

## Original Research Article

### **Performance of quinoa under rainfed alfisols of south peninsular India**

#### **Abstract:**

Quinoa, an ancient crop to contribute to world food security and it is a crop with high potential to contribute to food security in various Regions worldwide, especially in those countries where the population does not have access to protein sources or where production conditions are limited by low humidity, reduced availability of inputs, and aridity. An attempt was done at ARS, Ananthapuramu to study the feasibility to raise the quinoa under rainfed conditions during *kharif*, 2015 and 2016 under RBD with 6 treatments in four replications. The crop was grown on 24<sup>th</sup> standard week and harvested at 40<sup>th</sup> standard week. Among the different varieties highest yield was recorded with under transplanting with 2150 kg/ha, with water use efficiency of 7.32 kg hamm<sup>-1</sup> with IC-411824. Further highest germination percentage was recorded with the vermicompost when compared with soil when germination was kept under trays. IC-411824 recorded highest germination percentage (98 %) with vermicompost. The seed vigour and viability characters viz., germination index, seedling length and seed vigour index was highest with IC-411824. Under transplanting all the varieties matures earlier than direct sowing. The vegetative characters viz., plant height increases from vegetative to flowering in all varieties and recorded highest with IC-411824.

Key words: Quinoa, seed yield, rainfed

#### **Introduction:**

In the recent past, productivity of agriculture worldwide in general was on the decline, which prompted the per capita availability of food grain to fall from 510 g per day (1991) to 463g per day (2004). These declining trends across the world can be attributed to ever growing population, raising incomes of populous Asian nations and discovery of new uses such as bio fuels, besides weather-based abnormalities owing to climate change (Sidhu and Vatta, 2008). To feed the ever-burgeoning population of India, it is emphasized that agricultural production should be improved on sustainable basis by efficiently and judiciously utilizing the available resources. Under these circumstances, ensuring self-sufficiency and food security are challenging tasks before the populous nations like India. To ensure food security and also answer the above challenges quinoa is emerged with a new hope and it is called as super grain and mother grain of feature. (Pathan *et al.*, 2023). It is gluten free, after harvest the seeds are processed to remove the bitter tasting outer seed coat. FAO declared 2013 as international year of Quinoa (Bhargava *et al.*, 2006). While the main producers are Bolivia, Peru and the United States, quinoa production is expanding to other continents and it is currently being cultivated in several countries in Europe and Asia with good yields. In the climate change scenario, there is a dire need to study the emerging crops such as quinoa was quite essential. Hence the study on the crop was initiated and conducted at ARS, Ananthapuramu.

#### **Methodology:**

A field experiment was conducted under rainfed conditions for two years during *kharif*, 2015 and 2016 to test the feasibility of the quinoa in drylands of scarce rainfall zone of Andhra Pradesh at Agricultural Research Station, Ananthapuramu, Andhra Pradesh. The soil of the

experimental site was red sandy loam with shallow depth, low in organic carbon (0.35%) and low in available nitrogen ( $142 \text{ kg ha}^{-1}$ ), medium in available  $\text{P}_2\text{O}_5$  ( $32 \text{ kg ha}^{-1}$ ) and  $\text{K}_2\text{O}$  ( $226 \text{ kg ha}^{-1}$ ). The crop was grown on 24<sup>th</sup> standard week and harvested at 40<sup>th</sup> standard week. To test the performance of 3 varieties viz., EC-5077739, EC-5077738 and IC-411284 under rainfed conditions with direct sowing and transplanting with four replications under Randomised block design with 6 treatments with 45 cm x 10 cm spacing. The characters viz., Plant height, days to maturity, Panicle length, different phenophases were recorded. Physiological parameters viz., Seedling vigour index, Germination Percentage, Germination index etc. were studied. The plots were harvested individually and threshing was done manually and yield parameters were recorded. The data collected for all the parameters were subjected to statistical scrutiny by analysing variance for randomised block design (RBD) as Panse and Sukhatme (1985) outlined. Statistical significance was tested with the 'F' test at a 5 percent probability level and compared the treatment means with a critical difference. Non-significant treatment differences were denoted as NS. The physiological parameters were estimated in quinoa under lab conditions with different criteria.

## **Results & Discussion:**

The results were analysed in the opstat software through open access internet program and the interpreted here under.

### **Seed yield:**

Seed yield was recorded in both net plot and per ha was represented in table.1. The pooled seed yield data revealed that higher significant seed yield ( $2150 \text{ kg ha}^{-1}$ ) was recorded with IC-411824 with transplanting followed by IC-411824 with direct sowing which were on par with each other among all the six treatments. Among the six treatments lowest seed yield was recorded with EC-5077339 with direct sowing ( $1623 \text{ kg ha}^{-1}$ ). With the treatments tested the variety IC-411824 recorded significantly higher yields than the other varieties. This was contributed due to the better establishment, branching and more grain yield per plant and higher test weight of particular variety. With the two establishment methods there was slight edge of the transplanting treatments than the direct sowing. This might be due to better establishment of seed germination and growth under initial stages in green houses later on sturdy plants were transplanted at 2 weeks leads to better establishment.

### **Test weight:**

Among the different varieties test significantly higher test weight/1000 grain was recorded in IC-411824 and lowest 1000 grain weight was recorded with EC-5077339 which were different from each other. However, the slight variation on the two methods of establishment transplanting recorded bit higher test weight than the direct sowing due to the well-spaced plant geometry with better growth recorded the higher test weight than the direct sowing. Significant genotypic variation was recorded for 100-seed weight, with seed weight being significantly higher under drought condition than in the other two environments (rainfed and irrigated). This maybe because quinoa does not require the application of more water during the reproductive stage, which may be the case in irrigated and rainfed environments of this study. However, no significant variation was found between the irrigated and rainfed environments. Our study revealed a positive correlation between grain yield and seed weight, which agrees with earlier findings (Craine et al., 2023).

### **Panicle length:**

In the treatments under testing significantly higher panicle weight was attributed in IC-411824 with transplanting and the lowest panicle weight was EC-5077338 with direct sowing.

### **Days to maturity:**

Quinoa plants with direct sowing took 2 weeks extra to mature rather than the transplanted plants. Among the different treatments IC-411824 with direct sowing matured at 105 days rather than the other treatments. The transplanted established well in short span and completed all the growth phases and matured earlier than the transplanting. Under transplanting all the varieties matured earlier than direct sowing.

**Plant height:**

Plant height was measured in the quinoa crop at different phenophases from transplanting, vegetative, flowering and harvesting stages. In all the phenophases significantly higher plant height was recorded with IC-411824 with transplanting and significantly lowest plant height was recorded with EC-5077338 with direct sowing. This slightly higher variation of the plant height was attributed due to the better establishment in the transplanting compared to direct sowing treatments. The growth of plant height was at fastest rate in the vegetative to flowering stage and later on the difference in the gap from flowering to maturity was bit lower than the earlier phases where plant utilises most of the energy for the conversion of assimilates into seed rather than the growth of the plant. The vegetative characters viz., plant height increases from vegetative to flowering in all varieties and recorded highest with IC-411824. In this study, a positive association was observed between plant height and grain yield, indicating that taller quinoa plants tended to produce more.

**Actual depth of water received during crop growth season through rainfall:**

The water required for the quinoa was same for the different varieties among the different treatments was same. But the water required was significantly higher in the direct sowing treatments (293.6mm) per crop cycle than transplanting (254.3mm). Higher water requirement in direct sowing was due to the more duration to mature the crop took more water for the growth and development of the crop whereas in transplanting it took 2 weeks earlier to mature which enables the less water for the crop to complete the life cycle in short span of time.

**Water use efficiency:**

Water use efficiency was the direct measure for the yield with the water utilised for the season. Among the different varieties tested highest water use efficiency was recorded with IC-411824 with transplanting due to higher yield produced under lower water requirement and lowest water use efficiency was recorded with EC-5077339 with direct sowing.

**Physiological parameters:**

Before sowing the experiment, the entries were tested for the different physiological parameters under lab conditions. Among the different varieties tested IC-411824 recorded significantly higher germination percentage in both soil and vermicompost as a bedding material and lowest germination percentage was recorded with EC-5077339. Further highest germination percentage was recorded with the vermicompost when compared with soil when germination was kept under trays. IC-411824 recorded highest germination percentage (98 %) with vermicompost. With respect to days to initiation of germination all the varieties took same days to initiate germination. The seed vigour and viability characters viz., germination index, seedling length and seed vigour index was highest with IC-411824 and the lowest was recorded with EC-5077339. Total phenolic content increased by ascorbic acid results in increasing seedling growth, because phenolic compounds act as a major role in lignification and also helps in structural development throughout the growth period which further leads to increasing the seed vigour in faba bean as reported by Randhir and Shetty (2002). The seed vigour and viability characters viz., germination index, seedling length and seed vigour index was highest with IC-411824.

**Conclusion:**

Based on the above experimentation it can be concluded that significantly higher seed yield, plant height, panicle weight, days to maturity, higher water use efficiency was recorded with IC-411824 with transplanting.

**Table: 1. Pooled yield and yield attributes of quinoa under rainfed *alfisols***

Treatment	Seed yield/ Plot (kg)	Seed yield (kg/ha)	Panicle length (cm)	Test weight (g)	Days to maturity
EC-5077339 with transplanting	11.37	1776	31.2	17.21	86
EC-5077338 with transplanting	12.60	1970	31.8	17.23	87
IC-411824 with transplanting	13.76	2150	32.3	17.41	89
EC-5077339 with direct sowing	10.32	1623	29.6	17.20	102
EC-5077338 with direct sowing	11.34	1850	30.4	17.19	100
IC-411824 with direct sowing	12.96	1981	31.1	17.30	105
CD @ 5 %	1.41	105	1.32	0.05	9
CV	10.32	12.45	9.87	3.20	3.56
SEm <sub>+</sub>	4.21	294	3.89	0.15	26

**Table: 2. Pooled plant height (cm) of quinoa under rainfed *alfisols***

Treatment	Plant height at different phases (cm)			
	Transplanting	Vegetative	Flowering	Harvesting
EC-5077339 with transplanting	11.29	17.72	66.4	69.2
EC-5077338 with transplanting	11.69	18.22	69.3	70.8
IC-411824 with transplanting	11.97	20.19	71.1	73.4
EC-5077339 with direct sowing	10.32	14.52	54.1	57.8
EC-5077338 with direct sowing	9.81	15.43	58.6	62.1
IC-411824 with direct sowing	10.4	17.12	62.3	64.1
CD @ 5 %	0.36	0.52	2.89	3.01
CV	10.56	11.75	10.97	9.89
SEm <sub>+</sub>	1.08	1.58	8.95	9.41

**Table: 3. Pooled yield, water requirement and water use efficiency of quinoa under rainfed *alfisols***

Treatment	Actual depth of water received during crop growth season through rainfall (mm)	Seed Yield (kg/ha)	Water use efficiency (kg-hamm <sup>-1</sup> )
EC-5077339 with transplanting	254.8	1776	7.10
EC-5077338 with transplanting	254.8	1970	7.89
IC-411824 with transplanting	254.8	2150	8.63
EC-5077339 with direct sowing	293.6	1623	6.05
EC-5077338 with direct sowing	293.6	1850	6.71
IC-411824 with direct sowing	293.6	1981	7.32
CD @ 5 %	38.9	105	0.91
CV	5.76	12.45	10.34

SEm <sub>+</sub>	115.8	294	2.91
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**Table: 4. Physiological parameters of quinoa under rainfed *alfisols***

Treatment	Germination percentage (%)		Days to germination	Germination index	Seed ling length @ 5 DAS	Seed vigour index
	Soil	Vermi compost				
EC-5077339	56	97	3	26	6.6	640
EC-5077338	57	97	3	27	6.8	660
IC-411824	62	98	3	30	7.4	725

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