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Effect of pre-sowing seed treatments on germination yield and yield attributing characters of Quinoa (*Chenopodium quinoa* willd.).

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ABSTRACT

A laboratory and field experiment was conducted at Regional Agricultural Research Station, Nandyal, Andhra Pradesh during *rabi* 2016-17 to study the effect of different pre-sowing seed treatments on six months old IC 411724 variety quinoa seed for its germination, yield and yield attributing characters. Among different chemicals seed treatments soaking in 1 % KH_2PO_4 (60 %) followed by distilled water (54.7%) in 1:1 ratio (seed to solution) for 6 hours recorded significantly higher percent germination in the laboratory. In field study pre-sowing seed treatment with 1 % $Na_2B_4O_7.2H_2O$ in 1:1 ratio (seed to solution) for 6 hours recorded significantly higher seed yield (3262 kg/ha) followed by 1 % KCl in 1:1 ratio (seed to solution) for 6 hours (2669 kg/ha).

Key words: Quinoa, Pre- sowing treatments, Germination, Yield, Yield characters.

Quinoa (*Chenopodium quinoa Willd.*) is an allotetraploid (2n= 36) annual, self-fertile crop which is one of the 250 species included in the genus Chenopodium (Amaranthaceae). Research on quinoa started in India in the 1990s and was later extended into an extensive breeding programme. Quinoa has adapted well to Indian conditions with several accessions showing good adaptability and appreciable grain yield. Trials in the Indo-Gangetic Plains have shown that the crop can be successfully cultivated in this region with many cultivars giving grain yield as high as 9.83 t/ha. (Bharghava 2016). Quinoa grain is the only vegetable food that provides all amino acids essential to the life of humans in optimum quantities and is comparable with milk. The protein content ranges from 7.47 to 22.08 per cent with higher concentration of lycine, isoleucine, methionine, histidine, cystine and glycine. (Table 1). The oil content is 1.8 to 9.5 per cent and rich in essential fatty acids like linoleate and linolenate. In addition, quinoa seed is rich in thiamine (0.4 mg), folic acid (78.1mg), vitamin C (16.4 mg), riboflavin (0.39 mg) and carotene (0.39mg) in 100 g seed respectively. The calorific value is 350 cal per 100g grains and is greater than that of other cereal and legume foods. Quinoa also contain natural anti-oxidants like α-tocopheral (5.3 mg), γ-tocopheral (2.6mg) in 100 g seed and phytoestrogens that prevent chronic diseases such as osteoporosis, breast cancer, heart diseases and other feminine problems caused by lack of oestrogen during the menopause. Seeds contain more Ca, P, Mg,Fe, Zn, Na and Cu than cereals.

Over the years, the global production of quinoa had been increasing significantly, exceeding 193 metric tons in 2015. (Statista 2018).

Year	Production (metric tones)
2010	80.1
2011	84.6
2012	97.9
2013	118.2
2014	186.1
2015	193.8
2016	148.7

Seed coats (pericarp) are usually covered with bitter saponin compounds that must be removed before human consumption and also toxic to fish. Deresination (removal of pericarp and the saponins by mechanical or chemical means) does not affect the mineral content of the seed (Johnson and Croissant,1990) and useful in increasing germination percent of seed.

A laboratory experiment was conducted at Regional Agricultural Research Station, Nandyal, ANGRAU, Andhra Pradesh during rabi 2016-17 to study the effect of pre-sowing seed treatments on six months old quinoa seed. The variety used is IC 411724.The seed was taken and given different pre-sowing treatments like distilled water, 1 % $CaCl_2$, 1 % KCl, % KNO_3, 1% KH_2PO_4, 1% NaCl and 1 % $Na_2B_4O_7.2H_2O$ in 1:1 ratio (seed to solution) for 6 hours, dried back to original weight and kept for germination. All the treatments recorded significantly higher germination percent compared to control. (10 %). Among the treatments 1 % KH_2PO_4 (60 %) followed by distilled water (55 %) and 1 % $Na_2B_4O_7.2H_2O$ (46 %) recorded significantly higher germination values (Table 2). Similar results recorded by Ahamandvand *et al* (2012) who reported that seed priming

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Table 1: Approximate average composition of Quinoa grains compared with cereals (g 100 g^{-1} dm) (Maradini- Filho,2017).

Component	Quinoa	Rice	Barley	Wheat	Corn	Rye	Sorghum
Lipids	7.0	3.2	1.3	2.8	5.3	1.8	3.6
Proteins	16.3	8.8	11.0	14.8	10.5	11.6	12.4
Ashes	2.7	1.7	1.2	1.8	1.3	1.8	1.7
Dietary fibre	7.0	3.5	15.6	10.7	7.3	15.1	6.3
Carbohydrate[a]	74.0	86.3	86.5	80.6	82.9	84.8	82.3
K cal 100 g^{-1}[b]	424.2	409.2	401.7	406.8	421.3	401.8	411.2

[a]Carbohydrates calculated by difference = {100- (lipids% + protein%+ ashes%)}[b]Kcal 100 g^{-1}: 4 x (protein% + carbohydrate%) + 9 x (fat %).

of soybean with KNO_3 caused a significant increased in germination percent, emergence percent, radical ,plumule length, seedling dry weight, plant height, plant leaf area and plant dry weight which is attributed to increased activity of α amylase causing in better mobilization of stored carbohydrates reserves resulting in improvement of germination and other related parameters.

A field experiment was conducted with the above treated seed to study the effect of pre sowing seed treatments on yield and yield attributing characters. Seed was sown on raised nursery during first fortnight of October (06.10.2016) and the seedlings were transplanted after 30 days (07.11.2016) with a spacing of 45x10 cm. The fertilizer applied were 37.5 kg N/ha as basal + 37.5 kg N/ha as a top dressing at 25-30 days to after sowing. The experiment was laid out in randomized block design with three replication. The gross plot size was 5 m x 3 m and the samples were drawn randomly from ten plants per treatment for studying on yield and yield attributing characters. Analysis of data was carried out using statistical package OP Stat 1.0 version.

Table 2: Effect of pre sowing seed treatments on germination % of six months old quinoa seed.

Pre sowing seed Treatment (seed to solution in 1:1 ratio for 6 hrs)	Percent germination
Distilled water	55
1% $Cacl_2$	35
1% Kcl	39
1% KNO_3	38
1% KH_2PO_4	60
1% Nacl	35
1% $Na_2B_4O_7.2H_2O$	46
Control	10
SEm +	1.55
CD (0.05)	4.69
CV (%)	6.78

Table 3: Effect of pre sowing treatments on yield and yield attributing characters of quinoa in Scarce Rainfall Zone of Andhra Pradesh.

Entries (DON :6/10/16) (DOT:07/11/16)	Plant Height (cm)	No.of panicles/plant	Panicle length (cm)	Seed yield/ panicle (g)	Seed yield/ plant (g)	Seed yield (kg /ha)
Distilled water	60.67	12	36.67	13.27	35.67	1317
1% $Cacl_2$	78.01	13	32.33	18.23	53.33	1801
1% Kcl	67.33	20	32.01	22.67	78.5	2669
1% KNO_3	69.01	13	29.33	18.10	35.00	1585
1% KH_2PO_4	60.67	14	26.33	18.60	42.63	1545
1% Nacl	52.33	13	30.01	18.‘17	40.87	1384
1% $Na_2B_4O_7.2H_2O$	77.00	18	36.67	30.97	82.5	3262
Control	46.62	13	24.67	17.77	34.60	1111
SEm	4.08	1.54	1.67	1.41	0.51	36.89
CD (0.05)	12.51	4.71	5.08	4.31	5.57	112.98
CV (%)	11.06	17.7	8.91	4.84	4.49	3.48

Significantly higher plant height was recorded with 1 % $CaCl_2$ (78.01 cm) followed by 1 % $Na_2B_4O_7.2H_2O$ (77.0 cm), distilled water and 1 % $KHPO_4$ (60.67 cm) compared to control (46.67 cm). Significantly higher number of panicles per plant were more with 1 % KCl, (20) followed by 1 % $Na_2B_4O_7.2H_2O$ (18) than control (13) and panicle length with 1 % $Na_2B_4O_7.2H_2O$ and distilled water (36.67 cm) than control (24.67 cm). Seed yield per panicle, per plant and per hectare recorded were significantly higher with 1 % $Na_2B_4O_7.2H_2O$ (30.97 g : 82.5 g and 3262 kg/ha) followed by 1 % KCl (22.67 g : 78.5 g and 2669 kg/ha) compared to control (17.7 g : 34.6 g and 1111 kg/ha) respectively (Table 3). Similar results of increase in yield and yield attributing characters by pre sowing seed treatments with many chemical solutions (seed priming) was reported by many workers like Joystna and Srivastava (1998) in pigeon pea with $CaCl_2$ or KNO_3 due to improvement in proteins, free amino acids soluble sugars during germination, Srivastava and Bose (2012) in rice seeds with Mg $(No3)_2$ and KNO_3 which resulted in increased plant height, leaf area and number of leaves and yield attributing characters like

fertile tillers, panicle and grain quality due to deposition of more photo assimilates in key plant parts there by affecting final yield. Vazirimehr *et al* (2014) in corn with 1% KNO_3 which recorded higher germination percentage (92.6 %), biological yield (33.2 5), harvest index (10.4 %) and tassel weight (4.3 %) due to accelerated germination, shortens the time from seed emergence and prevention of biotic and abiotic factors and Chavan *et al* (2014) in soyabean with 0.5 % $CaCl_2.2H_2O$ which increased plant height, number of branches , number of pods per plant, number of seeds per pod and seed yield.

From the above study it can be concluded that pre-sowing seed treatment of six month old quinoa seed with chemical solution or distilled water for 6 hours in 1:1 ratio (seed to solution) and sowing during first fortnight of october will increase the crop yield of quinoa in scarce rainfall zone.

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