Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2582-2845.8081

ISSN: 2582 – 2845

Ind. J. Pure App. Biosci. (2020) *8*(3), 346-353

Research Article

Indian Journal of Pure & Applied Biosciences

Peer-Reviewed, Refereed, Open Access Journal

Effect of Micro-irrigation and Fertigation on Yield and Yield Contributing Characters of Acid Lime

H. B. Goramnagar*, P. K. Nagre, Y. V. Ingle and V. U. Raut

Department of Horticulture, Dr. PDKV, Akola-444104 (MS)

*Corresponding Author E-mail: kongharekar@gmail.com

Received: 7.05.2020 | Revised: 13.06.2020 | Accepted: 18.06.2020

ABSTRACT

The experiment was carried out in factorial randomized block design comprised of three levels of irrigation i.e. 100, 90 and 80 per cent micro-irrigation of Evp and three levels of fertigation i.e. 100, 80 and 60 per cent RDF with nine treatment combination to study the effect of micro-irrigation and fertigation on yield and yield contributing characters in acid lime crop. It is evident from the data that, flowers borne on one meter shoot had shown statistical difference due to an irrigation and fertigation levels during both the years. Fruit set and fruit retention data was non-significant due to the irrigation levels during both the years of experimentation. However, the higher fertigation level F_1 produced significantly the maximum fruit set (47.37 and 48.26 %, respectively) and fruit retention (87.54 and 88.53% respectively) during the tested years. In case of pooled yield, significantly the maximum fruits (25.07 kg/plant)and which was followed by the treatment combinations I_3F_2 (24.26 kg/ plant), I_2F_1 (24.26 kg/plant) and I_2F_2 (23.65 kg/ plant) which were at par with each other.

Keywords: *Acid lime, Irrigation, Fertigation, Yield*

INTRODUCTION

Acid lime usually known as Kagzi lime (*Citrus aurantifolia* Swingle) are exploit in many ways *viz.* cooking, garnishing, salads, pickles and beverage industry. Demand of the fruits is increasing and limes fetch maximum price in summer. To achieve this demand, huge scale plantations are coming up in Maharashtra state particularly in Vidarbha region. Alike to mandarin and sweet orange, the acid lime is also reactive to moisture deficit. Water and nutrition management is also one of the significant aspect for improving the productivity and quality of fruit crops. The awareness of specific nutrient and water requirement is prerequisite for improved fertilizer and water use efficiency for avoiding unnecessary use of excess fertilizer and water. Hence present investigation was carried out to find out the optimum level of micro-irrigation and fertigation for obtaining higher production of acid lime fruits in *Hasta bahar*.

Cite this article: Goramnagar, H.B., Nagre, P.K., Ingle, Y.V., & Raut, V.U. (2020). Effect of Micro-irrigation and Fertigation on Yield and Yield Contributing Characters of Acid Lime, *Ind. J. Pure App. Biosci. 8*(3), 346-353. doi: http://dx.doi.org/10.18782/2582-2845.8081

MATERIALS AND METHODS

The experiment was laid out in factorial randomized block design comprised of three levels of irrigation *i.e*. 100, 90 and 80 per cent micro-irrigation of Evp and three levels of fertigation i.e. 100, 80 and 60 per cent RDF with nine treatment combinations replicated thrice at experimental farm of Dr. PDKV, Akola during the year 2012-13 and 2013-14.

Treatment details

A. Irrigation levels

1. I_1: 100 % Irrigation of evaporation (Evp) through micro-irrigation
2. I_2: 90 % Irrigation of evaporation (Evp) through micro-irrigation
3. I_3: 80 % Irrigation of evaporation (Evp) through micro-irrigation

B. Fertigation levels

1. F_1: 100 % RDF through fertigation
2. F_2: 80 % RDF through fertigation
3. F_3: 60 % RDF through fertigation

C. Treatment combination

1. I_1F_1 Irrigation at 100 % of Evp with 100% of RDF through fertigation
2. I_1F_2 Irrigation at 100 % of Evp with 80% of RDF through fertigation
3. I_1F_3 Irrigation at 100 % of Evp with 60% of RDF through fertigation
4. I_2F_1 Irrigation at 90 % of Evp with 100% of RDF through fertigation
5. I_2F_2 Irrigation at 90 % of Evp with 80% of RDF through fertigation
6. I_2F_3 Irrigation at 90 % of Evp with 60% of RDF through fertigation
7. I_3F_1 Irrigation at 80 % of Evp with 100% of RDF through fertigation
8. I_3F_2 Irrigation at 80 % of Evp with 80% of RDF through fertigation
9. I_3F_3 Irrigation at 80 % of Evp with 60% of RDF through fertigation

Split doses of fertilizer applied with micro irrigation

Quantity of fertilizer through fertigation at each stage									
Split	F_1 (100%)			F_2 (80%)			F_3 (60%)		
	N (g)	P (g)	K (g)	N (g)	P (g)	K (g)	N (g)	P (g)	K (g)
1st October	150	75	60	120	60	48	90	45	36
2nd November	150	75	60	120	60	48	90	45	36
3rd December	120	60	60	96	48	48	72	36	36
4th January	120	60	60	96	48	48	72	36	36
5th February	60	30	60	48	24	48	36	18	36
Total (g)	600	300	300	480	240	240	360	180	180

The recommended dose of fertilizer (RDF) 600 g N, 300 g P2O5 and 300 g K2O per tree per year was applied with water soluble fertilizers and for fulfilling the nutrients requirement the fertilizers *viz*. urea (46 % N), 19:19:19, phosphoric acid (27 % P), sulphate of potash (50 % K) were used to quantify the dose of N, P and K in the splits.

A ring of drip lateral with suitable number of drippers of equal discharge rate (8 lph) was installed around each tree. For treatment I1- 10 drippers, for treatment I2- 9 drippers and for treatment I3- 8 drippers were installed at equal distance in the ring so that, the irrigation regimes of 100, 90 and 80 per cent of evaporation replenishment would have been achieved within single operation. For drip irrigation quantity of water to be applied was calculated by the following formula (FAO, 1998, Palve, 2012).

Water requirement (Q) = A x Epan x Kp x Kc

Where,

Q is the water requirement of plant (liters day-1plant-1), A is area of each plant (6 m x 6 m), Epan is pan evaporation (mm day-1) Kp is pan coefficient i.e. 0.8 (Deshmukh and Wadatkar, 2011), Kc is crop coefficient i.e. 0.7 for citrus crop (Allen et al., 1998).

The quantity of water in liters per day per plant was computed by the formula which was applied to irrigate the plant as per the treatment. The irrigation water was applied at alternate day considering the total evaporation during the interval gap. During the rainy days, the watering was done taking into account the amount of rainfall (mm) received. But, during the heavy rainfall and continuous rainy days, the irrigation was withheld for 72 hours so as to bring down the excess water in the soil to the field capacity level. Further, again the irrigation water was applied by considering the evaporation rate.

For recording the yield and yield contributing characters, number of flowers, fruit set percentage, fruit drop percentage, fruit retention percentage and fruits per plant(kg/plant) were computed from the flowers and fruits of *Hasta bahar* season during both the years.

RESULTS AND DISCUSSION

Flowers per shoot

The observations recorded on flowers borne per meter of shoot in *Hasta Bahar* are presented in Table 1 clearly indicated that, the flowers borne on shoot were significantly influenced due to the irrigation levels in both the years of experiment. The irrigation level I_3 produced the maximum flowers (29.25) and (35.86) which were statistically at par with the irrigation level I_2 (29.06) and (35.61) during the year 2012-13 and 2013-14 respectively. Significantly higher flowers (29.67 and 37.11, respectively)were recorded on shoot during both the years of experiment (2012-13 and 2013-14) under the fertigation level $F_1$and it was followed by the fertigation level F_2 (28.36 and 35.06) which were at par with each other during the respective years.

The flowers borne on one meter shoot had not shown statistical difference due to an interaction of the irrigation and fertigation levels during both the years. The supply of nutrients and water after sudden stress enhances the formation of new vegetative flush at higher levels as compare to lower levels. The stress period helps the carbon nitrogen balance to accelerate floral bud formation. The easy availability of water at lower levels and fertilizers at higher levels has generated more flower buds as compared to higher irrigation level. Singh and Srivastava (2001) reported that, the flowering is directly proportionate to nitrogen application in citrus. Ramniwas et al. (2012) also reported significantly higher number of flowers per shoot with 75 per cent irrigation of IW/CPE in guava.

Table 1: Effect of micro-irrigation and fertigation on flower induction and fruit set in acid lime

Treatment	Flowers /shoot		Fruit set (%)	
	2012-13	2013-14	2012-13	2013-14
Irrigation				
I_1 : 100 % Evp	24.92	30.58	44.11	43.59
I_2 : 90 % Evp	29.06	35.61	45.55	45.66
I_3 : 80 % Evp	29.25	35.86	46.99	47.57
F test	Sig	Sig	NS	NS
SE (m) ±	0.87	1.00	0.97	1.40
CD @ 5%	2.62	2.99	---	---
Fertigation				
F_1 : 100 % RDF	29.67	37.11	47.37	48.26
F_2 : 80 % RDF	28.36	35.06	46.40	46.25
F_3 : 60 % RDF	25.19	29.89	42.87	42.30
F test	Sig	Sig	Sig	Sig
SE (m) ±	0.874	0.997	0.974	1.397
CD @ 5%	2.621	2.989	2.919	4.189

Irrigation X Fertigation				
I_1F_1	26.50	33.75	44.95	47.08
I_1F_2	26.00	31.25	44.99	43.50
I_1F_3	22.25	26.75	42.37	40.18
I_2F_1	31.08	38.25	47.49	48.73
I_2F_2	30.08	35.50	46.52	46.46
I_2F_3	26.00	33.08	42.63	41.80
I_3F_1	31.42	39.33	49.66	48.98
I_3F_2	29.00	38.42	47.69	48.80
I_3F_3	27.33	29.83	43.61	44.92
F test	NS	NS	NS	NS
SE (m) ±	1.51	1.72	1.68	2.42
CD @ 5%	---	---	---	---

Fruit set (%)

On perusal of data in respect of fruit set (Table 1) indicated that, the result was non-significant due to the irrigation levels during both the years of experimentation. However, an increase in the fruit set was noted during 2012-13 and 2013-14 with the decrease in the irrigation level from I_1 (44.11 and 43.59 %, respectively) to I_3 (46.99 and 47.57 %, respectively). The higher fertigation level F_1 produced significantly the maximum fruit set (47.37 and 48.26 %, respectively) during the years 2012-13 and 2013-14. However, the fertigation level F_2 (46.20 and 46.25 %, respectively) was found to be at par and closely followed by the fertigation treatment F_1 during both the years of experimentation.

The data in respect of an interaction of the irrigation and fertigation levels on fruit set did not influenced statistically during both the years of experiment. The percentage of fruit set was varied from 49.66 and 48.98 in (I_3F_1) to 42.37 and 40.18 per cent in (I_1F_3) during 2012-13 and 2013-14, respectively in descending order. Though, the micro-irrigation do not influenced the fruit set but, the higher moisture might have helped in higher vegetative growth than reproductive growth. The more flower at lower irrigation level showed gradual increase in fruit set at lower irrigation regime. Similarly, the higher nutrient coupled with optimum moisture during winter months accelerated the fruit set. Higher nutrient application promotes more fruit setting with their increasing levels. These results are also confirmed by Govind and Prasad (1982) in sweet orange. Chauhan et al. (2006) also noted the highest fruit set at 66 per cent fertigation as compared with 100, 50 and 33 per cent dose of N, P and K. Similarly, Ramniwas et al. (2012) also reported higher fruit set at 75 per cent fertigation.

Fruit drop (%)

The data pertaining to the fruit drop as influenced by the irrigation and fertigation levels is presented in Table 2. The effect of irrigation levels during both the years on fruit drop was non-significant. However, the fruit drop was increased with decreasing levels of irrigation from I_1(14.04 and 12.20 %, respectively) to I_3(14.58 to 14.96 %, respectively) during the years 2012-13 and 2013-14. Fertigation levels influenced the fruit drop during both the years of experiment. The significantly lower fruit drop (12.46 %) was observed with the higher level of fertigation i.e.F_1 which was found to be at par with the fertigation level F_2 (13.28%) during first year of the study (2012-13). Similarly, in the second year, the fertigation level F_1recordedlower fruit drop (11.47%) which was statistically at par with the fertigation level F_2 (12.50 %). Fruit drop did not influenced statistically due to an interaction effect of the irrigation and fertigation levels during both the experimental years. However, the fruit drop was ranged from 11.87 (I_2F_1) to 17.98 per cent (I_2F_3) and 9.90 (I_1F_1) to 17.52 per cent (I_3F_3) during the years 2012-13 and 2013-14, respectively in ascending order. In general, the fruit drop decreased with increasing irrigation and fertigation regimes.

Inverse relation was noticed during present study of fruit drop with lower levels of irrigation and fertigation. Due to lower levels of irrigation plant absorb less amount of water thereby decreasing osmotic concentration and affecting auxin mechanism (Verma and Verma, 2014). This might leads to the formation of abscission layer causing fruit drop. This might be due to higher flower numbers, fruit set and flower drop due to increased moisture and nutritional status, which facilitates higher fruit retention and less drop. Similar findings were recorded by the Barbera and Carimi (1988) in lemon tree. Chauhan et al. (2006) also noted higher fruit set with increasing fertigation levels but, did not observed any significance in fruit drop.

Table 2: Effect of micro-irrigation and fertigation on fruit drop and fruit retention in acid lime

Treatment	Fruit drop (%)		Fruit retention (%)	
	2012-13	2013-14	2012-13	2013-14
Irrigation				
I_1 : 100 % Evp	14.04	12.20	85.96	87.80
I_2 : 90 % Evp	14.28	13.44	85.72	86.56
I_3 : 80 % Evp	14.58	14.96	85.42	85.04
F test	NS	NS	NS	NS
SE (m) ±	1.20	1.37	1.20	1.37
CD @ 5%	---	---	---	---
Fertigation				
F_1 : 100 % RDF	12.46	11.47	87.54	88.53
F_2 : 80 % RDF	13.28	12.50	86.72	87.50
F_3 : 60 % RDF	17.16	16.64	82.84	83.36
F test	Sig	Sig	Sig	Sig
SE (m) ±	1.202	1.37	1.202	1.37
CD @ 5%	3.604	4.10	3.604	4.10
Irrigation X Fertigation				
I_1F_1	12.25	9.90	87.75	90.10
I_1F_2	13.24	11.55	86.76	88.45
I_1F_3	16.62	15.15	83.38	84.85
I_2F_1	11.87	10.88	88.13	89.12
I_2F_2	12.98	12.22	87.02	87.78
I_2F_3	17.98	17.23	82.02	82.77
I_3F_1	13.26	13.62	86.74	86.38
I_3F_2	13.61	13.72	86.39	86.28
I_3F_3	16.88	17.52	83.12	82.48
F test	NS	NS	NS	NS
SE (m) ±	2.08	2.37	2.08	2.37
CD @ 5%	---	--	---	---

Fruit retention (%)

The data regarding fruit retention (Table 2) was found to be statistically non-significant due to the irrigation levels during both the years of experimentation. The fruit retention showed a linear increasing trend with the increasing levels of irrigation from I_3 to I_1.

Whereas, the fertigation level F_1registered significantly higher fruit retention (87.54 %) which was at par with the fruit retention of fertigation level F_2 (86.72 %) during the year 2012-13. In the second year of experimentation, similar trend of observation was noted by recording the maximum fruits (88.53%) on the plant under the fertigation level F_1. An interaction effect of irrigation and fertigation levels was found to be statistically non-significant during both the years.

However, the percentage of fruit retention was varied from 88.38(I_1F_3) to 82.02 per cent (I_2F_3) in 2012-13 and 90.10(I_1F_1) to 82.48 per cent (I_3F_3) in 2013-14. In common fruit drop and fruit retention is inversely related with each other. Fruit retention increases with increase in irrigation and fertigation regimes. This might have resulted due to less fruit drop at higher levels of irrigation and fertigation perhaps due to the minimum formation of abscissic layer in the best treatment. The more flowering, fruit set and lower flower and fruit drops at higher level of irrigation and fertigation facilitates higher fruit retention. Sujatha et al. (2006) reported the reduction of fruit drop was due to increase in retention of fruits. Ramniwas et al. (2012) also noted significantly higher fruit retention with 75 per cent irrigation and fertigation individual and in combination.

Fruit yield (kg/ plant)

The result pertaining to fruit yield per plant in *hasta bahar* showed the significant response to the irrigation and fertigation levels separately and in pooled combination during both the experimental years (Table 3).Significantly the maximum *hasta bahar* fruits were harvested from the tree of irrigation level I_3(20.02 kg/tree) in 2012-13 whereas,I_2 produced significantly maximum fruits (24.84 and 22.23 kg /tree) during 2013-14 and under pooled mean, respectively which were followed by the irrigation level I_2 (19.62 kg/plant in 2012-13, 23.93 kg/ tree in the irrigation level I_3 during 2013-14 and 21.97 kg/plant in the irrigation level I_3 during pooled analysis) which were found to be at par with each other.

Significantly the maximum fruits per plant of *hasta bahar* were harvested from the fertigation level F_1 (21.09, 26.04 and 23.57 kg tree^{-1} in 2012-13, 2013-14 and in pooled result, respectively). However, it was at par with the fertigation level F_2 (20.67, 24.86 and 22.76 kg tree^{-1} in 2012-13, 2013-14 and in pooled result, respectively). During the year 2012-13,the treatment combination did not showed significant difference however, the treatment combination I_3F_1 produced the maximum fruit yield per plant in *hasta Bahar* (22.95 kg/ plant) followed by the treatment combinations I_3F_2(22.35 kg/ plant), I_2F_1(21.38 kg/ plant)and I_2F_2 (21.12 kg/ plant).So as during 2013-14, the treatment combination I_3F_1 recorded the maximum fruit yield (27.20 kg/ plant) followed by the treatment combinations I_2F_1 (27.14 kg/ plant), I_3F_2 (26.20 kg/ plant), I_2F_2 (26.19 kg/plant) and I_1F_1 (23.79 kg/ plant).But, significant results were observed in pooled analysis, the treatment combination I_3F_1produced significantly the maximum fruits (25.07 kg/ plant)and which was followed by the treatment combinations I_3F_2 (24.26 kg/ plant), I_2F_1(24.26 kg/ plant) and I_2F_2 (23.65 kg/plant) which were at par with each other. The increase in number of fruits per plant at lower levels of irrigation coupled with higher levels of fertilizer and higher fruit size and more fruit weight at these levels of irrigation and fertigation yielded more fruit weight per plant. Similarly, higher levels of nutrients especially potassium at fruit development stage resulted into more number of quality fruits per plant. The number of fruits per plant was higher in higher levels of fertilizers but, the magnitude of increase in number was comparatively more in intermediate levels of irrigation which were closer to higher levels. Similarly the higher fruit weight at higher levels of irrigation and fertilizers resulted in overall increase in fruit yield per plant in terms of kg per plant. Similar findings were noted by the earlier workers like Dasberg et al. (1983) and Petillo (2000) in citrus. Shirgure et al. (2001) also noted significantly higher yield per plant in kg with increase in irrigation level. The maximum yield was observed due to 66 per cent fertigation as compared to 100, 50 and 33 per cent dose of NPK (Chauhan et al., 2006). Similar increase in yield with irrigation water was also reported by Sujatha et al. (2006), Chauhan and Chandel (2010) and Kumar et al.(2013), whereas, enhancement in yield due to increase in fertigation level was observed by Bhat et al.(2007) and Ramniwas et al.(2012).

Table 3: Effect of micro-irrigation and fertigation on fruit yield per plant of *Hasta bahar* in acid lime

Treatment	Fruit (kg/plant)		
	2012-13	**2013-14**	**Pooled**
Irrigation			
I_1 : 100 % Evp	17.53	21.64	19.59
I_2 : 90 % Evp	19.62	24.84	22.23
I_3 : 80 % Evp	20.02	23.93	21.97
F test	Sig	Sig	Sig
SE (m) ±	0.49	0.69	0.36
CD @ 5%	1.47	2.08	1.05
Fertigation			
F_1 : 100 % RDF	21.09	26.04	23.57
F_2 : 80 % RDF	20.67	24.86	22.76
F_3 : 60 % RDF	15.41	19.50	17.45
F test	Sig	Sig	Sig
SE (m) ±	0.49	0.69	0.36
CD @ 5%	1.47	2.08	1.05
Irrigation X Fertigation			
I_1F_1	18.94	23.79	21.37
I_1F_2	18.57	22.18	20.38
I_1F_3	15.09	18.95	17.02
I_2F_1	21.38	27.14	24.26
I_2F_2	21.12	26.19	23.65
I_2F_3	16.35	21.18	18.76
I_3F_1	22.95	27.20	25.07
I_3F_2	22.32	26.20	24.26
I_3F_3	14.79	18.37	16.58
F test	NS	NS	Sig
SE (m) ±	0.85	1.20	0.62
CD @ 5%	2.54	3.60	1.81

CONCLUSION

According to the present investigation, concluded that treatment combination I_3F_1 recorded the maximum flower per shoot, fruit set, fruit retention and fruit yield followed by the treatment combinations I_2F_1.

REFERENCES

Allen, R. G., Pereira, L. S., Dirk, R., & Martin, S. (1998). FAO guidelines for computing crop water requirement, irrigation and drainage paper 56, FAO, UN, Rome.

Barbera, G., & Carimi, F. **(**1988). Effect of different levels of water stress on yield and quality of lemon trees. In: Proc. 6th Inter. Citrus congress, 6-11 March, R. Goren and K. Mendel (Eds.), PP 717-722.

Bhat, R., Sujatha, S., & Balasimha, D. (2007). Impact of drip fertigation on productivity of arecanut (*Areca catechu* L.). *Agric. Water Manage*., *90* (1-2), 101–111.

Chauhan, N., &. Chandel, J. S. (2010). Growth, productivity, leaf nutrient contents and water-use efficiency of kiwi fruit (*Actinidia deliciosa*) under drip and basin irrigation system. *Indian J. Agric. Sci., 80*(7), 587.

Chauhan, P. S., Sharma, L. K., & Rana, S. S. (2006). Study on effect of NPK fertigation levels on growth, fruiting, fruit quality and leaf nutrient status of Red fuji and Scarlet gala apple cultivars in high density plantation, In Temperate Horticulture: Current Scenario. Kishore, D. K., S. K. Sharma and K. K. Pramanik, (eds.) PP 237-244. New India publishing agency, New Delhi.

Dasberg, S. C., Bieloria, H., & Erner, Y. (1983). Nitrogen fertigation of Shamouti oranges. *Pl. Soil*. *75*, 41-51.

Deshmukh, M. M., & Wadatkar, S.B. (2011). Determination of pan coefficient for Akola. *PKV Res. J. 35*(1), 40-49.

FAO,(1998). FAO Guidelines for Computing Crop Water Requirement, Irrigation and Drainage, Rome, UN, Paper 56.

Govind, S. and A. Prasad, 1982. Effect of nitrogen nutrition on fruit set, fruit drop and yield in Sweet orange. Punjab Hort. J. *22*(2), 15-19.

Kumar, H. P., Yadav, Y., & Singh, A. K., & Sharma, S.K. (2013). Evaluation of water regime and fertigation on growth, yield and economics of sweet orange (*Citrus sinensis* Osbeck) cv. mosambi. *Asian J. Hort.*, *8*(2), 709-713.

Palve, D. B. (2012). Response of garlic to different irrigation systems. M. Tech. (IDE) Thesis (unpub): *34*, Dept. IDE., Dr PDKV., Akola.

Petillo Garcia M., (2000). Fertigation versus conventional nitrogen fertilization of Valentia oranges. *Agrocencia* (Montevideo), *4*(1), 23-30.

Ramniwas, R. A., Kaushik, D. K., Sarolia, S., & Singh, Pareek, V. (2012). Effect of irrigation and fertigation scheduling on growth and yield of guava (*Psidium guajava* L.) under meadow orcharding. *African J. Agricultural Research*, *7*(47), 6350-6356.

Shirgure, P. S., Srivastava, A. K., & Singh, S. (2001). Growth, yield and quality of Nagpur mandarin *(Citrus reticulata* Blanco) in relation to irrigation and fertigation. *Indian J. Agric. Sci., 71*(8), 547- 550.

Srivastava, A. K. (2001). Citrus Nutrition, In Citrus, Singh, S. and Naqvi, S. A. M. H. (eds.), Published by International book distribution company, Lucknow, India. PP 187-200.

Sujatha. S., Rao, J. V., & Reddy, N. N. (2006). Effect of drip irrigation and nutrient management on mango (*Mangifera indica*) in Alflsols of semi-arid tropics. *Indian J. Agric. Sci*., *76*(10), 8-12.

Verma, S. K., & Verma, M. (2014). Growth and Metabolism of Growth Hormones. A text book of Pl Phy. Biochem. And Biotech., S. Chand and company Pvt. Ltd., New Delhi. PP 349-370.