Volume 2018; Issue 02

Open Access Journal of Agriculture Research

Research Article

Jbawi EA. Open Acc J Agri Res: OAJAR-100007.

Effect of Deficit Irrigation and Manure Fertilizer on Improving Growth and Yield of Quinoa in Syria

Entessar Al Jbawi[1*], Rasha Danoura[1] and Abdallah Yaacoub[2]

[1]General Commission for Scientific Agricultural Research (GCSAR), Syria

[2]Rural Engineering Department, Faculty of Agriculture, Damascus University, Syria

[*]**Corresponding author:** Entessar Al Jbawi, Sugar Beet Department, Crops Research Administration, General Commission for Scientific Agricultural Research (GCSAR), Damascus, Syria. Tel: 963113947168; 963988699884; Fax: 963112254884; Email: dr.entessara@gmail.com

Citation: Jbawi EA, Danoura R, Yaacoub A (2018) Effect of Deficit Irrigation and Manure Fertilizer on Improving Growth and Yield of Quinoa in Syria. Open Acc J Agri Res: OAJAR-100007.

Received Date: 22 August, 2018; **Accepted Date:** 18 September, 2018; **Published Date:** 05 October, 2018

Abstract

There is renewed interest in quinoa (*Chenopodium quinoa* Willd) production in Syria. However, recommended agronomic practices for maximizing productivity are limited. A field experiment was conducted at Karahta Agricultural Station, in Damascus Countryside Agricultural Research Center, General Commission for Scientific Agricultural Research (GCSAR), Syria, during 2017 to study the effect of organic amendment on the productivity and growth of quinoa under deficit irrigation. The experiment was split-plot design with three replications, with irrigation regimes (Full Irrigation FI 100, Deficit Irrigation DI 80 and DI 60) allocated in the main-plots, while organic fertilizer (control and sea weeds fertilizer) occupied the sub-plots. The results showed that the highest ($p \leq 0.05$) values of the studied traits were obtained under the addition of sea weeds extracts. So, it is recommended to be added. In terms of irrigation regime, FI 100 was superior over DI 80 and DI 60 in stem diameter, and panicle length and diameter. But it had no significant effect on plant number per hectare, harvest index, panicle weight plant weight and grain weight per plant. Hence it is recommended to be follow the DI 60 in areas with water shortages.

Keywords: Irrigation Regime; Quinoa; Sea Weeds Extracts; Syria; Yield

Introduction

The demand for food is rising by rapid world population growth, and food security is one of the main concerns of this century. On the other hand, agricultural production is increasingly faced with environmental constraints such as drought, salinity and negative impacts of climate changes, therefore, the effective usage of limited water and soil resources, and the inclusion of new stress tolerant crops such as quinoa in cropping systems have become important.

Quinoa (*Chenopodium quinoa* Willd.) is an annual grain plant native to the Andean region of South America. This plant is known by resistance to various abiotic stresses such as salinity, drought and frost [1,2]. Also, it has been cultivated in diverse environmental conditions include low precipitation, high evapotranspiration rate, frost and soil salinity for thousands of years [3]. This crop has adapted to different agro-ecological zones range from sea level up to 4000 m altitude with its rich genetic diversity [3,4]. Its high gluten free nutritional component is another characteristic. It considers a unique food crop that contains all the essential amino acids, trace elements and vitamins [2]. Quinoa has been indicated as a good candidate to offer food security, especially in the face of the predicted future world scenario of increasing salinization and aridity [4]. Because of that quinoa has attracted interest all over the world and its cultivation has begun expand in many countries in Europe, Africa and Asia [5].

It is well known that irrigation plays a key role in increasing agricultural productivity. On the other hand, the irrigated agriculture is already the largest water user with an average about 70% of global fresh water consumption. The climate change effects are further threat for limited fresh water resources especially in arid and semi-arid region. It is possible to obtain high yields using less water with appropriate deficit irrigation strategies. Deficit irrigation strategy could be a judicious solution to increase crop water productivity, and it was shown to be very efficient in arid and semi-arid region, which is suffering from water scarcity [6-10].

There is no crop other than quinoa that resists the combination of adverse factors [3]. Quinoa is generally less affected by frost than most other crop species [1]. Geerts et al., (2008) [2] reported that maximal yield obtained under full irrigation was 2.04t/ ha, similar to deficit irrigation with 2.01 t/ha, while rainfed conditions yield was reduced to 1.68 t/ha. Studies were conducted on several crops in order to study the effect of organic amendment on water-holding capacity of soils and especially under arid and semi-arid conditions, indicating that organic matter input improved field capacity and soil water content and increased soil hydraulic conductivity [11,12]. Organic matter incorporation in the soil has also a positive effect on growth, productivity and yield [13-16].

Very few studies conducted on quinoa evaluating organic amendment on yield are available; nevertheless, other crops were tested with regard to organic amendment and showed a positive response. Adding organic manure in to the soil will improve the soil content in terms of nutrients after mineralization of the organic matter and will increase the nutrients availability for plants; therefore, the nutrients uptake will be increased and the plant growth and productivity will be improved [17]. Supplying organic matter under deficit irrigation conditions could be a practical solution to compensate the negative effect of water stress. Therefore, this study was carried out in order to determine: how organic amendment improves quinoa productivity and growth under deficit irrigation. Seaweeds and seaweed products are increasingly used in crop production. Further, seaweed extracts are considered an organic farm input as they are environmentally benign and safe for the health of animals and humans [18]. Seaweed components such as macro- and microelement nutrients, amino acids, vitamins, cytokinins, auxins, and Abscisic Acid (ABA)-like growth substances affect cellular metabolism in treated plants leading to enhanced growth and crop yield [19,20]. Plants sprayed with seaweed extracts also exhibit enhanced salt and freezing tolerance [21]. The study is carried out to detect the effect of organic amendment on the productivity and growth of quinoa under deficit irrigation under the Syrian conditions.

Materials and Methods

Experimental Site and Soil

This research was conducted in the mid of February (2017), at Karahta Agricultural Station, in Damascus Countryside Agricultural Research Center, General Commission for Scientific Agricultural Research (GCSAR), Syria. The site has a latitude of 33.39 N, and longitude of 36.45 E. The soil of the experimental site is classified as sandy, with medium texture throughout the soil profile, and has a pH 8, and electrical conductivity of the saturation extract (ECe) 0.9 dS m^{-1}.

The soil of the experimental site is characterized by medium nitrogen, phosphorous and potassium content (38.7, 7.6 and 62 mg. Kg^{-1} respectively). Nitrogen fertilization in the form of urea (46% N) was divided equally, the first half was added pre-planting, while the second half after thinning. Triple superphosphate (46% P_2O_5) and (K_2O) were added pre-planting. Two factors experiment were conducted in a randomized complete block design (RCBD) in a split plots arrangement and three replications. The main plots were allotted to irrigation levels (100, 80 and 60) and the sub-plots to the organic manure (control and sea weeds extracts). The land was disc- ploughed, harrowed twice, leveled and ridged 50 cm apart, and 20 cm the space between holes. The size of the plot was 8X5 m, consisting of eight ridges of 8 m length. The seeds were sown manually on the shoulder of the ridge at a rate of 0.5 kg. ha^{-1} (three seeds per hole) on November 15th.

Irrigation System and Scheduling

Drip laterals of 16 mm in diameter had in-line emitters spaced 0.20 m apart, each delivering 2.0 L h^{-1}at an operating pressure of 100 kPa. One drip lateral was placed at the center of adjacent crop rows 0.50 m apart in the experimental plots. A locally produced drip-irrigation system was used in the study. Irrigations were applied at 2-week intervals depending on the temperature, relative humidity and soil moisture conditions. Soil-water deficit in the 90-cm soil profile in the FI treatments was replenished to field capacity. The deficit irrigation treatments received the nominated percentage of water applied to the FI plots.

Irrigation treatments used in the experiment:

FI: Full irrigation

DI 80%: Deficit irrigation, 80% water applied to FI

DI 60%: Deficit irrigation, 60% water applied to FI

Agronomic Practices

Quinoa (cv. NSL-106398) seeds were sown by hand 20 cm apart in the row and at 50-cm row spacing on 15th February 2017. Hand thinning to one plant per hole and replanting by the removed seedlings were done simultaneously after 5-6 weeks from planting. Manual weeding was done, after 5 weeks from planting. At harvest (4 months from sowing), when plants showed signs of maturity which is indicated by leaf yellowing and partial drying of the lower leaves, a sample of five plants was taken per plot from the inner two ridges randomly hand-pulled to determine: Plant weight (g), panicle weight.plant^{-1} (g), grain weight.plant^{-1} (g), plant length and diameter (cm), panicle length and diameter (cm), and three inner rows were harvested to determine number of plants.ha^{-1} (plant density), and grain yield.ha^{-1} (GY). Harvest index (HI) was calculated as the ratio of the GY to total aboveground dry matter (DM) yield at harvest. Plant samples were dried at 65˚C until constant weight was achieved. The temperatures during harvest reached 35˚C, (Table 1).

Month	Max. Temperature ˚C	Min. Temperature ˚C	Rainfall mm
January	16	-1	15.0
February	23	-3	16.3
March	25	3	6.7
April	22	12	5.1
May	35	13	2.3
June	35	18	0
Source: Meteorology Station in Damascus Countryside governorate.			

Table 1: Temperatures and rainfall distribution during 2017 season.

Citation: Jbawi EA, Danoura R, Yaacoub A (2018) Effect of Deficit Irrigation and Manure Fertilizer on Improving Growth and Yield of Quinoa in Syria. Open Acc J Agri Res: OAJAR-100007.

Statistical analyses

Analysis of variance (ANOVA) appropriate for the split plot design was applied [22]. The treatment means were compared using Least Significant Difference (LSD) procedures at 5% level using Gene Stat Computer Program v.12.

Results and Discussion

Plant Weight (g)

Table (2) illustrates a significant (P≤0.05) effect of organic fertilizer on plant weight, while the effect of irrigation level was not significant on this trait. This trait was greater when adding sea weeds extracts (O1) (72.1 g) as compared with the control (O0) (61.9 g) (Table 4). This could be explained by the fact that seaweed components in treated plants led to enhanced growth and crop yield [19,20].

		Plant weight (g)			Plant length (cm)		
Source of variance	df	MS	Variance %	P	MS	Variance %	P
Replications	2	71.68	0.51	-	22.39	1.10	-
Irrigation level (I)	2	97.69	0.70	0.549	926.06	45.61	0.002
Organic amendment (O)	1	466.78	23.87	0.003	826.89	57.69	<.001
I * O	2	89.61	4.58	0.062	196.06	13.68	0.006

DF: Degree of Freedom = n - 1, MS: Mean Square = SS / DF, SS: Sum of Squares, Variance % = (MS Factor / MS Total) * 100, P: Probability 0.05

Table 2. Analysis of variance (ANOVA) of plant weight (g) and plant length (cm).

Plant length (cm)

The analysis of variance (Table 2) for plant length showed a significant (P≤0.05) effect of irrigation level, organic amendment and the interaction on this character. Full irrigation FI and Deficit Irrigation DI 80 gave the highest values (11.7 and 105.8 cm respectively) with no significant differences (Table 3). Also, the organic treatment (108.6 cm) surpassed significantly the control (95.0 cm). The treatment FI 100 with the addition of organic amendment accounted the highest value (125 cm).

		Grain weight. plant^{-1} (g)			Stem diameter (cm)		
Source of variance	**df**	**MS**	**Variance %**	**P**	**MS**	**Variance %**	**P**
Replications	**2**	0.683	0.21	-	0.00167	0.12	-
Irrigation level (I)	**2**	6.880	2.07	0.241	1.29167	96.87	<.001
Organic amendment (O)	**1**	95.206	32.49	0.001	0.93389	80.05	<.001
I * O	**2**	4.450	1.52	0.293	0.01056	0.90	0.454

DF: Degree of Freedom = n - 1, MS: Mean Square = SS / DF, SS: Sum of Squares, Variance % = (MS Factor / MS Total) * 100, P: Probability 0.05

Table 3: Analysis of variance (ANOVA) of stem diameter (cm) and grain weight. Plant^{-1} (g).

Grain weight. plant^{-1} (g)

Table (3) exhibited a significant (P≤0.05) effect of organic fertilizer on grain weight per plant, while the effect of irrigation level was not significant on this trait. This trait was greater when adding sea weeds extracts (O1) (21.5 g) as compared with the control (O0) (16.9 g) (Table 4).

Irrigation Level (I)	Organic Amendment (O)	Plant weight (g)	Plant length (cm)	Stem diameter (m)	Grain weight. plant^{-1} (g)
FI 100	O0	67.0	98.3	1.5	16.8
	O1	76.3	125.0	2.0	19.4
Mean		71.7^{a}	111.7^{a}	1.7^{a}	18.1^{a}
DI 80	O0	63.4	101.7	1.1	17.3
	O1	66.3	110.0	1.7	23.0
Mean		64.9^{a}	105.8^{a}	1.4^{b}	20.2^{a}
DI 60	O0	55.4	85.0	0.6	16.7
	O1	73.7	90.7	1.0	22.2
Mean		64.6^{a}	87.8^{b}	0.8^{c}	19.5^{a}
Mean over irrigation level	O0	61.9^{b}	95.0^{b}	1.1^{b}	16.9^{b}
	O1	72.1^{a}	108.6^{a}	1.5^{a}	21.5^{a}
General mean		67.0	101.8	1.3	19.2
LSD (I)		19.0^{ns}	7.2*	0.2**	2.9^{ns}
LSD (O)		5.1**	4.4**	0.1**	2.0**
LSD (I*O)		18.6^{ns}	7.7**	0.2^{ns}	3.2^{ns}
CV%		6.6	3.7	8.2	8.9

*, and **: Significant at 0.05 and 0.01 level of probability respectively. ns: not significant at 0.05 level of probability. Panicle weight (g):

Table 4: The effect of organic manure on plant weight (g), length and diameter (cm), and grain weight. plant^{-1} (g) under deficit irrigation.

Stem diameter (cm)

The analysis of variance (Table 3) for stem diameter showed a significant (P≤0.05) effect of irrigation regime, and organic amendment on this character. Full irrigation FI gave the highest value (1.7 cm), followed by DI 80 (1.4 cm), and then DI 60 which achieved (0.8 cm) (Table 4). Also, the organic treatment (1.5 m) surpassed significantly the control (1.1 cm).

Panicle length and diameter (cm)

Both traits were affected significantly (P≤0.05) by irrigation regime and sea weeds extracts (organic fertilizer) (Table 5). The highest panicle length and diameter values were approached for FI 100 (44.76 and 11.1 cm respectively). Also, the treatment of organic fertilizer achieved the highest values of panicle length and diameter (42.6 and 9.8 cm respectively) (Table 6).

		Panicle weight (g)			Panicle length (cm)			Panicle diameter (cm)		
Source of variance	df	MS	Variance %	P	MS	Variance %	P	MS	Variance %	P
Replications	2	60.93	0.59	-	1.722	2.70	-	0.5972	1.62	-
Irrigation level (I)	2	134.17	1.31	0.365	233.389	365.30	<.001	32.7639	89.02	<.001
Organic amendment (O)	1	14.70	0.83	0.397	128.000	46.08	<.001	9.3889	56.33	<.001

I * O	**2**	69.80	3.95	0.080	5.167	1.86	0.235	0.4306	2.58	0.155
DF: Degree of Freedom = n - 1, MS: Mean Square = SS / DF, SS: Sum of Squares, Variance % = (MS Factor / MS Total) * 100, P: Probability 0.05										

Table 5: Analysis of variance (ANOVA) of panicle weight (g), length and diameter (cm).

Irrigation Level (I)	Organic Amendment (O)	Panicle weight (g)	Panicle length (cm)	Panicle diameter (cm)
FI 100	**O0**	40.3	41.0	10.7
	O1	43.9	48.3	11.5
Mean		42.1^{a}	44.7^{a}	11.1^{a}
FI 80	**O0**	36.4	39.7	8.7
	O1	30.6	44.7	10.5
Mean		33.5^{a}	42.2^{b}	9.6^{b}
FI 60	**O0**	30.6	31.0	5.7
	O1	38.1	34.7	7.3
Mean		34.4^{a}	32.8^{c}	6.5^{c}
Mean over irrigation level	**O0**	35.8^{a}	37.2^{b}	8.3^{b}
	O1	37.6^{a}	42.6^{a}	9.8^{a}
General mean		36.7	39.9	9.1
LSD (I)		16.2^{ns}	1.3**	1.0**
LSD (O)		4.8^{ns}	1.9**	0.5**
LSD (I*O)		15.9^{ns}	2.4	1.0^{ns}
CV%		11.5	4.2	4.5
*, and **: Significant at 0.05 and 0.01 level of probability respectively. ns: not significant at 0.05 level of probability.				

Table 6: The effect of organic manure on panicle weight (g), length and diameter (cm) under deficit irrigation.

Plant number (thousands. ha^{-1})

Table (7) illustrates a significant ($P \leq 0.05$) effect of organic fertilizer on plant number per hectare, while the effect of irrigation regime was not significant on this trait. This trait was greater when adding sea weeds extracts (O1) (94 thousands. ha^{-1}) as compared with the control (O0) (88 thousands. ha^{-1}) (Table 8).

		Plant number (thousands. ha^{-1})			Grain yield (Kg. ha^{-1})			Harvest index (%)		
Source of variance	**df**	**MS**	**Variance %**	**P**	**MS**	**Variance %**	**P**	**MS**	**Variance %**	**P**
Replications	**2**	9.290	0.46	-	0.00394	0.35	-	13.501	0.76	-
Irrigation level (I)	**2**	27.332	1.34	0.359	0.11045	9.92	0.028	66.115	3.71	0.123
Organic amendment (O)	**1**	153.003	55.90	<.001	1.27011	52.92	<.001	28.261	3.39	0.115
I * O	**2**	4.973	1.82	0.242	0.02753	1.15	0.379	25.639	3.08	0.120
DF: Degree of Freedom = n – 1, MS: Mean Square = SS / DF, SS: Sum of Squares, Variance % = (MS Factor / MS Total) * 100, P: Probability 0.05										

Table 7: Analysis of variance (ANOVA) of plant number (thousands. ha^{-1}), grain yield (Kg. ha^{-1}) and harvest index (%).

Irrigation Level (I)	Organic Amendment (O)	Plant number (thousands. ha^{-1})	Grain yield (Kg. ha^{-1})	Harvest index (%)
FI 100	O0	85	1.42	25.0
	O1	92	1.79	25.5
Mean		89^{a}	1.60^{b}	25.2^{a}
FI 80	O0	90	1.56	27.8
	O1	94	2.17	35.1
Mean		92^{a}	1.86^{a}	31.5^{a}
FI 60	O0	90	1.50	30.5
	O1	95	2.11	30.3
Mean		92^{a}	1.80^{a}	30.4^{a}
Mean over irrigation level	O0	88^{b}	1.49^{b}	27.8^{a}
	O1	94^{a}	2.02^{a}	30.3^{a}
General mean		91	1.76	29.0
LSD (I)		7.2^{ns}	0.17*	6.8^{ns}
LSD (O)		1.9**	0.18**	3.3^{ns}
LSD (I*O)		7.1^{ns}	0.2^{ns}	6.9^{ns}
CV%		1.8	8.8	9.9

*, and **: Significant at 0.05 and 0.01 level of probability respectively. ns: not significant at 0.05 level of probability.

Table 8: The effect of organic manure on plant number (thousands. ha^{-1}), grain yield (Kg. ha^{-1}) and harvest index (%) under deficit irrigation.

Grain yield (Kg. ha^{-1})

The analysis of variance (Table 7) for grain yield trait showed a significant ($P \leq 0.05$) effect of sea weeds extracts treatment (2.02 Kg. ha^{-1}) which surpassed significantly the control (1.49 Kg. ha^{-1}). This could be explained by the fact that seaweed components in treated plants led to enhanced growth and crop yield [19,20].

Harvest index (%)

Table (7) showed no significant ($P \geq 0.05$) effect of the main factors or the interaction on harvest index trait.

Conclusion

The highest ($p \leq 0.05$) values of the studied traits were obtained under the addition of sea weeds extracts. So, it is recommended to be added. In terms of irrigation regime, FI 100 was superior over DI 80 and DI 60 in stem diameter, and panicle length and diameter. But it had no significant effect on plant number per hectare, harvest index, panicle weight plant weight and grain weight per plant. Hence it is recommended to be follow the DI 60 in areas with water shortages. Most interactions between sowing date and varieties were not significant for the studied production traits.

References

1. Jacobsen SE, Monteros C, Christiansen JL, Bravo LA, Corcuera LJ, et al. (2005) Plant responses of quinoa (*Chenopodium quinoa* Willd.) to frost at various phonological stages. Food and Agriculture Organization of the United Nations.
2. Geerts S, Raes D, Garcia M, Vacher J, Mamani R, et al. (2008) Introducing deficit irrigation to stabilize yields of quinoa (*Chenopodium quinoa* Willd.). Eur J Agron 28: 427-436.
3. Jacobsen SE, Mujicab A, Ortizb R (2003) The global potential for Quinoa and other Andean crops. Food Rev Int 19: 139-148.
4. Garcia M, Raes D, Jacobsen SE (2003) Evapotranspiration analysis and irrigation requirements of quinoa (*Chenopodium quinoa*) in the Bolivian highlands. Agr Water Manage 60: 119-134.
5. FAO (2013) Food and Agriculture Organization statistic.
6. Hirich A, Choukr-Allah R, Jacobsen SE, Benlhabib O (2012a) Could quinoa be an alternative crop of wheat in the Mediterranean region: Case of Morocco? Les notes d'alerte du CIHEAM N°86. Pg No: 1-8.
7. Hirich A, Choukr-Allah R, Jacobsen SE, El Yousfi L, El Omari H (2012b) Using deficit irrigation with treated wastewater in the production of quinoa (*Chenopodium quinoa* Willd.) in Morocco. Rev Cient UDO Agr 12: 570-583.

8. Hirich A, Rami A; Laajaj K, Choukr-Allah R, Jacobsen SE, et al. (2012c) Sweet corn water productivity under several deficit irrigation regimes applied during vegetative growth stage using treated wastewater as water irrigation source. World Acad Sci Eng Techn 61: 840-847.

9. Hirich A, Ragab R, Choukr-Allah R, Rami A (2013) The effect of deficit irrigation with treated wastewater on sweet corn: experimental and modelling study using SALTMED model. Irri Sci 32: 205-219.

10. Hirich A, Choukr-Allah R (2013) Faba bean (*Vicia faba* L.) production under deficit irrigation with treated wastewater applied during vegetative stage. Desalination Water Treat 52: 1-6.

11. Ouattara K, Ouattara B, Assa A, Sedogo PM (2006) Long-term effect of ploughing, and organic matter input on soil moisture characteristics of a Ferric Lixisol in Burkina Faso. Soil Till Res 88: 217-224.

12. Wesseling J, Stoof C, Ritsema C, Oostindie K, Dekker L (2009) The effect of soil texture and organic amendment on the hydrological behaviour of coarse textured soils. Soil Use Manage 25: 274-283.

13. Parr J, Papendick R, Hornick S, Colacicco D (1989) Use of organic amendments for increasing the productivity of arid lands. Arid Land Res Manage 3: 149-170.

14. Ouedraogo E, Mando A, Zombre N (2001) Use of compost to improve soil properties and crop productivity under low input agricultural system in West Africa. Agr Ecosys Environ 84: 259-266.

15. Gopinath K, Saha S, Mina B, Pande H, Kundu S, et al. (2008) Influence of organic amendments on growth, yield and quality of wheat and on soil properties during transition to organic production. Nutr Cycl Agroecosys 82: 51-60.

16. Ibrahim M, Hassan A, Iqbal M, Valeem EE (2008) Response of wheat growth and yield to various levels of compost and organic manure. Pak J Bot 40: 2135-2141.

17. Hartley IP, Hopkins DW, Sommerkorn M, Wookey PA (2010) The response of organic matter mineralisation to nutrient and substrate additions in sub-arctic soils. Soil Biol Biochem 42: 92-100.

18. Khan W, Rayirath UP, Subramanian S, JitheshMn, Rayorath P, et al. (2009) Seaweed extracts as bio stimulants of plant growth and development. J Plant Growth Regul 28: 386-399.

19. Durand N, Briand x, Meyer C (2003) The effect of marine bioactive substances (NPRO) and exogenous cytokinins on nitrate reductase activity in Arabidopsis thaliana. Physiol Plant 119: 489-493.

20. Ordog V, Stirk WA, Van Staden J, Novak O, Strnad M (2004) Endogenous cytokinins in the three genera of microalgae from the Chlorophyta. J Phycol 40: 88-95.

21. Mancuso S, Azzarello E, Mugnai S, Briand X (2006) Marine bioactive substances (IPA extract) improve ion fluxes and water stress tolerance in potted Vitis vinifera plants. Adv Hortic Sci 20: 156-161.

22. Gomez KA, Gomez AA (1984) Statistical procedures for agricultural research. (2nd edition), john Willy and sons Inc. New York. Pg No: 680.