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Evaluation of Different Genotypes of Quinoa (*Chenopodium Quinoa Willd*.) for Yield and Yield Contributing Parameters

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation, "Evaluation of different genotypes of quinoa (*Chenopodium quinoa Willd*.) for yield and yield contributing parameters", was conducted to characterize the quinoa genotypes for different quantitative parameters. The experiment comprised thirteen genotypes, and accordingly, a trial was conducted. The experiment was conducted during *Rabi*, 2018, using Randomized Block Design with three replications under field conditions at All India Coordinated Research Network on Potential Crops, Department of Agricultural Botany, Mahatma Phule Krishi Vidyapeeth, Rahuri. Observations were recorded on five randomly selected plants in each treatment for branches per plant, inflorescence length (cm), inflorescence width (cm), seed yield/ plant (g), seed yield/plot (kg) and seed yield/ha (qtl). Among the genotypes, EC – 507749 (28.43 qtl/ha) recorded the significantly highest seed yield per hectare, which was followed by EC –

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507747 (27.59 qtl/ha) & EC – 507743 (26.20 qtl/ha). The increase in seed yield per hectare was due to the increase in inflorescence length (27.06 cm), inflorescence width (22.63 cm) and branches per plant EC – 507749 (42.26).

Keywords: Quinoa; inflorescence; seed yield; genotypes; potential crops.

1. INTRODUCTION

"Quinoa (*Chenopodium quinoa willd*.) is an annual herbaceous plant that belongs to the Amaranthaceae family but was formerly placed in the Chenopodiaceae family that originated in the Pacific slopes of the Andes in South America. Quinoa is a dicotyledonous plant species, very different from monocotyledonous cereal grains. Most of the seed is the middle perisperm, of which cells have fragile walls and angular-shaped starch grains" [1]. "The plant belongs to a complex of allotetraploid taxa (2n = 4x = 36), which includes *Chenopodium berlandieri* subsp. *berlandieri*, *Chenopodium berlandieri* subsp. *nuttalliae, Chenopodium hircinum*, and *Chenopodium quinoa"* [2,3].

"It has abilities to tolerate the extreme conditions of the environment [4]. The people of the developing countries are taking great interest in quinoa" [5]. "Quinoa shows genetic diversity with respect to its flowers, colour, seed shape, protein, calcium oxalates and saponin contents in leaves, which appeal breeders or farmers to cultivate it in all ecological conditions" [6].

"Quinoa grain is the only vegetable food that provides all amino acids fundamental to the life of humans in most favorable quantities and is comparable with milk. The crop is rich in protein (7.47 to 22.08%) with higher concentration of lycine, isoleucine, methionine, histidine, cystine and glycine. The ash substance is 3.4 per cent containing high amount of Ca, Fe, Zn, Cu and Mn. The oil content is 1.8 to 9.5 per cent and loaded in necessary fatty acids like linoleate and linolenate. In adding up, quinoa seed is wealthy in thiamine (0.4 mg), folic acid (78.1 mg), vitamin C (16.4 mg), riboflavin (0.39 mg) and carotene (0.39 mg) in 100 g seed, respectively. The calorific assessment is 350 cal per 100 g grains and is bigger than that of additional cereal and legume foods and its glycemic index is 53 which is much lower than white rice. The digest ability of quinoa protein is more than 80 per cent. Quinoa also have usual defiant Oxidants like α-tocopheral (5.3 mg), γ-tocopheral (2.6 mg) in 100 g seed and phytoestrogens that avoid regular diseases such as osteoporosis, breast cancer, heart diseases and additional feminine troubles caused by require of estrogen during the menopause. FAO declared 2013 as International year of Quinoa" [7]. Medicinal uses of quinoa are also well documented. The plant is well known for its use against inflammation, pain suppression (as an analgesic) and disinfectant. It is also used in fractures and internal bleeding and controls insects' spread [8]. To shed light on this, this study aimed at evaluation of different genotypes of quinoa (*Chenopodium quinoa Willd*.) for yield and yield contributing parameters. Selection of high yielding traits for improving the stability of quinoa genotypes was important for future prospective. Any crop variety's elite strains must be developed by carefully selecting variety's elite strains must be developed through careful selection of ideal genotypes with suitable progenitors. Considering its current popularity and significance, it is clear that its traits require to be modified. As a result, research was done to assess the genotypes of *C. quinoa* that exhibited the greatest potential for future cultivated in Maharashtra.

2. MATERIALS AND METHODS

The experiment was conducted during *Rabi* 2018 in Randomized Block Design with three replications with spacing of 30 x 15 cm^2 and a plot size of 3.00 x 1.20 m^2. "All the standard cultural practices, such as fertilizer application, intercultural, weeding etc., were followed to raise a good crop. The thirteen genotypes of *Chenopodium quinoa Willd*. used for the present investigation were obtained from the Plant Breeder, AICRN on Potential Crops, Mahatma Phule Krishi Vidyapeeth, Rahuri, which were given as follows: 1.IC-411824, 2.IC-411825, 3.EC-507738, 4.EC-507739, 5.EC-507740, 6.EC-507741, 7.EC-507742, 8.EC-507743, 9.EC-507744, 10.EC-507746, 11.EC-507747, 12.EC-507748 and 13.EC-507749. The following observations were recorded on five randomly selected plants from each genotype in each replication, and averages were worked out. For taking quantitative characters of quinoa were recorded as per the guidelines of Minimal Descriptors of Agri-horticultural Crops by NBPGR was followed" [9,10].

2.1 Branches per Plant

Branches per plant were measured at total vegetative growth, and the mean was worked out by randomly selecting 5 plants from each treatment.

2.2 Inflorescence Length

Inflorescence length was measured from the tip of the inflorescence to the emergence of inflorescence starting on the stem. It was measured in centimetres and calculated the mean from randomly selected 5 plants from each treatment.

2.3 Inflorescence Width

The width of inflorescence was measured off the main panicle at physiological maturity. It was measured in centimetres and calculated the mean from randomly selected 5 plants from each treatment.

2.4 Seed Yield /Plant

The plants were harvested separately from the randomly selected five plants, and seed weight was worked out and expressed in grams per plant.

2.5 Seed Yield/ Plot

The plants were harvested separately from the plot of each genotype, and seed weight was recorded per plot in kilograms.

2.6 Seed Yield/ha

The total plants from the plot of each genotype were threshed separately and cleaned to obtain seeds; their weight was recorded separately, and the average seed yield per plot was worked out. The seed yield per ha (qtl/ha) was converted on a hectare basis.

3. RESULTS AND DISCUSSION

3.1 Branches per Plant

The data on branches per plant of different quinoa genotypes are presented in Table 1. It was observed that among all the genotypes, the highest number of branches per plant was recorded in genotypes EC – 507749 (42.26), followed by EC – 507747 (41.26) and EC – 507743 (40.47). However, the lowest branches per plant were recorded in genotype EC – 507740 (24.33) followed by EC – 507738 (25.73). Similar results were found by Bhargava et al. [7], Razzaghi et al. [11] and Omar et al. [12].

3.2 Inflorescence Length

From the data represented in Table 1, it is revealed that all the genotypes (I.C. – 411824, I.C. – 411825, EC – 507738, EC – 507739, EC – 507740, EC – 507741, EC – 507742, EC – 507743, EC – 507744, EC – 507746, EC – 507747, EC – 507748 and EC – 507749 of quinoa had short inflorescence length (<40 cm). The data on the inflorescence length of different quinoa genotypes were recorded and observed per the guidelines of Minimal descriptors of Agri-horticultural crops by NBPGR. The genotypes were categorized as short (<40 cm), medium (40-70 cm) and long (>70 cm). None of the genotypes under study observed medium inflorescence length (40-70 cm) and long inflorescence length (>70 cm). Inflorescence length is one of the crucial yields contributing character for obtaining higher yields in grain amaranthus. Kishore et al. [13] recorded similar observations for inflorescence length, and a positive association between seed yield and inflorescence length was shown by Kunj Chandra and Kute [14] in different grain amaranthus varieties.

3.3 Inflorescence Width

The data on the inflorescence width of different quinoa genotypes are presented in Table 1. It was seen that among the genotypes, the highest inflorescence width was recorded in genotypes EC – 507749 (22.66 mm), followed by EC – 507747 (21.67 mm) and EC-507743 (20.55 mm). The lowest inflorescence width was recorded in genotype EC – 507740 (14.54 mm), followed by EC – 507738 (15.24 mm).

3.4 Seed Yield/Plant (g)

From the data represented in Table 1, it is observed that the genotype EC – 507749 (26.04 g) of quinoa recorded a significant maximum seed yield per plant, followed by EC – 507747 (24.80 g) and EC – 507743 (22.04 g). However, the lowest yield per plant was recorded in the genotype EC – 507740 (13.55 g), followed by EC – 507738 (15.37 g) and EC – 507744 (15.73 g). It is the individual parameter which shows the capacity of the plant to produce. Kumari Anjali et al. [15] found similar results for seed yield per plant in different grain amaranthus varieties.

Table 1. Evaluation of quinoa genotypes on the basis of yield and yield contributing parameters

Sr No.	Genotypes	Branches per plant	Inflorescence length (cm)	Inflorescence Width (cm)	Seed yield/ plant (g)	Seed yield/ plot (Kg)	Seed yield/ha (q)
1.	IC – 411824	35.40	26.06	18.79	21.80	0.940	26.11
2.	IC – 411825	32.33	23.56	16.71	20.60	0.933	25.93
3.	EC – 507738	25.73	20.50	15.24	15.37	0.730	20.28
4.	EC – 507739	33.46	23.90	16.73	21.66	0.923	25.65
5.	EC – 507740	24.33	19.80	14.54	13.55	0.700	19.44
6.	EC – 507741	29.53	22.20	16.21	19.82	0.853	23.70
7.	EC – 507742	31.33	23.13	16.28	20.14	0.910	25.28
8.	EC – 507743	40.47	26.46	20.55	22.04	0.943	26.20
9.	EC – 507744	27.00	20.80	15.53	15.73	0.763	21.20
10.	EC – 507746	27.46	21.60	16.08	17.00	0.810	22.50
11.	EC – 507747	41.26	26.50	21.57	24.80	0.993	27.59
12.	EC – 507748	27.60	22.03	16.10	19.64	0.830	23.06
13.	EC – 507749	42.26	27.06	22.63	26.04	1.020	28.43
	Mean	32.17	23.35	17.46	19.86	0.873	24.26
	SE(+)	2.40	1.48	0.87	3.51	0.063	1.75
	CD@5%	7.01	4.32	2.56	10.58	0.184	5.11

3.5 Seed Yield/Plot (kg)

The data on seed yield/plot of different quinoa genotypes are presented in Table 1. It is revealed that the significantly highest seed yield/plot recorded in genotype EC – 507749 (1.02 kg) followed by EC – 507747 (0.993 kg) and EC – 507743 (0.943 kg). The lowest seed yield per plot was observed in genotype EC – 507740 (0.70 kg), followed by EC – 507738 (0.73 kg) and EC – 507744 (0.76 kg). A high value for yield attributes was recorded in EC – 507749 (1.14 kg) genotype.

3.6 Seed Yield/ha (q)

From the data represented in Table 1, it is revealed that the genotype EC – 507749 of quinoa recorded significantly highest seed yield per ha, *i.e*. 28.43 (q) followed by EC – 507747 (27.59 q) and EC – 507743(26.20 q). While the lowest seed yield per ha was recorded in EC – 507740 (19.44 q), followed by EC – 507738 (20.28 q) and EC – 507744 (21.20 q). This is the most crucial parameter, which shows the direct relation with branches per plant, inflorescence length (cm), and days to maturity for increased yield. Similar results were recorded for seed yield/ha (qtl) by Spehar [16] in grain amaranthus varieties [17,18].

4. CONCLUSION

Among the genotypes EC – 507749 gave a higher yield (28.43 qtl/ha) and other yield-contributing characters like inflorescence length (27.06 cm), inflorescence width (22.63 cm) and number of branches per plant (42.26).

5. FUTURE SCOPE

The genotypes EC – 507749, followed by EC – 507747 and EC – 507743, having better seed yield, can be utilized in the breeding programme for improving the seed yield of quinoa.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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