ISSN Print: 2664-844X
ISSN Online: 2664-8458
Impact Factor: RJIF 5.6
IJAFS 2022; 4(1): 98-102
www.agriculturaljournals.com
Received: 18-03-2022
Accepted: 21-05-2022

Kavya Pattar
Department of Seed Science and Technology, College of Agriculture, UAS, GKVK, Bangalore, Karnataka, India

P Venkappa
Department of Seed Science and Technology, College of Agriculture, UAS, GKVK, Bangalore, Karnataka, India

K Vishwanath
Department of Seed Science and Technology, College of Agriculture, UAS, GKVK, Bangalore, Karnataka, India

KB Palanna
Department of Seed Science and Technology, College of Agriculture, UAS, GKVK, Bangalore, Karnataka, India

K Muruli
Department of Seed Science and Technology, College of Agriculture, UAS, GKVK, Bangalore, Karnataka, India

Corresponding Author:
Kavya Pattar
Department of Seed Science and Technology, College of Agriculture, UAS, GKVK, Bangalore, Karnataka, India

Influence of foliar spray on seed yield and quality in white quinoa (*Chenopodium quinoa* Willd)

Kavya Pattar, P Venkappa, K Vishwanath, KB Palanna and K Muruli

DOI: https://doi.org/10.33545/2664844X.2022.v4.i1b.124

Abstract
A field experiment was conducted at Zonal Agricultural Research Station (ZARS), UAS, GKVK, Bangalore during 2018-19, to know the influence of foliar spray on growth, seed yield and quality of quinoa cv. 507740. The experiment was laid out in RCBD and replicated in three times with eight treatment combination, T_0-Control, T_1- GA_3 @ 100 mg/l, T_2-boron @ 0.4%, T_3-urea @ 2%, T_4-ascorbic acid @ 50mg/l, T_5-*Moringa* leaf extract @ 3%, T_6-DAP @ 2%, T_7-salicylic acid @ 5-10 mg/l at 45 DAS. The results revealed that Foliar spray of ascorbic acid @ 50mg/l45 DAS recorded maximum growth, seed yield and quality attributes *viz.*,plant height at 60 and at harvest (118.67 and 127 cm), total number of panicles per plant (9.67), productive panicles per plant (7.33), panicle length of main tiller (35.33 cm), seed yield per plant (153.33 g), seed yield per hectare (16.87 q/ha), 1000 seed weight (3.33 g), seed recovery (95.62%), seed germination (90.67%), mean seedling length (14.50 cm), mean seedling dry weight (16 mg),seedling vigour index I (1193), seedling vigour index – II (1457), EC (341.33µS cm^{-1}) and protein content (14 g) over control (96.67 and100 cm, 6.67, 4.00, 27 cm, 105.67 g, 12.85 q/ha,3.10 g,87.89%, 85%, 11.50 cm, 9 mg, 1004,729, 357 and 13 g respectively)

Keywords: Foliar spray, growth, seed yield and quality

Introduction
Quinoa (*Chenopodium quinoa* Willd) is a halophytic, allotetraploid grain crop of the *Amaranth* family with the impressive drought tolerance, nutritional content and an inceasing the worldwide market (Risi and Galwey, 1984) [18]. The nearest wild species to quinoa are *C. hicinum* and *C. berlandieri*, which have the same number of chromosomes (2n = 4x = 36), and *C. pallidicaule* with 2n = 2x 18 chromosomes. It is dicotyledonous annual plant grown as a grain crop primarily for its edible seeds. Small achenes, measure upto 2 mm in diameter. It has good nutritive value. It is commonly called as quiuna, parka, dawe, chuppah and kinwah and quinoa is not a grass, but a pseudo cereal botanically related to spinach and amaranth (*Amaranthus* spp.) Quinoa provides protein, dietary fibre, vitamin B and dietary minerals in rich amounts above those of wheat, corn, rice or oats. 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) [4].

Quinoa is a fast-growing plant, measuring up to 0.2 to 3 m in height with alternate, coarsely toothed, triangular to ovate leaves and the racemose inflorescence produce hundreds of fruits (a seed-like fruit with a hard coat) occurs in an indehiscent achene and it is protected by perigonium with diversified colours ranging from white or pale yellow to orange, red, brown and black. Quinoa has greater plasticity of adaptation to photoperiod, altitudes, soil pH range of 6 to 8.5 and temperature from sub-tropical to tropical and humid areas. Base temperature of quinoa is 3 πC with optimum temperature of 15-30 πC and maximum temperature is of 50 πC.

The crop cycle varies from 90 to 240 days and it is well suited to different environmental conditions. The phenology phases are emergence, two, four and six true leaves, branching, start of ear formation, full formation of ear, start of inflorescence, anthesis, woody grain, soft grain and physiological maturity. Quinoa has got wider adaptability to different stress environmental conditions such as cold and drought. From the point of its variability, it may be considered an oligocentric species, with an ample centre of origin of multiple diversifications. The Andean region and within it, the shores of Lake Titicaca, are where the greatest diversity and genetic variation occur.

In 2009, production in the Andean region was about 70 thousand tons with almost 40 thousand tons produced by Peru, 28 thousand tons by Bolivia and 746 tons by Ecuador. The main countries producing quinoa in the world are Bolivia and Peru. They both accounted for 90 per cent of the world quinoa production. (FAOSTAT of united nations 2013). Quinoa was cultivated in an area of 440 hectares with an average yield of 1.053 tonnes hectare^{-1} in India.

Crop nutrients are the elements, which are essential in providing healthy and vigorous plants. They initiate all processes which are vital for crop development. Therefore, plant needs nutrients throughout its growing cycle. Plant nutrients are available in various forms and ratios. Among the various plant nutrients, whether based on organic or mineral composition, they can be applied to crops by foliar and granular application. By foliar spray plants take nutrients more efficiently through stomata. Application is done when there is lack of particular nutrient in the soil or when the plant roots are not able to absorb the required amounts of nutrients. quinoa is superior nutritional profile and abiotic stress tolerance crop, However its performances decreases under high temperature that can be improved by foliar treatment. The present investigation study was carried out during *Rabi* 2018 with the objective of "To study the influence of foliar spray on seed yield and quality".

Materials and Methods

The study on influence of foliar spray on seed yield and quality in white quinoa cv. 507740 was studied at ZARS, UAS, GKVK, Bangalore. Sowing was taken up in the month of October and foliar spray of different nutrients at different concentration was carried out at 45 days after sowing. The experimental site is situated between 12° 15' N latitude and 77° 35' E longitude at an altitude of about of about 930 m above Mean sea level. The experiment was laid out in randomized complete block design and replicated in three times with eight treatments, T_0- Control, T_1- Foliar spray of GA_3 @ 100 mg/l, T_2- Boron @ 0.4%, T_3- Urea @ 2%, T_4- Ascorbic acid @ 50 mg/l, T_5- *Moringa* leaf extract @ 3%,T_6- DAP @ 2%, T_7- Salicylic acid @ 10 mg/l. Five tagged plants were used for getting results on growth and seed yield parameters. Quality attributes were also evaluated as per ISTA (2015).

Results and Discussion

The growth parameters of quinoa *viz*., Highest plant height at 60 DAS and at harvest, number of branches at 60 DAS, days taken to 50 per cent flowering and maturity differed significantly as influenced by the foliar spray are represented in Table 1.

Plant height (cm)

Among the different foliar spray significant difference was observed for plant height. At 60 DAS significantly higher plant height (118.67 cm) was noticed in foliar spray of ascorbic acid at 50 mg/l (T_4). Which is followed by salicylic acid @ 10 mg/l (117 cm) and the lowest was noticed in the control (96.67 cm). At harvest, significantly highest plant height was recorded in ascorbic acid @ 50 mg/l (127 cm) followed by salicylic acid @ 10 mg/l (117 cm) and lowest plant height was recorded in control (100 cm).

The significant difference in plant height might be because of the ascorbic acid which acts as a cofactor of gibberllin-3-β-dioxygenase enzyme which helps in the production of gibberellin as found by Davey *et al*. (2000) [5]. Since, gibberellin play a important role in elongation of internodes this may be the reason for higher growth in the plant height.

Total number of panicles per plant

There was a significant difference among the treatments at different growth stages. At harvest, highest number of panicles were obtained in the foliar spray of ascorbic acid @ 50 mg/l (9.67) followed by salicylic acid @ 10 mg/l (9.33) and lowest number of panicles were seen in the control (6.67).

This might be due to bio-regulator effect of ascorbic acid on various physiological and biochemical behavior in plants such as, sink and source regulation, protein synthesis, enzymatic activities, reversal of stress effects were induces flowering, prolongs the reproductive phase ion uptake, cell elongation, cell division, cell differentiation as reported by Indira *et al*. (1977) [8], Singh and Singh (1975) [15], Mehrotra *et al*. (1983) [12], Kaul *et al*. (1973). The results uphold the findings of earlier studies made by Gad E-Hak *et al*. (2012) [7] in pea.

Number of productive panicles plant^{-1}

Significantly higher total number of productive panicles per plant were found in the plots of ascorbic acid @ 50 mg/l foliar application (7.33), followed by salicylic acid @ 10 mg/l (6.33)and in the control (4.00). This might be due to the role of ascorbic acid helped in increase in the number of panicles per plant.

Days to 50 per cent flowering

Days taken to 50 per cent flowering varied significantly among the treatments where the minimum values were observed in ascorbic acid @ 50 mg/l (48.33) followed by salicylic acid @ 10 mg/l (48.67) and maximum values were recorded in the control (50.33).

The significant difference might be due to the ascorbic acid role in phyto-hormones which is mediated by signalling process during the vegetative to reproductive transition phase as stated by Smirnof and Wheeler (2000) [16].

Days to maturity

The days taken to maturity did not differ significantly between the treatments. However the minimum number of days taken to maturity was observed in ascorbic acid @ 50 mg/l (88.33) followed by salicylic acid @ 10 mg/l (89.00) and maximum days were recorded in the control (90.00).

Table 1: The foliar spray

Treatments	Plant height (cm)		No. of panicles per plant	No. of productive panicles per plant	Days to 50% flowering	Days to maturity
	60 DAS	At harvest				
T_0: Control	96.67	100.00	6.67	4.00	50.33	90.00
T_1: Foliar spray of GA_3 @ 100 mg/l	106.33	111.67	7.00	4.33	49.33	89.33
T_2: Foliar spray of boron @ 0.4%	110.60	120.33	8.00	5.33	50.00	89.67
T_3: Foliar spray of urea @ 2%	105.33	116.00	7.33	5.00	49.33	89.67

T_4: Foliar spray of ascorbic acid of 50 mg/l	118.67	127.00	9.67	7.33	48.33	88.33
T_5: Foliar spray of *Moringa* leaf extract @ 3%	104.67	115.00	7.33	4.67	49.00	89.67
T_6: Foliar spray of DAP @ 2%	102.00	108.00	7.33	4.33	49.67	89.33
T_7: Foliar spray of salicylic acid @ 10 mg/l	117.00	123.67	9.33	6.33	48.67	89.00
S.Em±	4.39	4.96	0.58	0.39	0.47	0.37
CD @ 5%	13.31	15.03	1.75	1.19	1.44	NS
CV (%)	7.03	7.45	12.73	13.10	1.66	0.72

Influence of foliar spray on plant growth parameters of quinoa

Panicle length of main tiller (cm)

There was a significant difference among the treatments. Longer panicle length was observed in ascorbic acid @ 50 mg/l (35.33 cm) followed by salicylic acid @ 10 mg/l (35.00 cm) and shorter length was recorded in the control (27.00 cm). Ascorbic acid helps in cell elongation, cell division and cell expansion. Similar findings were reported by Nagwa *et al.* (2013) in onion seeds.

Thousand seed weight (g)

Thousand seed weight did not exhibit significant difference among application foliar nutrients. However the maximum 1000 seed weight was recorded in ascorbic acid @ 50 mg/l (3.33 g) followed by boron @ 0.4 per cent (3.27 g) and minimum was recorded in the control (3.10 g).

Seed yield per plant (g)

The results on seed yield per plant revealed significant difference among treatments with highest value in ascorbic acid @ 50 mg/l (153.33 g) followed by salicylic acid @ 10 mg/l (149.67 g) and lowest yield per plant was recorded in the control (105.67 g) enlarged quantity of assimilates in plants which are then transported to the reproductive organ later Similar results were also reported by Abido *et al.* (2015) [1] in sugar beet.

Table 2: Seed yield per plant (g)

Treatments	Panicle length of main tiller (cm)	1000 seed weight (g)	Seed yield per plant (g)	Seed yield (q/ha)	Seed recovery (%)
T_0: Control	27.00	3.10	105.67	12.85	87.89
T_1: Foliar spray of GA_3 @ 100 mg/l	30.33	3.27	119.33	13.07	93.17
T_2: Foliar spray of boron @0.4%	34.67	3.17	135.33	13.27	93.66
T_3: Foliar spray of urea @ 2%	31.33	3.20	126.00	14.70	88.66
T_4: Foliar spray of ascorbic acid of 50 mg/l	35.33	3.33	153.33	16.87	95.62
T_5: Foliar spray of *Moringa* leaf extract @ 3%	30.67	3.13	123.33	13.83	90.76
T_6: Foliar spray of DAP @ 2%	29.67	3.17	114.00	14.07	91.68
T_7: Foliar spray of salicylic acid @ 10 mg/l	35.00	3.27	149.67	15.63	94.83
S.Em±	1.41	0.061	10.02	1.19	1.36
CD (p=0.05)	4.28	NS	30.40	1.84	4.13
CV (%)	7.70	3.310	13.43	8.00	2.56

Influence of foliar spray on seed yield attributes

Seed yield (q/ha)

The data regarding seed yield per hectare was revealed the significant difference among the treatments. Highest yield obtained by foliar application of ascorbic acid @ 50 mg/l (16.87 q/ha) followed by salicylic acid @ 10 mg/l (ha) and lowest yield per hectare was 15.63 q/ recorded in the control (12.85 q/ha).

The seed yield per hectare are significantly enhanced by foliar spray of ascorbic acid @ 50 mg/l has recorded the highest yield among all the treatments. This might be due to ascorbic acid plays an important role in the activation of RUBISCO, PEP carboxylase and carbonic anhydrase. These are the key enzymes aids for photosynthesis as specified by Khan *et al.* (2003) [10]. The results obtained were correlated with the findings of Amal *et al.* (2009) [2] in pea. Yousof (2014) in paddy, Bakry *et al.* (2013) [3] and Abido *et al.* (2015) [1] in sugar beet. Yield obtained by spraying ascorbic acid was 47.69 per cent higher.

Seed recovery (%)

The significant differences were noticed among the treatments for the seed recovery percentage and highest values of seed recovery per cent was observed in ascorbic acid @ 50 mg/l (95.62%) treatment followed by salicylic acid @ 10 mg/l which accounted 94.83 per cent and lowest values were recorded in the control (87.89%).

The significant results for per cent seed recovery might be due to the enlarging of the seed size there by higher transport of assimilate from leaves to reproductive parts. These findings are in agreement with the findings of Khan *et al.* (2003) [10].

Seed germination (%)

Germination percentages revealed significant difference among treatments. Highest germination was observed in the ascorbic acid @ 50 mg/l (90.67%) followed by salicylic acid @ 10 mg/l which accounted89.67% and lowest values were recorded in the control (85.00%). Significant difference might be due to the free radicle production which is reduced by ascorbic acid which might have helped in the maintenance of integrity of the cell membrane as recommended by Amal *et al.* (2009) [2].

Mean seedling length (cm)

The mean seedling length showed marked difference among treatments. Higher mean seedling length was recorded in ascorbic acid@ 50 mg/l (14.50 cm) followed by salicylic acid @ 10 mg/l (13.37 cm) and lowest values were recorded in the control (11.50 cm).

Significant difference might be due to the presence of greater amount of stored food materials and role of ascorbic acid in the cell elongation might be the reason for the

increase in the seedling length. Similar results were noticed by Naheif (2013) in wheat.

Mean seedling dry weight (g)

The results showed the significant difference among treatments for mean seedling dry weight, maximum values are noticed in ascorbic acid @ 50 mg/l (16 mg) followed by salicylic acid @ 10 mg/l (14 mg) also urea @ 2 per cent (0.14 mg) and minimum values were recorded in the control (9 mg).

Significant difference has been obtained among the treatments for mean seedling dry weight for foliar spray of ascorbic acid@ 50 mg/l. This might be due to the presence of higher quantity of stored food materials in the seeds and also part of ascorbic acid in cell elongation, cell division and cell expansion. Similar findings were reported by Nagwa *et al.* (2013) [14] in onion seeds.

Seedling vigour index-I

There was a significant difference among treatments for seedling vigour index I. Maximum values was noticed in ascorbic acid @ 50 mg/l (1193) followed by salicylic acid @ 10 mg/l (1164) and minimum values were recorded in the control (1004).

Seedling vigour index-II

For seedling vigour index II also there was significant difference among treatments. Highest data were recorded in ascorbic acid @ 50 mg/l (1457) followed by salicylic acid @ 10 mg/l (1161) and lowest values were recorded in the control (729). Total phenolic content increased by ascorbic acid results in increasing seedling growth, because phenolic compounds acts 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) [17].

Electrical conductivity (µS cm^{-1})

Seeds harvested from plots of ascorbic acid @ 50 mg/l foliar spray recorded EC values (341.33 µS cm^{-1}) and higher values in control (356.00 µS cm^{-1}).

The antioxidant ascorbic acid treatments have revealed significant difference on electrical conductivity by stopping lipid peroxidation. Cell membrane is affected by one of the dangerous reactions like lipid peroxidation and it results in the loosing of cell wall integrity. Hence ascorbic acid helps in maintaining cell integrity by reducing the loss of leachates from the seed as suggested by Kunert and Ederer (1985) [11].

Table 3: Influence of foliar sprayon quality attributes of quinoa

Treatments	Seed germination (%)	Mean seedling length (cm)	Mean seedling dry weight (g)	Seedling vigour index I	Seedling vigour index II	Electrical conductivity (µS cm^{-1})
$T_{0:}$ Control	85.00	11.50	9	1004	729	357.00
$T_{1:}$ Foliar spray of GA_3 @ 100 mg/l	87.33	12.70	11	1079	906	355.67
$T_{2:}$ Foliar spray of boron @ 0.4%	87.67	13.13	13	1105	1174	349.33
$T_{3:}$ Foliar spray of urea @ 2%	86.00	12.90	14	1099	1161	354.00
$T_{4:}$ Foliar spray of ascorbic acid of 50 mg/l	90.67	14.50	16	1193	1457	341.33
$T_{5:}$ Foliar spray of *Moringa* leaf extract @ 3%	86.33	13.10	12	1103	1016	352.67
$T_{6:}$ Foliar spray of DAP @ 2%	86.67	12.83	12	1112	1035	359.67
$T_{7:}$ Foliar spray of salicylic acid @ 10 mg/l	89.67	13.37	14	1164	1161	345.67
S.Em±	0.456	0.310	0.004	21.6	38.4	3.708
CD (p=0.05)	1.368	0.930	0.011	65.5	116.5	11.11
CV	0.904	4.132	5.147	3.4	6.2	1.826

References

1. Abido WAE, Ibrahim MEM, El-zeny MM. Growth, productivity and quality of sugarbeat as affected by antioxidants foliar applications and potassium fertilizers top dressing. Asian J Crop. Sci. 2015;7(2):113-127.
2. Amal M, El-Shraiy, Amira MH. Effect of acetylsalicylic acid, indole-3-butyric acid and gibberellic acid on plant growth and yield of pea (*Pisum sativum* L.). Aus. J Basic and Appli. Sci. 2009;3(4):3514-3523.
3. Bakry BA, Elewa TA, El-Kramany MF, Wali AM. Effect of humic acid and ascorbic acid foliar application on yield and yield components of two wheat cultivars grown under newly reclaimed sandy soil. Int. J Agron. Pl. Prod. 2013;4(6):1125-1133.
4. Bhargava A, Sudhir S, Deepak O. Quinoa (*Chenopodium quinoa* Willd). An Indian perspective. Industrial Ccrops and Products. 2006;23:73-87.
5. Davey MW, Montagu MV, Inze D, Samartin M, Kanellis A, Smirnoff N, *et al.*, Plant L-ascorbic acid: chemistry, function, metabolism, bioavailability and effects of processing. J Sci. Food Agric. 2000;80:825-860.
6. FAOSTAT. Quinoa area and production in the world; c2013. http:www.fao.org.
7. Gad SH, Ahmed AM, Moustafa YMM. Effect of foliar application with two antioxidants and humicacid on growth, yield and yield components of peas (*Pisum sativum* L.). J Horti. Sci. Ornamental Plants. 2012;4(3):318-328.
8. Indira P, Kurian T, Maini SB. Effect of ascorbic acid on growth and yield attributes of cassava. J Root Crops. 1977;3:37-40.
9. Kaur H, Gupta N. Ameliorative effect of proline and ascorbic acid on seed germination and vigour parameters of tomato (*Solanum lycopersicum* L.). under salt stress. Int. J Curr. Microbiol. App. Sci. 2018;7(1):3523-3532.
10. Khan N, Prithviraj B, Smith DL. Photosynthetic response of corn and soybean to foliar application of salicylates. J Plant Physiol. 2003;160:485-492.
11. Kunert KJ, Ederer M. Leaf aging and lipid peroxidation: The role of the antioxidants vitamin C and E. Physiol. Plant. 1985;65:85-88.
12. Mehrotra ON, Mathur RK, Tripathi RS. Effect of ascorbic acid on crop growth and seed yield of wheat. Indian J Agric. Res. 1983;17:57-61.

13. Naheif EM. Behavior of wheat cv. Masr-1 plants to foliar application of some vitamins. Nature and Sci. 2013;11(6):1-5.
14. Nagwa MKH, Shafeek MR, Saleh SA, El-Greadly NHM. Growth, yield and nutritional values of onion (*Allium cepa* L.). plants as affected by bio-regulators and vitamin E under newly reclaimed lands. J Appl. Sci. Res. 2013;9(1):795-803.
15. Singh G, Singh TH. Effect of ascorbic acid on crop growth and seed yield in cotton. J Res. Punjab. Agric. Uni. 1975;12:329-332.
16. Smirnoff N, Wheeler GL, Ascorbic acid in plants: biosynthesis and function. Critical Rev. Bio-chem. and Molecular Bio. 2000;35(4):291-314.
17. Randhir R, Shetty K. Light-mediated faba bean (*Viciafaba*) response to phytochemical and protein elicitors and consequences on nutraceutical enhancement and seed vigour. Process Bio-Chem. 2002;38:945-952.
18. Risi C, Galwey NW. The Chenopodium grains of the Andes: Inca crops for modern agriculture. Adv. Appl. Biol. 1984;10:145-216.
19. Yousof FI. Influence of some antioxidants on emergence, growth and yield of direct-seeded rice. J Pl. Prod. 2014;5(2):267-281.