.72	382.91	385.06
F_2 S_2	264.70	269.59	17.76	19.62	382.33	384.32
F_2 S_3	261.39	268.73	17.43	19.11	381.65	383.90
F_3 S_1	258.63	265.96	17.33	18.68	379.92	382.76
F_3 S_2	257.45	265.46	17.24	18.31	379.61	382.36
F_3 S_3	256.15	261.81	17.12	18.01	379.36	381.97
F_4 S_1	255.04	262.17	16.87	17.59	379.01	381.51
F_4 S_2	253.77	259.10	16.79	17.30	378.70	381.26
F_4 S_3	252.15	258.52	16.23	17.01	378.24	382.44
F_5 S_1	248.04	256.56	16.03	16.47	378.19	381.76
F_5 S_2	245.51	255.81	15.91	16.27	377.99	380.12
F_5 S_3	244.10	254.74	15.88	16.18	377.55	379.97

Conclusion

On the basis of the results, it can be concluded that the application of 120% RDF (120:60:60 kg/ha NPK) through fertigation with 4 days interval in equal splits gave best results with respect to total nutrient uptake and available nutrients of soil in bittergourd.

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