Egypt. J. of Appl. Sci., 34 (12) 2019 *233-250*

COWPEA FORAGE AND SEEDS PRODUCTIVITIES AS AFFECTED BY SOME ORGANIC ACIDS AND SOLUBLE CALCIUM UNDER PLANT SPACES

Fadia M. Sultan ; Azza Kh. M. Salem and Magda N. Rajab
Forage Crop Res. Depart. Field Crop Res. Inst. Agri. Res. Center, Giza, Egypt.

Key Words: Cowpea, plant spaces, organic acids, soluble calcium and Economic evaluation.

ABSTRACT

A field experiment was carried out at Sids Agricultural Station Farm, Beni Suef Governorate, during 2017 and 2018 seasons to study the effect of two hill spaces (20 and 30 cm) and spray (citric, salicylic, ascorbic acids and soluble calcium) on forage and seed yields of Cowpea (Baldy local variety) and economic evaluation of studied treatments. The experimental layout was arranged in a split plot design in a randomized complete block arrangement with four replications. Mainresults could be summarized as follow:

- Cowpea plants sown at 30 cm between hills had increased values of number of branches plant^{-1}, seed yield attributes (pod length, number of pods plant^{-1}, number of seeds pod^{-1}, seed weight plant^{-1} and 100-seed weight) and forage quality (i.e. crude protein, digestible crude protein, crude fiber and ash percentages) whereas, 20cm a part between hills recorded the highest values for plant height and cowpea yields fed $^{-1}$ i.e. fresh, dry, CP, DCP and seed yields in combined analysis.
- All yield attributes of cowpea were increased significantly by using organic acid or soluble calcium compared with untreated in both seasons as well as in combined; and soluble calcium was superiority of treated treatments.
- The interaction between 20cm apart between hills and soluble calcium gave the highest values for cowpea yields fed $^{-1}$ i.e. fresh, dry, CP, DCP and seed yields in combined analysis.
- Soluble calcium gave the highest value for net economic return (22075.0L.E) compared with other treated treatments in both seasons and combined.
- It could be concluded that the increased in forage and seed yields of cowpea with organic acids and soluble calcium certainly improving the income of the farmer.

INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp.) is a quick growing and high yielding crop feed to livestock and also makes a valuable contribution towards human food in tropical and subtropical parts of the world **(Kumar *et al.,* 2014)**. Cowpea is suitable for Egypt summer environmental conditions. Cowpea is the fastest growing annual summer forage legume. It is an excellent quality crop for fattening both sheep and cattle and is also regarded as good feed for milking cows.

It is worth noticing that determining of the optimal plant density that achieves the minimal intra-specific competition is essential to maximize the usage of water and nutrients per land unit area resulting in increasing productivity under these conditions .**Yadav (2003 (**reported that plant population had a significant effect on plant height, yield attributes and seed yield .**Ahmed and Abdelrhim (2010** (showed that increased plant density significantly the number of pods per plant, 100-seed weight and seed yield per plant reduced with increasing plant density .**Helmy *et al* (2015) .**indicated that forage and seed yields were significantly affected by the planting density and use of 70000 plants fed^{-1}increased plant height, fresh and dry forage yield fed $^{1-}$of cowpea plants. While, use of 35000 plants fed $^{1-}$increased number of branches plant ،$^{1-}$number of pods plant ،$^{1-}$number of seeds pod،$^{1-}$pods weight plant^{-} -100 ،^{1}seed weight, seed yield fed $^{1-}$and protein percentage .

Although good agronomic practices like optimum seed rate, fertilization, weed control and harvesting have significant positive influence on seed yield, however, environmental conditions like temperature, soil moisture and relative humidity during the reproductive phase play an important role for seed formation and development in cowpea **(Kiari *et al.,* 2011)**. High temperatures and prolonged dry spells duringreproductive phase can cause male sterility, anther dehiscence and excessive floral abscission leading to poor pod setting as well as seed yield of cowpea **(Thuzar *et al.,* 2010)**. High night temperatures at flowering stimulate respiration, damage the cell membranes and reduce net photosynthesis and the transfer of photo simulates into the seed **(Kumar *et al.,* 2013).** Night temperature during summer season as well as at time of reproductive phase (August-September) of cowpea in North-West India remains > 20^{o}C (around 24^{o}C) **(Prabhjyot-Kaur *et al.,* 2006)** which may adversely affect the flowering and seed setting in cowpea.

Foliar bio-regulators (organic acids and soluble calcium) can modify plant physiological/biochemical processes during biotic and a biotic stresses **(Kumar *et al.,* 2013)**. Salicylic acid may induce tolerance to plants to heat stress which helps to increase seed yield in number of crops **(Bons *et al.,* 2015).** Improving the seed productivity of cowpea under moderately high temperature has practical relevance **(Kumar and Sarlach, 2015). Abo El-Soud and Hokam (2017)** found that application of salicylic acid had a positive effect on both vegetative characters and seed yield as compared to controltreatment. **Mandour *et al.* (2019)** showed that, spraying strawberry plants with $CaCl_2$ and citric acid increased yield and yield component compared to control. Foliar sprays of bio-regulators will be equally effective, easy and economical approach for increasing the seed yield of crops.

The present study was to the effect of different organic acids (i.e . citric, salicylic and ascorbic acids) and soluble calcium on growth ،yield attributes, forage and seed yields under hill spaces of forage cowpea as well as economic evaluation .

MATERIALS AND METHODS

A field experiment was carried out at the Experimental Farm of Sids Station, Beni Suef Governorate, Egypt, during 2017 and 2018 seasons to study the effect of hill spaces (i.e. 20 and 30 cm) and foliar application [ascorbic, citric, salicylic acids (200 ppm for every one) and chelated soluble calcium (5 mL/L)] on growth yield attributes, forage and seed yields as well as quality of cowpea (*Vigna unuiculata* L.Walp). Some physical and chemical properties of the experimental site in the two growing seasons are shown in Table (1) which was determined according to **Page *et al.* (1982).** Mean maximum and minimum monthly air temperatures recorded were 37.1^{o}C and 24.6^{o}C, 37.1^{o}C and 25.1^{o}C during the month of August and 34.9^{o}C and 22.3^{o}C, 35.6 ^{o}C and 24.1^{o}C in September during the year 2017 and 2018, respectively.

Table (1) Physical and chemical properties in soil study

<table>
<tr><th>Crosse sand (%)</th><th>Fin sand (%)</th><th>Silt (%)</th><th>Clay (%)</th><th colspan="2">Texture</th><th>O.M (%)</th><th>SAR</th><th>$CaCO_3$ (%)</th></tr>
<tr><td>5.90</td><td>22.58</td><td>30.80</td><td>40.72</td><td colspan="2">Clay</td><td>0.75</td><td>6.19</td><td>6.18</td></tr>
<tr><td rowspan="2">pH</td><td rowspan="2">EC (dS/m)</td><td colspan="4">Cations (meq/l)</td><td colspan="3">Anions (meq/l)</td></tr>
<tr><td>Ca^{++}</td><td>Mg^{++}</td><td>Na^+</td><td>K^+</td><td>HCO^-_3</td><td>Cl^-</td><td>SO^{--}_4</td></tr>
<tr><td>7.83</td><td>1.32</td><td>8.15</td><td>5.55</td><td>20.45</td><td>0.85</td><td>2.35</td><td>13.95</td><td>18.70</td></tr>
<tr><td colspan="3">Macronutrients (mg/kg)</td><td colspan="6">Micronutrients (mg/kg)</td></tr>
<tr><td>N</td><td>P</td><td>K</td><td colspan="2">Fe</td><td colspan="2">Mn</td><td colspan="2">Zn</td></tr>
<tr><td>44.85</td><td>4.90</td><td>179</td><td colspan="2">2.34</td><td colspan="2">1.77</td><td colspan="2">0.69</td></tr>
</table>

The preceding crop in the two seasons was barley crop. Sowing dates were May, 15 and 20 in the first and second seasons 2017 and 2018, respectively. The experimental layout was arranged in a split plot design in a randomized complete block arrangement with four replications. The two plant distances between hills were assigned to the main plots (20 cm between hills and 30 cm between hills) with leaving two plants hill^{-1}. Whereas, three organic acids and soluble calcium (Without (control), 200ppm of ascorbic acid, 200ppm of citric acid, 200ppm of salicylic acid, 5m L/L of soluble calcium (in the form of chelated calciven 15% gole) were allocated in sub-plots. Sub-plot area was 12 m^2 (3m x 4m) and consisted of five ridges 4 m long 60 cm wide.. Foliar application of the three organic acids and soluble calcium were sprayed three times, the first after 30 days from sowing and applied at two week interval starting from flower initiation. The volume of water was 1.5L/plot, o.5% wetting agent of Tween 20 was used.

Experimental land was prepared by calcium superphosphate (15.5% P_2O ($_5$was added before sowing at the rate of 100kg fed .$^{1-}$ Nitrogen fertilizer was added as urea (46% N) as activation dose of 15 kg N fed $^{1-}$after seed germination and before irrigation as an encouraging dose ،and seeds were inoculated with appropriate Rhizobia (Okadin) before planting. After two weeks the plants were thinned into two plants per hill. The plots were weeded twice where the first weeding was done two weeks after emergence and the second weeding was done just before flowering. One cut was taken from each treatment at 60 days then the cowpea crop was left for flowering and seed production from each season ،when the pods turned yellow and was allowed to dry in the field for one week for easy threshing and storage. Harvest was done on September 20 and 14 for the two successive seasons 2017 and 2018, respectively .

Parameter Assessments

A-Yield and its components: Observations andmeasurements were recorded on 10 guarded plantschosen at random from each plot for the following characteristics:Plant height(cm): was measured from the soil surface to top of the plant, number of branches plant^{-1},fresh and dry forage yield in ton fed^{-1}, all plants were hand clipped and weighted in kg sub-plot, then converted to ton fed^{-1} according to **Kirshnasamy and Seshu (1990).** Dry forage yield (ton fed^{-1}), 500g plant samples from each sub-plot were dried at 70^0C till constant weight and dry matter percentage (DM %) was estimated. The dry forage yield (ton fed^{-1}) was calculated by multiplying fresh forage yield (ton fed^{-1}) with dry matter percentage.

Seed Yield and its Components

At pod maturity, a sample of ten plants was taken to estimate: pod length (cm), number of pods plant^{-1}, seeds number pod^{-1}, seed weight plant^{-1} (g), 100- seed weight (g), Seed yield (kg fed^{-1}) was recorded from all sub-plot, then converted to kg fed^{-1}.

B- Chemical composition and yields of CP and DCP fed :$^{1-}$Dry mattersamples of first cut in both years were analyzed in the Forage Crops Research Dep. Lab at Giza to determine **:**

1. CP%: Nitrogen percentage was determined by micro-Kjeldahl method, (N content by 6.25) then crude protein was calculated by multiplying.

2. CF%: Crude fiber percentage.

3. Ash%: Ash percentage**.**

4. DCP%: Digestible crude protein percentage was calculated as

DCP %= (CP% X 0.9115)-3.62) according to **Mcdonald *et al*. (1994)**.

5. CP yield: crude protein yield (Kg fed^{-1}); estimated by multiplying forage dry yield by CP%.

6- DCP yield : Digestible crude protein yield (Kg fed^{-1}); estimated by multiplying forage dry yield by DCP%.

Chemical analysis followed the conventional method recommended by the **A.O.A.C., 2005.**

E- Economic evaluation: -

The economic evaluation included three treatments organic acid and soluble calcium that were estimates as follows:

1. Average input variables as well as total costs of forage cowpea production under different organic acid and soluble calcium, control treatments and the applied different culture practices during the different stages of growth in each season.

2. Net farm income of forage cowpea production as affected by the different studied treatments. Net farm income is the values of forage yield according to the actual marketing price.

3. Net farm return of forage cowpea production as affected by applied treatments. It's calculated as the difference between the forage yield value (according to the actual price) and the total costs.

All fertilizers and seed prices as well as the costs of all farm operations are based on the official and the actual market prices (L.E.) determined by the Egyptian Ministry of Agriculture **(Anonymous, 2014)**. Total costs included values of production tools and requirements such as seeds, fertilizers, irrigation, man, power, machinery and other general or different costs without land rent average.

Statistical analysis :

The collected data were statistically analyzed according to procedures outlined by **Snedecor and Cochran (1980).** Means between treatments were compared by L.S.D. at 0.05 level of probability. **Bartlett's test** was done to test the homogeneity of error variance. The test was not significant for all assessed traits, so, the two season's data were combined analyzed.

RESULTS AND DISCUSSION

A-Effect of hill spaces on:-

1-Yield attributes

Data presented in Table (2) indicated that distance between hills had significant effects on plant height, number of branches plant^{-1}, pod length, number of pods plant^{-1}, number of seed pod^{-1}, seed weight plant^{-1} and 100- seed weightin both seasons as well as in combined analysis.

Table 2: Effect of hill spaces on yield attributes of cowpea in the first and second seasons as well as combined.

Characters / Treatments	plant height (cm)	Number ofbranches plant^{-1}	Pod length (cm)	Number of pods plant^{-1}	Number of seeds pod^{-1}	Seed weight (g plant^{-1})	100- Seed weight (g)
Season 2017							
20cm	154.93	8.2	16.11	16.41	9.91	23.67	14.56
30cm	137.92	9.1	18.90	19.57	11.29	27.19	15.49
F test	*	*	*	*	*	*	*
Season 2018 2018							
20cm	149.6	7.08	15.46	17.94	9.18	22.67	14.81
30cm	131.37	8.47	17.80	21.89	10.7	25.76	15.63
F test	*	*	*	*	*	*	*
Combined							
20cm	152.27	7.64	15.79	17.18	9.55	23.17	14.69
30cm	134.64	9.04	18.35	21.71	10.95	26.47	15.56
F test	*	*	*	*	*	*	*

Cowpea plant which sown on closer distance (20 cm) between hills was more higher than those grown on wide distance (30 cm) in plant height. These results may be due to the high competition between plants in closer distance for light, nutrient and water than other plants grown in wide spaces. On the other hand, the lowest values were obtained from 20cm between hills in number of branches plant^{-1}.These results are in agreement with the previous findings reported by **Alege and Mustapha, (2007)** who showed that increased plant densities reduced the number of branches per plant. These results are in line with those obtained by **Achuo *et al.* (2004)** who found highly significant differences among treatments for plant height and number of branches plant^{-1}.

The highest values of pod length, number of pods plant ، $^{1-}$number of seeds pod ، $^{1-}$seed weight plant $^{1-}$and 100-seed weight were recorded when plants grown in wide space30) cm). Generally increasing plant spaces increased the number of pods plant $^{1-}$in both seasons (Table. 2). This increased may be attributed to the interference among branches. These findings are in accordance with the previous results reported by **Hamad (2004 (**who indicated that plants produced at the highest densities set fewer pods than those at the lowest densities and similar trends were observed by **Khan *et al* (2003) .**who found significant differences for 100-seed weight among treatments. Increased plant spaces resulted in increased 100-seed weight. This may be due to better availability of nutrients and better translocation of photosynthetic from source to sink and may be due higher accumulation of photosynthetic in the seeds. Contrasting results were reported by **Mohamed (2002)** who found that 100-seed weight was not affected by plant population. This may be due to better translocation and partitioning of assimilates from source to sink (seeds). Generally, increasing plant population decreased seed yield per plant. This was primarily because of reduced number of pods per plant and number of seeds per pod at the higher plant population .Similar results were obtained by **Hamad, (2004**) **.**

2- Chemical composition

Analysis of variance indicated significant differences among test treatments for percentages of crude protein Table (3).30cm spacing between plants gave higher crude protein percentage than those of 20cm spacing. Data inTable (3) indicated that plants grown on 30cm between hills led to pronounced increase in crude protein % compared to 20cm. These findings are in harmony with those of **Krishna (2006).** DCP%, and Ash% behaved the same trend of CP% in average of two seasons.

Table 3: Effect of hill spaces on percentages of crude protein, digestible crude protein, crude fiber and ash of cowpea as average two seasons.

Characters / Treatments	CP%	DCP%	CF%	Ash%
20cm	17.61	12.43	23.64	13.50
30cm	20.56	15.12	22.17	15.13
F test	*	*	*	*

3-Cowpea yields (fed^{-1}).

Data in Table (4) show that fresh, dry, seed, crude protein and digestible crude protein yields over two seasons were statistically affected by the distance between plants. Plants grown under closer distance (20cm) recorded the highest fresh and dry yields fed^{-1}for these traits. These results may be due to the highest plants and increments in number of plants fed^{-1} for plants grown in closer spaces (20cm). Hill space of 20 cm produced significantly higher fresh, dry, seed, CP and DCP yields compared to 30cm. These results may be due to the highest plants and increments in number of plants fed^{-1} for plants grown in closer spaces (20 cm). Similar results were obtained by **Magashi *et al*. (2014)**.

On the other hand, results in Table 4 revealed that significant differences for CP, DCP yields of forage cowpea. The data showed an increase in CP yield as well as DCP yield due to decrease plant density . Generally, increasing the plant population increased competition among plants for soil moisture, nutrient, light and carbon dioxide. These results agree with those reported by **Abu baker (2008) .**

Results revealed that seed yield fed^{-1} of cowpea was significantly affected by hill distances in both seasons and combined as shown in Table (4). Data indicated that 20 cm apart between hills (70000 plants fed^{-1}) recorded the highest value compared with 30cm apart between hills. The increase in seed yield (kg fed^{-1}) was 14.95% when cowpea was planted at 20 cm between hills compared with 30 cm (46.666 plants fed^{-1}) in combined. These results was coincided with those obtained by **Yadav (2003),** while **Helmy *et al.* (2015)** found that use of 35000 plants fed^{-1} increased seed yield (kg fed^{-1}) than use of 70000 plants fed^{-1}.

Table 4: Effect of hill spaces on fresh, dry and seed yield of cowpea in the first and second seasons as well as combined and crude protein and digestible crude protein yields of cowpea as average two season .

Characters / Treatments	Fresh yield (ton fed^{-1})	Dry yield (ton fed^{-1})	CP Yield	DCP Yield	Seed yield (kg fed^{-1})
			Season 2017		
20cm	12.86	2.126	---	---	503.6
30cm	10.22	1.783	---	---	433.8
F test	*	*	---	---	*
			Season 2018		
20cm	12.98	2.180	---	---	519.3
30cm	10.32	1.816	---	---	456.0
F test	*	*	---	---	*
			Combined		
20cm	12.92	2.153	25.49	19.61	511.4
30cm	10.27	1.800	22.71	17.08	444.9
F test	*	*	*	*	*

B- Effect of organic acids as well as soluble calcium on -:

1-Yield attributes

Under effect organic acids (ascorbic, citric and salicylic acids) and soluble calcium on plant height, number of branches plant^{-1}, pod length, number of pods plant^{-1}, seeds number pod^{-1}, seed weight plant^{-1} and 100- seed weight were significantly affected as presented in (Table 5). Cowpea treated with organic acids or soluble calcium increased plant height, number of branches plant^{-1}, pod length, number of pods plant^{-1}, seeds number pod, seed weight plant^{-1}and 100- seed weight compared with control treatment in both seasons as well as in combined. Also, data revealed that soluble calcium was a superiority for these characters that other organic acids followed by ascorbic acid followed by salicylic acid, simultaneously; citric acid showed the lowest values for those characters with respect treatments in both seasons as well as in combined. The increased availability of Ca_2+ from $CaCl_2$ increase chlorophyll content and photosynthesis leading to higher plants than control **(Rab and Haq, 2012).** These results are in agreement with those obtained by **Talebi *et al*. (2014).** The relative increases in yield attributes were 43.58, 48.31, 35.35, 53.95, 44.49, 51.88 and 11.47% for soluble calcium in combined of plant height, number of branches plant^{-1}, pod length, number of pods plant^{-1}, number of seeds pod^{-1}, seed weight plant^{-1} and 100- seed weight, respectively, compared control. These results are in harmony with those obtained by **Peksen and Artik (2004)** Application of organic acids and soluble calcium played significant role in all pod characters under study (Table 5). Plants treated with soluble calcium gave the highest values. **Rab and Haq (2012)** reported that spraying strawberry plants with 0.5% $CaCl_2$ solution significantly increased yield components over control. Solublecalcium was the most effective one which increased poly phenoloxidase activity in the treatments, these findings may be due to that soluble calcium is responsible for formation of strong cell walls **(Suzuki *et al*., 2003), Abd El Moneim, and Maisa 2005),** foliar spray of lower concentrations of salicylic acid conferred heat tolerance in plants due to enhanced H_2O_2 level and reduced the catalase (CAT) activity, thereby increasing the potential of plants to withstand the heat stress **(Hayat *et al.,* 2010).** Alsosalicylic acid protects cell membranes and their binding transporter proteins which maintain and their binding transporter proteins which maintain their structure and function against the toxic and destructive effects of reactive oxygen species (ROS) released during heat stress **(Kumar *et al.,* 2013; Bons *et al.,* 2015).**

Table 5: Effect of organic acids as well as soluble calcium on yield attributes of cowpea in the first and second seasons as well as combined .

Characters / Treatments	plant height (cm)	Number of branches plant^{-1}	Pod length (cm)	Number of pods plant^{-1}	Seeds number pod^{-1}	Seed weight (g plant^{-1})	100- Seed weight (g)
Season 2017							
Control	115.84	7.12	15.99	13.20	8.04	17.65	14.10
Ascorbic acid	152.17	9.17	18.25	19.45	11.44	27.29	15.41
Citric acid	142.67	7.92	16.25	17.20	10.19	25.50	14.72
Salicylic acid	148.62	8.95	17.22	18.57	11.30	26.93	15.18
Soluble calcium	163.17	10.35	19.85	21.52	11.80	29.76	15.71
L.S.D. (5%)	11.25	0.58	0.88	1.45	0.53	1.03	0.42
Season 2018							
Control	109.42	6.45	12.4	15.67	7.73	19.62	14.32
Ascorbic acid	148.17	8.38	18.04	19.66	10.96	26.53	15.59
Citric acid	139.35	7.53	16.54	19.67	9.31	24.65	14.90
Salicylic acid	145.07	7.98	17.54	21.58	10.70	25.96	15.33
Soluble calcium	160.27	9.78	18.58	22.93	11.00	28.31	15.97
L.S.D. (5%)	8.15	0.84	1.48	1.92	1.03	1.19	0.16
Combined							
Control	112.63	6.79	14.20	14.44	7.89	18.64	14.21
Ascorbic acid	150.17	8.77	18.15	19.56	11.20	26.53	15.50
Citric acid	141.01	7.73	16.40	18.44	9.75	24.65	14.81
Salicylic acid	146.80	8.47	17.38	20.08	11.00	25.96	15.26
Soluble calcium	161.72	10.07	19.22	22.23	11.40	28.31	15.84
L.S.D. (5%)	6.67	0.49	0.83	1.16	0.55	1.09	0.22

2-Chemical composition

Results in Table 6 showed that the percentage of crude protein, digestible crude protein, crude fiber and ash of cowpea as average two seasons were significantly influenced by the different applied treatments, compared to the control. Regarding to foliar spraying treatments, soluble calcium was surpassed the other in all traits as compared to control.

Table 6: Effect of organic acids as well as soluble calcium on percentage of crude protein, digestible crude protein, crude fiber and ash of cowpea as average two seasons.

Characters / Treatments	CP%	DCP%	CF%	Ash%
Control	16.62	11.53	24.04	12.78
Ascorbic acid	20.35	14.93	22.30	15.36
Citric acid	18.00	12.78	23.54	13.57
Salicylic acid	18.98	13.68	22.95	14.63
Soluble calcium	21.47	15.95	21.71	15.23
L.S.D. $_{0.05}$	0.72	0.65	0.53	0.37

Cowpea plants sprayed by soluble calcium gave the highest chemical composition value, compared to other organic treatments. Soluble calcium gave the highest CP, DCP and CF % followed by Ascorbic acid compared to the control. Similar results were reported by **Mandour *et al* .(2019) .**The maximum value of ash was obtained from plants treatment with ascorbic acid followed by soluble calcium with no significant difference between these treatments. Soluble calcium was the most effective one which increased polyphenol oxidase activity in the treatments, these findings may be due to that soluble calcium is responsible for formation of strong cell walls**(Suzuki *et al.,* 2003 ; Abd El Moneim, and Maisa 2005) .**

3- Cowpea yields fed^{-1}

Results in Table 7 showed that all studied fresh, dry, seed, CP and DCP yields fed^{-1} over two seasons were significantly influenced by the different applied treatments, compared to the control.

Results in Table (7) indicated that fresh and dry yields (ton fed^{-1}) recorded significant differences among spraying treatments. Results revealed that soluble calcium recorded the maximum values for fresh, dry and seed yields fed^{-1} followed by ascorbic acid compared to the other treatments under study. The lowest values of these traits were obtained by spraying citric acid. The relative increases were 17.40, 17.12, 13.46 and 9.71 % for Soluble calcium, Ascorbic acid, Salicylic acid, and Citric acid respectively in combined of fresh yield , 24.64, 21.85,15.80 and 12.78 % of dry yield in combined, respectively, compared control. It is worthy to mention that citric acid recorded the lowest values of fresh and dry yields compared to the other treatments under study and followed by Salicylic acid. It can be noticed that spraying soluble calcium was surpassed other treatments in fresh and dry yields fed^{-1}. Similar results were recorded by **Mandour *et al.* (2019)**. The maximum value of CP and DCP yields were obtained from soluble calcium treatment whereas CP and DCP yields recorded minimum value by control treatment. In this regard, our results are promising with higher mean value than that reported by **Peksen and Artik (2004).**

The mean increase in CP yield over control with soluble calcium, ascorbic salicylic and citric acid was 28.67%, 24.39%, 15.23 and 9.20%, respectively. Clear significant differences were obtained when differences values were compared to control. Seed yield fed^{-1} in both seasons and combined, seed yield in combined was significantly affected by spraying soluble calcium under study. Results revealed that seed yield of cowpea under treated treatment by organic acids and calcium soluble compared with untreated treatment. The increases in seed yield under treated treatment may my induce tolerance to plant to heat stress (through August and September) which helps to increase seed yield **(Bons *et al.*, 2015)**

Table 7: Effect of organic acids as well as soluble calcium on Fresh ‹Dry and Seed yield of cowpea in the first and second seasons as well as combined and crude protein and digestible crude protein yields of cowpea as average two season .

Characters / Treatments	Fresh yield (ton fed^{-1})	Dry yield (ton fed^{-1})	CP Yield (Kg fed^{-1})	DCP Yield (Kg fed^{-1})	Seed yield (kg fed^{-1})
Season2017					
Control	10.35	1.694	---	---	322.5
Ascorbic acid	12.12	2.070	---	---	504.8
Citric acid	11.33	1.922	---	---	431.8
Salicylic acid	11.74	1.970	---	---	461.0
Soluble calcium	12.17	2.123	---	---	623.8
L.S.D. $_{0.05}$	0.83	0.16	---	---	22.5
Season2018					
Control	10.44	1.721	---	---	341.2
Ascorbic acid	12.23	2.123	---	---	548.7
Citric acid	11.48	1.959	---	---	451.0
Salicylic acid	11.85	2.016	---	---	474.1
Soluble calcium	12.25	2.169	---	---	622.6
L.S.D. $_{0.05}$	0.51	0.22	---	---	25.4
Combined seasons					
Control	10.40	1.721	21.73	15.36	331.8
Ascorbic acid	12.18	2.097	27.03	18.55	526.7
Citric acid	11.41	1.941	23.73	15.81	441.4
Salicylic acid	11.80	1.993	25.04	16.40	467.5
Soluble calcium	12.21	2.145	27.96	20.45	623.2
L.S.D. $_{0.05}$	0.47	0.13	2.98	2.16	16.2

C- The interaction effects:-

The interaction between plant spaces and organic acids and soluble calcium had a significant on number of branches plant^{-1} as in the first season, dry yield (ton fed^{-1}) in combined, Pod length in the first and combined seasons, number of pods plant^{-1} in combined, Seed weight plant^{-1} in second season, 100- Seed weight in combined and seed yield in the first, second and combined season shown in Table (8). Planting cowpea at 30 cm between hills gave the highest values for number of branches plant^{-1} , pod length, Pods number /plant , Seed weight /plant and 100- Seed weight when treated with soluble calcium , whereas, the lowest value was showed when cowpea planted at 20 cm between hills and untreated (control treatment). The highest values for character in Table (8) were achieved where 30 cm by soluble calcium. On the other hand applying soluble calcium for cowpea plants which sown in 20cm between hills gave the highest dry yield and seed yield significantly under study, simultaneously; the lowest values for these characters were showed at 30 cm and untreated treatment (control) in Table (8).

Table 8: Effect of interaction between hill spaces and organic acids as well as soluble calcium of cowpea characters

Characters / Treatments	number of branches season 2017	Dry yield (ton fed^{-1}) combined season	Pod length (cm) season 2017	Pod length (cm) combined season	number of pods/ plant combined season	Seed weight /plant (g) season 2018	100- Seed weight (g) combined season	Seed yield (kg/fed.) season 2017	Seed yield (kg/fed.) season 2018	Seed yield (kg/fed.) combined season
20cm + control	7.07	1.846	12.10	11.80	12.67	18.27	13.63	368.4	387.2	377.8
20cm + Ascorbic acid	8.50	2.319	17.17	16.80	17.67	24.02	15.12	516.9	567.1	542.0
20cm + Citric acid	7.87	2.083	16.10	15.79	17.12	22.83	14.43	465.0	470.7	467.9
20cm + Salicylic acid	8.07	2.223	17.10	16.77	17.53	22.93	14.87	501.1	485.1	493.1
20cm + Soluble calcium	9.50	2.332	18.10	17.78	21.02	25.30	15.39	666.6	685.0	675.8
30cm + Control	7.17	1.595	14.80	14.05	16.20	20.97	14.79	276.6	295.1	285.9
30cm + Ascorbic acid	9.83	1.887	20.39	19.75	21.20	27.50	15.89	507.7	530.2	518.9
30cm + Citric acid	7.97	1.758	18.33	17.97	22.02	24.85	15.19	398.7	431.2	434.9
30cm + Salicylic acid	9.83	1.797	19.40	19.55	20.70	27.05	15.64	405.0	463.1	469.5
30cm + Soluble calcium	11.20	1.959	21.60	20.35	23.43	28.42	16.29	581.2	560.2	570.6
L.S.D. (5%)	0.82	0.19	1.24	1.17	0.37	0.94	0.31	31.8	35.4	22.85

4-Economic evaluation:

Total costs including values of production tools and requirements such as seeds and bio-regulators (three organic acids), soluble calcium man power machinery and other general or miscellaneous costs without land rent average summer 2017 and 2018 seasons are shown in Table (9) .The data presented in Table (9) reveal that the highest net return, without including land rent, equal 22075.0L.E was achieved by soluble calcium treatment followed by ascorbic acid treatment (18698.5L.E.) then treatment salicylic acid (16512.5L.E.). Meanwhile, the treatment control (11378 L.E.) had the lowest net return and net return of invested Egyptian pound. In general, it could be recommended that to maximize forage cowpea production, spraying three organic acids or soluble calcium for cowpea plants sown at 20cm hill space under the conditions of the clay soil at Beni Suef.

Table (9): Estimates of costs for inputs farm operations and economic return of cowpea as affected by spraying treatments over the two growing seasons of 2017 and 2018.

Costs of production inputs	Treatment				
	Control	Ascorbic acid	Citric acid	Salicylic acid	Soluble calcium
Land preparation Tillage	500	500	500	500	500
Planting	300	300	300	300	300
Seeds	525	525	525	525	525
Irrigation	500	500	500	500	500
Mineral fertilizers					
Urea (46% N)	180	180	180	180	180
Superphosphate(15.5%P2O5)	450	450	450	450	450
Ascorbic acid	-	35	-	-	-
Citric acid	-	-	35	-	-
Salicylic acid	-	-	-	35	-
calcium chloride	-	-	-	-	45
Hoeing and weeding	300	300	300	300	300
Harvesting	600	600	600	600	600
Total variable coast	3355	3390	3390	3390	3400
Forage yield t/f	10.40	12.18	11.41	11.80	12.21
Seed yield kg/f	331.8	526.7	441.4	467.5	623.2
Price of forage L.E. / ton	300	300	300	300	300
Price of seeds L.E. / kg	35	35	35	35	35
Forage revenue	3120.0	3654.0	3423.0	3540.0	3663.0
Seed l revenue	11613.0	18434.5	15449.0	16362.5	21812.0
Total revenue	14733.0	22088.5	18872.0	19902.5	25475.0
Net return	11378.0	18698.5	15482.0	16512.5	22075.0
Return of invested L.E.	4.4	6.5	5.6	5.9	7.5
Net return of invested L.E.	3.4	5.5	4.6	4.9	6.5

- **Net return (L.E.fed^{-1}) = Total revenue - Total variable costs**
- **Return of invested L.E. = Total revenue/ Total variable costs**
- **Net return of invested L.E. = Return of invested L.E – 1**

CONCLUSION

It could be concluded that planting cowpea to obtained forage and seed yields fed^{-1} must be plant combined at 20 cm a part between hills with using organic acids (citric, salicylic and ascorbic) or soluble calcium to improve forage, seed yields and economic return of farmer.

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تأثير انتاجيه العلف والبذور لمحصول لوبيا العلف بالأحماض العضوية والكالسيوم المذاب تحت مسافات الزراعه

فادية محمد سلطان – عزة خيل محمد سالم – ماجدة نادى رجب

قسم بحوث محاصيل العلف – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية–الجيزة – مصر.

أجريت تجربه حقليه فى محطة البحوث الزراعية بسدس – محافظة بنى سويف خلال موسمى 2017 و 2018 لدراسة تأثير بعض الاحماض العضويه (اسكوربيک– ستريک – سالسيلک) بالاضافه الى الكالسيوم المذاب على انتاجيه العلف و البذور لمحصول لوبيا العلف تحت مسافات الزراعه (20 و30 سم بين الجور) صنف (المحلى) بالإضافة إلى التقيم الاقتصادى و قد استخدم تصميم القطع المنشقه مره واحده فى أربع مكررات وتشير اهم النتائج الى:–

- ادت زراعة لوبيا العلف على مسافة 30 سم بين الجور الى زيادة عدد الافرع /للنبات و مكونات محصول البذره (طول القرن و عدد القرون /نبات وعدد البذور/قرن ووزن 100 بذره) وجوده العلف (نسبه البروتين الخام والبروتين المهضوم والالياف والرماد) بينما سجلت الزراعه على مسافه 20 سم بين الجور اعلى القيم لارتفاع النبات وإجمالى إنتاجية العلف الاخضر والجاف و البذره ومحصول البروتين الخام ومحصول البروتين المهضوم خلال موسمى الدراسه والتحليل التجميعى .
- تاثرت كل صفات مكونات المحصول للوبيا حيث زادت معنويا باستخدام الاحماض العضويه و الكالسيوم المذاب مقارنه بالكنترول و تفوقت معامله الكالسيوم المذاب على الاحماض العضويه (اسكوربيک– ستريک –سالسيلک) .
- سجل التفاعل بين زراعه اللوبيا على مسافه 20سم والرش بالكالسيوم المذاب اعلى القيم لحاصلات لوبيا العلف (الاخضر والجاف والبذره والبروتين و البروتين المهضوم للفدان) خلال موسمى الدراسه و التحليل التجميعى.
- سجل الكالسيوم المذاب اعلى القيم لصافى العائد الاقتصادى للفدان(22075.0 جنيها) مقارنه بباقى المعاملات خلال موسمى الدراسه والتحليل التجميعى.

نستنتج من الدراسه: للحصول على اعلى انتاجيه لمحصول العلف و البذور للوبيا عندما يتم زراعه اللوبيا على مسافه 20سم بين الجور مع استخدام احد الاحماض العضويه (اسكوربيک– ستريک – سالسيلک) او الكالسيوم المذاب ويفضل الكالسيوم المذاب للتغلب على ظروف الاجهاد الحرارى التى تؤثر على انتاجيه البذره خلال شهر اغسطس و سبتمبر تحت ظروف محافظه بنى سويف.