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Effect of fertigation levels and intervals on growth performance of 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 growth performance *viz.*, vine length (cm), number of branches, leaf area (cm²) and chlorophyll content (mg/g) of bittergourd. The experiment was laid out in Split Plot Design with two replications. The main plot treatment consist of five fertigation levels (F) *viz.*, F₁- 100% of RDF through soil as a straight fertilizer, F₂- 120% of RDF through water soluble fertilizer, F₃- 100% of RDF through water soluble fertilizer, F₄- 80% of RDF through water soluble fertilizer, and F₅- 60% of RDF through water soluble fertilizer and sub plot treatment included three fertigation intervals (S) *viz.*, S₁- at 4 days interval, S₂- at 8 days interval and S₃- at 12 days interval. The results revealed superiority of fertigation treatment F₂ (120% of RDF through water soluble fertilizer) for vine length (426.70, 385.00 and 405.85 cm respectively), number of branches (20.60, 26.40 and 23.50 respectively) both at 90 DAS and leaf area (73.20, 74.46 and 68.03 cm² respectively) whereas, treatment S₁ (fertigation at 4 days interval) which showed maximum values in both the season and pooled mean for above characters like vine length (408.58, 368.68 and 388.63 cm respectively), number of branches (19.48, 25.24 and 22.36 respectively) both at 90 DAS and leaf area (69.80, 70.20 and 65.59 cm² respectively). As regards the treatment combination that the application of 120% of RDF through water soluble fertilizer (fertigation) with 4 days interval recorded highest vine length at 90 DAS (460.60, 429.00 and 444.80 cm respectively), number of branches at 90 DAS (24.70, 28.60 and 26.65 respectively) and leaf area during *kharif* season, summer season and pooled mean.

Keywords: Bitter gourd, fertigation, growth, vine length

Introduction

Bitter gourd (*Momordica charantia* L.) is one of the most important cucurbitaceous vegetable of grown in Maharashtra state for its immature tuberculate fruits which have unique bitter taste. The area and production of bitter gourd in India is around 97 thousand hectars and 1137 thousand metric tons respectively (Anon, 2018)^[1]. Its tender fruits are cooked or pickled. The fruit accumulates bitterness due to build up of three pentacyclic triterpenes momordicin, momordicinin and momordicilin. Fruits are rich source of vitamin C, iron, calcium, phosphorous, protein and carbohydrates. Fruits have medicinal value and are used for curing diabetes, asthma and rheumatism. It is used as a hypoglycemic and anti diabetic agent because it Posses hypoglycemic (blood sugar lowering) properties. It has analgesic, immune suppressive and anti-tumor properties useful in killing bacteria, viruses, fights free radicals, cancer cells, leukemia cells, prevents tumors, cleanses blood, reduce inflammation, reduces blood sugar and balance hormones. (Triveni *et al.*, 2015)^[11]. Enhancement of yield and quality of bittergourd is always proved to be important task which can be met out through advance technique like fertigation. Fertigation plays a major role for nutrient application to increase the nutrient use efficiency. Fertigation has the potential to supply a right mixture of water and nutrients to the root zone and thus meeting plants water and nutrient requirements in most efficient possible manner during a growing season. With fertigation, nutrient use efficiency is increased and the loss of nutrients to the ground water is reduced. Hence a precise scheduling of irrigation and fertilizer applications has provided sustainable production solution of every crop (Thenmozhi *et al.*, 2017)^[3]. Split fertilizer applications help to avoid salt damages to the crop and improves germination rate. Applying smaller amounts of fertilizers at shorter intervals reduce salt stress. Split fertilizer applications can play an important role in a nutrient management strategy that is productive, profitable and environmentally responsible.

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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 more and smaller quantity can help growers to enhance nutrient efficiency, promote optimum yields and mitigate the loss of nutrients.

Material and Methods

A field experiment with bitter gourd variety '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., F₁- 100% of RDF (100:50:50kg/ha NPK) through soil as a straight fertilizer, F₂- 120% of RDF (120:60:60kg/ha NPK) through water soluble fertilizer, F₃- 100% of RDF(100:50:50kg/ha NPK) through water soluble fertilizer, F₄ - 80% of RDF(80:40:40kg/ha NPK) through water soluble fertilizer, and F₅- 60% of RDF (60:30:30kg/ha NPK) through water soluble fertilizer and sub plot treatment included three Fertigation intervals (S) viz., S₁- at 4 days interval, S₂- at 8 days interval and S₃- 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. Seeds were sown uniformly at a spacing of 2 x 1m. After sowing, the crop was irrigated at four days interval in *kharif* and daily in summer for about 2 hours with drip system. Bower system established with plastic net and vines were trailed on this. Online dripper (1 dripper plant⁻¹) with discharge rate of 4 L hr⁻¹ were 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 (Snedecor and Cochran, 1975) [10]. In cases where F values were found significant, critical differences (CD) were calculated.

Result and Discussion

Fertigation levels

The growth parameters of bittergourd were significantly influenced by different fertigation levels. The data presented in table 1 and 2 revealed that the maximum vine length was recorded by F₂ i.e. 120% RDF through fertigation in both season and pooled mean (426.70, 385 and 405.85 cm respectively in 90 DAS) however, it was at par with F₃ (100% RDF through fertigation) at 60 and 90 DAS during both season and pooled mean, and F₄ at 90 DAS during summer season. NPK fertigation at higher doses significantly increased the length of vines (Abraham *et al.*, 2018) [4]. The maximum and vigorous plant growth was due to frequent and increased application of fertilizers applied directly in vicinity of root zone increases the availability and uptake of nutrient which leads to increase the cell size and cell elongation. The results were supported reported by Lee *et al.*, (2005) [5], Sharma *et al.* (2009) [6] and Jilani *et al.* (2009). The treatment F₂ i.e. 120% RDF through fertigation also produced more number of branches during both the season and pooled mean (13.23 and 20.60 respectively during *kharif* season), (17.87 and 26.40 respectively during summer season) and (15.55 and 23.50 respectively in pooled mean) which was at par with F₁ during summer season at 60 and 90 DAS (13.00 and 20.60 respectively). The variation in number of branches per vine

may be due to varied nutrient supply levels. The role of nitrogen is important as an essential constituent of chlorophyll, which has got a direct bearing on the rate of photosynthesis and as a constituent of protein for the promotion of growth of meristematic tissues. The effect of nitrogen in promoting vegetative growth and also the role of potassium as an essential element for promotion of growth of meristematic tissue has been well established (Tisdale *et al.*, 1985). For both the season, fertigation levels had significant influence over leaf area. In *kharif* and summer season the maximum leaf area was recorded by F₂ (73.20 and 74.46 cm² respectively), however, it was at par with treatment F₃ in both the season as well as F₄ during summer season. The effect of nitrogen in enhancing the leaf area is well established phenomena and increased levels of nutrition usually had positive relationship with growth (Sarro *et al.*, 1989) [7]. There was non significant influence of different fertigation levels on chlorophyll content of leaf during both the season and pooled mean. However numerically maximum chlorophyll content was reported by F₂ (35.29, 43.76 and 39.52 mg/g respectively) during both the season and pooled mean.

Fertigation intervals

The data presented in table 1 and 2 further revealed that during *both* season and pooled mean, the treatment S₁ i.e. fertigation at 4 days interval recorded significantly maximum vine length (408.58, 368.68 and 388.63 cm respectively in 90 DAS). The frequent application of recommended dose of N, P and K at 4 days interval increases the availability of these nutrients leading to increased uptake of N, P and K during growth period which increases protein and protoplasm synthesis for higher rate of mitosis resulting in increased growth attributes. These results are in agreement with those reported by Hari *et al.*, (2016) [2], Al-Jaloud *et al.* (1999) [8] and Shinde *et al.* (2010) [9]. Fertigation at 4 days interval also produced maximum number of branches during both season and pooled mean (12.24 and 19.48 respectively during *kharif* season), (17.48 and 25.24 respectively during summer season) and (14.86 and 2.36 at pooled mean) at 60 and 90 DAS. Treatment S₁ i.e. 4 days interval also recorded maximum leaf area (69.80, 70.20 and 70.00 cm² respectively), however, it was at par with S₂ i.e. fertigation at 8 days interval during pooled mean (63.88 cm²). As regards, the chlorophyll content, fertigation intervals did not show any significant influence during *kharif* season, however, during summer season and pooled mean it was significant. The treatment S₂ recorded numerically maximum chlorophyll content of leaf 33.68 mg/g during *kharif* season. Whereas, S₁ recorded numerically maximum chlorophyll content of leaf (41.82 and 37.56 mg/g respectively) during summer season and pooled mean.

Interaction effect

Considering the interaction effects of fertigation levels and intervals on growth performance of bittergourd at 60 and 90 DAS, the treatment F₂S₁ i.e. 120% RDF through fertigation with 4 days interval recorded significantly maximum vine length (310.02 and 460.60 cm respectively for *kharif* season), (429.00 cm respectively for summer season at 90 DAS) and (308.76 and 444.80 cm respectively for pooled mean) during both season and pooled mean. Treatment F₂S₁ at 60 and 90 DAS (15.60 and 24.70 respectively for *kharif* season), (20.70 and 28.60 cm respectively for summer season) and (18.15 and 26.65 respectively for pooled mean) which was at par with F₃S₁ (120% RDF through fertigation with 4 days interval) during *kharif* season at 60 DAS and during summer season at

90 DAS (14.50 and 28.00 respectively). The maximum leaf area was also recorded by treatment F₂S₁ i.e. 120% RDF through fertigation with 4 days interval (78.66 and 79.09 cm² respectively) during both the season which was at par with F₃S₁ i.e. 100% RDF through fertigation with 4 days interval

(76.47 and 76.93 cm² respectively) during both the season. The interaction effect between fertigation levels and intervals on leaf area and chlorophyll content of leaf was found to be non significant during both the season and pooled mean.

Table 1: Effect of fertigation levels and intervals on Vine length (cm) at 60 and 90 DAS and Leaf area (cm²)

Treatments	Vine length (cm)						Leaf area (cm ²)		
	60 DAS			90 DAS			Kharif	Summer	Pooled
	Kharif	Summer	Pooled	Kharif	Summer	Pooled			
Fertigation Levels (F)									
F ₁	235.20	207.00	221.10	364.47	289.67	327.07	61.50	55.37	57.00
F ₂	285.37	277.47	281.42	426.70	385.00	405.85	73.20	74.46	68.03
F ₃	274.46	262.93	268.70	414.20	372.83	393.52	71.82	72.53	66.91
F ₄	262.87	255.03	258.95	400.43	360.67	380.55	70.45	70.80	66.03
F ₅	218.20	217.23	217.72	338.20	309.77	323.98	54.46	62.59	59.37
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	NS
SE(m) ±	2.09	5.56	2.51	4.18	8.46	3.04	1.28	0.58	1.98
CD 5%	8.41	22.43	10.13	16.86	34.11	12.26	5.01	2.29	-
Fertigation Intervals (S)									
S ₁	271.54	262.62	267.08	408.58	368.68	388.63	69.80	70.20	65.59
S ₂	251.92	244.30	248.11	388.12	343.62	365.87	66.93	67.47	63.88
S ₃	242.20	224.88	233.54	369.7	318.46	344.08	62.13	63.79	60.94
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	1.40	4.45	1.80	1.57	2.13	1.61	0.44	0.21	0.56
CD 5%	4.49	14.21	5.76	5.02	6.81	5.14	1.40	0.67	1.76
Interaction effects (F X S)									
F ₁ S ₁	236.60	207.50	222.05	363.30	293.40	328.35	61.47	55.83	58.65
F ₁ S ₂	233.00	204.50	218.75	364.00	287.70	325.85	61.51	55.20	58.36
F ₁ S ₃	236.00	209.00	222.50	366.10	287.90	327.00	61.52	55.08	58.30
F ₂ S ₁	310.02	307.50	308.76	460.60	429.00	444.80	78.66	79.09	78.88
F ₂ S ₂	280.10	277.40	278.75	422.40	382.50	402.45	73.79	74.08	73.94
F ₂ S ₃	266.00	247.50	256.75	397.10	343.50	370.30	67.15	70.22	68.69
F ₃ S ₁	293.37	291.50	292.44	438.90	404.00	421.45	76.47	76.93	76.70
F ₃ S ₂	270.60	264.20	267.40	412.80	378.50	395.65	73.16	73.30	73.23
F ₃ S ₃	259.40	233.10	246.25	390.90	336.00	363.45	65.84	67.37	66.61
F ₄ S ₁	287.40	283.00	285.20	425.30	396.00	410.65	75.06	75.25	75.16
F ₄ S ₂	260.60	255.60	258.10	398.30	358.00	378.15	72.52	72.12	72.32
F ₄ S ₃	240.60	226.50	233.55	377.70	328.00	352.85	63.77	65.04	64.41
F ₅ S ₁	230.30	223.60	226.95	354.80	321.00	337.90	57.33	63.89	60.61
F ₅ S ₂	215.30	219.80	217.55	343.10	311.40	327.25	53.67	62.64	58.16
F ₅ S ₃	209.0	208.30	208.65	316.70	296.90	306.80	52.38	61.24	56.81
F test	Sig.	NS	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	NS
SE(m) ±	3.15	0.10	4.04	3.51	4.80	3.60	0.99	0.48	1.25
CD 5%	9.93	--	12.73	11.06	15.0	11.30	3.12	1.50	-

Table 2: Effect of fertigation levels and intervals on number of branches (at 60 and 90 DAS) and Chlorophyll content of leaf

Treatments	Number of branches						Chlorophyll content of leaf (mg/g)		
	60 DAS			90 DAS			Kharif	Summer	Pooled
	Kharif	Summer	Pooled	Kharif	Summer	Pooled			
Fertigation Levels (F)									
F ₁	9.27	13.00	11.13	14.30	20.60	17.45	31.48	38.84	35.16
F ₂	13.23	17.87	15.55	20.60	26.40	23.50	35.29	43.76	39.52
F ₃	12.43	17.30	14.87	19.20	25.77	22.48	33.44	41.38	37.41
F ₄	11.87	16.80	14.33	18.20	25.10	21.65	33.96	39.12	36.54
F ₅	7.50	14.10	10.80	13.03	21.50	17.27	33.24	39.84	36.54
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	NS	NS	NS
SE(m) ±	0.12	0.21	0.11	0.45	0.16	0.21	0.054	0.07	0.06
CD 5%	0.49	0.82	0.43	1.78	0.63	0.81	-	-	-
Fertigation Intervals (S)									
S ₁	12.24	17.48	14.86	19.48	25.24	22.36	33.30	41.82	37.56
S ₂	10.64	15.40	13.02	16.92	23.90	20.41	33.68	41.38	37.53
S ₃	9.70	14.56	12.13	14.80	22.48	18.64	33.46	38.56	36.01
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	NS	Sig.	Sig.
SE(m) ±	0.17	0.11	0.07	0.18	0.14	0.11	0.04	0.06	0.04
CD 5%	0.52	0.36	0.21	0.55	0.43	0.35	-	0.19	0.12
Interaction effects (F X S)									
F ₁ S ₁	9.20	13.10	11.15	14.00	20.30	17.15	30.95	37.72	34.34

F ₁ S ₂	9.20	13.00	11.10	14.60	20.70	17.65	33.31	40.80	37.06
F ₁ S ₃	9.40	12.90	11.15	14.30	20.80	17.55	30.18	37.99	34.09
F ₂ S ₁	15.60	20.70	18.15	24.70	28.60	26.65	34.89	46.74	40.82
F ₂ S ₂	12.80	17.10	14.95	20.30	26.40	23.35	35.35	44.63	39.99
F ₂ S ₃	11.30	15.80	13.55	16.80	24.20	20.50	35.63	39.90	37.77
F ₃ S ₁	14.50	19.80	17.15	22.80	28.00	25.40	33.19	43.70	38.45
F ₃ S ₂	12.00	16.60	14.30	18.80	25.70	22.25	32.65	40.84	36.75
F ₃ S ₃	10.80	15.50	13.15	16.00	23.60	19.80	34.48	39.60	37.04
F ₄ S ₁	13.80	19.20	16.50	22.00	27.20	24.60	33.92	40.30	37.11
F ₄ S ₂	11.70	16.10	13.90	17.70	25.20	21.45	34.15	40.54	37.35
F ₄ S ₃	10.10	15.10	12.60	14.90	22.90	18.90	33.81	36.52	35.17
F ₅ S ₁	8.10	14.60	11.35	13.90	22.10	18.00	33.55	40.62	37.09
F ₅ S ₂	7.50	14.20	10.85	13.20	21.50	17.35	32.95	40.10	36.53
F ₅ S ₃	6.90	13.50	10.20	12.00	20.90	16.45	33.22	38.79	36.01
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	NS	NS	NS
SE(m) ±	0.37	0.25	0.15	0.39	0.30	0.25	0.08	0.13	0.09
CD 5%	1.17	0.79	0.47	1.24	0.96	0.78	-	-	-

Conclusion

It can be summed up that maximum growth performance viz., vine length, number of branches and leaf area etc. of bittergourd in desirable direction could be achieved by application of 120% RDF (120:60:60 kg/ha NPK) through fertigation with 4 days interval in equal splits which ultimately resulted in improving yield of bittergourd.

attributes of Bitter guards (*Momordica Charantia* L),
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