ISSN: 0974 - 0376

The Ecoscan : Special issue, Vol. VII: 79-83: 2015
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES
www.theecoscan.in

EFFECT OF FOLIAR APPLICATION OF WATER SOLUBLE FERTILIZERS ON GROWTH, YIELD AND ECONOMICS OF VEGETABLE COWPEA PRODUCTION

Vivek Kumar Singhal *et al.,*

KEYWORDS

Pod yield
Foliar Spray
BCR and Water soluble fertilizers

Proceedings of National Conference on Harmony with Nature in Context of Bioresources and Environmental Health
(HORMONY - 2015)
November 23 - 25, 2015, Aurangabad,
organized by
Department of Zoology,
Dr. Babasaheb Ambedkar Marathwada University
Aurangabad (Maharashtra) 431 004
in association with
National Environmentalists Association, India
www.neaindia.org

The Ecoscan
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES

VIVEK KUMAR SINGHAL*[1], G. G. PATEL[1], DIPAK H. PATEL[1], UTTAM KUMAR[2] AND LOKESH KUMAR SAINI[1]
[1]Department of Soil Science and Agricultural Chemistry,
N.M.C.A., NAU, Navsari, Gujarat - 396 450
[2]Department of Soil Science and Agricultural Chemistry,
COA, SKRAU, Bikaner, Rajasthan - 334 006
e-mail: vscoolvivek44@gmail.com

ABSTRACT

The field experiment was conducted during the summer season of 2014 at the Regional Horticultural Research Station, Navsari Agricultural University, Navsari, Gujarat to study the effect of spraying of water soluble fertilizers on cowpea crop. Water soluble fertilizers were applied thrice at 30, 45 and 60 DAS of cowpea. The application of banana pseudostem enriched sap @ 1 % resulted in achieving significantly the highest plant height (56.33 cm), number of pods per plant (13.33), yield per plant (104.67g), dry seed yield (1453 kg/ha), dry plant yield (1658 kg/ha) as well as commercial pods yield (9.71 t/ha) of cowpea and was found at par with mixed fertilizer 19:19:19 @ 0.5% in all cases. From the economics point of view, for securing maximum return, an application of mixed fertilizer 19:19:19 @ 0.5% was found superior with the highest BCR of 3.4:1. Both these treatments (T_1 and T_6) were found economical, profitable and proved highly remunerative. Hence, 3 spray of banana pseudostem enriched sap (T_6) or mixed fertilizer (T_1) (19:19:19) is recommended for cowpea.

*Corresponding author

INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp) is also a one of the most important pulse crops native to Central Africa and belong to family Fabaceae. Cowpea is called as vegetable meat due to high content of protein in grain with better biological value on dry weight basis. Apart from this, cowpea forms excellent forage and it produces a heavy vegetative growth and covers the ground so well that it checks the soil erosion.

Cowpea is a warm-season crop well adapted to many areas of the humid tropics and temperate zones. In Gujarat, cowpea is grown in July-August or in February. The area under cowpea cultivation in Gujarat is about 0.27 lakh hectares with an annual production of 2.89 lakh tonnes and the productivity of 10.49 t/ha (Anonymous, 2012).

Nutrient management is the most basic factor and is found to exert a great influence not only on growth and yield attributes of vegetables but also for obtaining sustained productivity. Among all nutrients; N, P and K are most important nutrients which contribute to proper growth and yield of plants and it also has direct effect on metabolism of plants (Abusaleha and Shanmugavelu, 1988). Method of fertilization also plays an important role in supplying the nutrient to the plants because the efficacy of fertilizers applied in soil being low due to various losses and fixation, mainly in area of problematic soil. Under this condition, foliar application seems to be promising for ensuring use efficiency of applied nutrients. Foliar spray enables plants to absorb the applied nutrients from the solution through their leaf surface and thus, may result in the economic use of fertilizer (Manasa *et al.,* 2015). The high effectiveness, rapid plant responses, convenience and elimination or reduction of toxicity symptoms brought by excessive soil accumulation of given element due to foliar nutrition makes it more reliable (Jules, 1984). Recently specialty fertilizers with different ratios of N, P and K having high solubility had been introduced and is highly amenable for foliar nutrition (Jeyabal *et al.*, 1998). The importance of foliar feeding of water soluble fertilizers in horticultural crops is immensely felt among the scientists and farmers, since macro and micro nutritional deficiencies in Indian soils have been on the increase due to adoption of high input agriculture (Garhwal *et al.*, 2007).

The farmers of South Gujarat are using different water soluble macro nutrient fertilizers as foliar sprays to increase the productivity of vegetables besides to reduce the cost of cultivation. The information available on the use of these water soluble fertilizers in vegetables is meager and hence the present investigation was carried out under South Gujarat condition.

MATERIALS AND METHODS

Field experiment was conducted during the summer season of 2014 at the Regional Horticultural Research Station (RHRS) of Navsari Agricultural University, Navsari, Gujarat. The soil of the experimental block was silty clay in texture with a pH of 8.1

and EC of 0.36 dS/m. The experimental soil was low in available nitrogen (243 kg/ha), medium in available phosphorus (42.8 kg/ha) and available potash (280 kg/ha).The cowpea variety "Anand Cowpea-1" was used for the study. The seed are sown in plat bed at an espacement of 30 x 10 cm with plot size of 2.4 x 1.4 m. The experiment comprised of seven treatments of spraying of water soluble fertilizers; *viz.*, T_1 (Mixed fertilizer 19:19:19 @ 0.5%), T_2 (Urea @ 1%), T_3 (MCP @ 0.5%), T_4 (MOP @ 0.5), T_5 (DAP @ 2%), T_6 (Banana pseudostem enriched sap @ 1%), T_7 (Water spray) were evaluated in a Randomized Block Design with three replications. Water soluble fertilizers were applied thrice at 30, 45 and 60 DAS. Enriched sap of banana pseudostem (T_6) is novel organic liquid fertilizer prepared by the team of National Innovative Project on "A Value Chain on Utilization of Banana Pseudostem for Fiber and Other Value added Products". This enriched sap is a very good source of essential plant nutrients (Table 1) could be applied through fertigation (MIS) or by foliar method of application. All the treatments received soil application of fertilizers as recommended dose (20:40:00 kg/ha). The entire quantity of common dose of organic manure (10 t/ha) *i.e.* FYM was well mixed in all the experimental plots at the time of field preparation. Methods followed in present study are described below:

Growth and yield attributes

Observation were recorded on five randomly selected plants in each replication on plant height, numbers of leaves (at 30, 45 and 60 DAS), numbers of pods per plant as well as yield per plant.

Dry matter yield

Ten cowpea pods were collected randomly from each treatment and seeds are separated from the pods. After recording the green weight of cowpea seeds, seeds were oven dried at 65ºC till constant weight to record oven dried weight and converted into kg/ha using commercial yield data. Similarly, after last picking of pods above ground part of the plant were harvested separately from net area. This aerial biomass was allowed to sundry in respective plots. Treatment wise plant dry matter yield was recorded and converted into kg/ha.

Commercial Pod yield

The picking of green pods was done separately from net plot and after each picking, fruit yield per net plot area were recorded. The total commercial pod yield was obtained by summing up the yields of all the pickings.

Chemical analysis of soil

To know the effect of foliar fertilization on soil chemical properties, soil samples were collected from each plot (0-22.5cm depth) after harvesting and analyzed for pH, EC, OC and available soil nutrients as per the set procedures given in Table 2.

Statistical analysis

Data pertaining to growth, yield attributes, yield and soil chemical properties were subjected to statistical analysis as per the methods described by Panse and Sukhatme (1967).

Economics

Net returns of each treatment were calculated by deducting the total cost of cultivation from the gross return. The Benefit Cost Ratio (BCR) was calculated on the basis of following formula.

$$BCR = \frac{\text{Net returns}}{\text{Cost of cultivation}}$$

RESULTS AND DISCUSSION

Growth attributes

The foliar application of water soluble fertilizers were failed to exert any significant effect on days to 50 per cent flowering, days to initiation of pod formation and number of leaves/plant (at 30, 45 and 60 DAS) in cowpea (Table 3). But, plant height of cowpea recorded at final harvest was significantly affected by different treatments under study. It was noted that application of enriched sap @ 1% (T_6) recorded significantly higher plant height (56.33 cm) and was found at par with T_1, T_2, T_4 and T_5. Significantly the lowest plant height (46.00 cm) was recorded in water spray (T_7). The increase in plant height was due to increased cell division and cell elongation at higher level of N. The pronounced effect of water soluble fertilizers on plant height have also been reported by Chaurasia *et al.* (2005) and Venkatesh and Basu (2011).

Yield and Yield attributes

The entire yield attributes *viz.*, number of pods per plant, pod yield per plant and total pod yield per hectare were significantly influenced by foliar feeding of water soluble fertilizers (Table 4). The treatment receiving 1 % banana pseudostem enriched sap (T_6) recorded significantly the highest number of pods/

Table 1: Chemical composition of banana pseudostem enriched sap

Plant nutrient	Macro-nutrient		Micro-nutrient					GA_3	Cytokinin
	N	P	K	Fe	Mn	Zn	Cu		
concentration (mg/L)	119	50.4	1289	124	6.73	6.73	0.97	110-205	137-244

Table 2: Method followed for soil analysis

Sr. No.	Parameters	Method
(1)	pH	Potentiometric (Jackson, 1973)
(2)	EC	Conductometric (Jackson, 1973)
(3)	Organic carbon (OC)	Wet oxidation (Walkley and Black 1934)
(4)	Available N	Alkaline permanganate oxidation (Subbhiah and Asija,1956)
(5)	Available P_2O_5	Spectrometric (0.5 M $NaHCO_3$, pH 8.5, blue color) (Olsen *et al.*,1954)
(6)	Available K_2O	Flame photometric (neutral N NH_4OAc) (Jackson, 1973)

Table 3: Effect of different treatments on growth attributes of cowpea

Treatments	Days to 50% Flowering	Days to initiation of pod formation	Numbers of leaves/plant			Plant height(cm)
			30 DAS	45 DAS	60 DAS	
T_1 - Mixed fertilizer (19-19-19) @ 0.5%	40.33	45.33	5.33	10.33	19.33	56.33
T_2 - Urea @ 1.0 %	41.67	46.00	4.67	10.00	18.00	53.33
T_3 - Mono calcium phosphate (MCP) @ 0.5%	42.00	46.67	4.33	9.33	17.67	49.00
T_4 - Murat of potash (MOP) @ O.5 %	41.00	46.00	4.33	9.00	18.00	50.67
T_5 - Di-ammonium phosphates (DAP) @ 2%	41.33	46.00	4.67	9.67	18.33	51.67
T_6 - Banana pseudostem enriched sap @ 1.0%	39.00	44.00	5.33	10.33	19.33	56.33
T_7 - water spray (Irrigation Water)	44.33	47.67	4.33	9.00	16.67	46.00
S. Em. ±	2.15	2.19	0.31	0.53	1.11	2.10
CD at 5%	NS	NS	NS	NS	NS	6.46
CV %	8.99	8.27	11.49	9.78	10.54	6.99

Table 4: Effect of foliar application of water soluble fertilizers in yield attributes, yield and economics of cowpea cultivation

Treatments	Numbers of pods/plant	Pod Yield/ plant (g)	Pod yield (t/ha)	Dry seed yield(kg/ha)	Dry plant yield(kg/ha)	BCR
T_1 - Mixed fertilizer (19-19-19) @ 0.5%	12.67	98.00	9.49	1377	1631	3.4:1
T_2 - Urea @ 1.0 %	11.67	92.22	8.45	1245	1597	2.9:1
T_3 - Mono calcium phosphate (MCP) @ 0.5%	8.67	89.85	7.17	1207	1313	2.3:1
T_4 - Murat of potash (MOP) @ O.5 %	11.00	91.06	8.23	1253	1359	2.8:1
T_5 - Di-ammonium phosphates (DAP) @ 2%	11.33	93.33	8.34	1260	1579	2.8:1
T_6 - Banana pseudostem enriched sap @ 1.0%	13.33	104.67	9.71	1453	1658	3.3:1
T_7 - water spray (Irrigation Water)	7.67	78.33	6.59	1180	1274	2.0:1
S. Em. ±	0.52	4.53	0.37	38	47	
CD at 5%	1.61	13.95	1.15	118	145	
CV %	8.33	8.78	7.82	5.15	5.48	

Table 5: Effect of water soluble fertilizers on soil chemical properties of cowpea field after harvest

Treatments	pH	EC(dS/m)	OC(%)	N(kg/ha)	P_2O_5(kg/ha)	K_20(kg/ha)
T_1 - Mixed fertilizer (19-19-19) @ 0.5%	7.6	0.36	0.54	224	39	247
T_2 - Urea @ 1.0 %	7.7	0.37	0.56	224	40	252
T_3 - Mono calcium phosphate (MCP) @ 0.5%	7.8	0.37	0.53	238	40	255
T_4 - Murat of potash (MOP) @ O.5 %	7.8	0.36	0.53	229	41	252
T_5 - Di-ammonium phosphates (DAP) @ 2%	7.9	0.37	0.51	236	43	248
T_6 - Banana pseudostem enriched sap @ 1.0%	7.7	0.36	0.54	222	38	247
T_7 - water spray (Irrigation Water)	7.8	0.37	0.52	242	42	262
S.Em. ±	0.20	0.01	0.02	8	2	8
CD at 5%	NS	NS	NS	NS	NS	NS
CV %	4.54	5.17	6.91	5.97	9.81	5.34

plant (13.33) and pod yield/plant (104.67g) and remained statistically at par with the treatments T_1 in case of number of pods/plant and T_1, T_2, T_4 and T_5 in case of pod yield/plant. The treatment receiving only water spray registered significantly minimum number of pods/plant (7.67) and pod yield/plant (78.33g). The increase in numbers of fruits/pods and yield/ plant might be due to a reason of supply of more nutrients at critical stage (*i.e.* flowering and fruit setting) and an abundance of nitrogenous fertilizers for photosynthesis activity which ultimately enhanced utilization of photosynthates and increased allocation of photosynthates towards the economic part (Batra *et al.,* 2002). The results of the present investigation are also corroborated by Karpagam *et al.* (2004) and Choudhary and Yadav, (2011).

Similarly, foliar spray of pseudostem banana enriched sap (T_6) recorded maximum pod yield (9.71 t/ha) which was found on par with the treatment T_1 (9.49 t/ha), receiving spraying of mixed fertilizer (19-19-19) @ 5 %. Further, foliar spray of Urea @ 1 % (T_2) recorded the third highest green pod yield (8.45 t/ha) of cowpea and remained at par with T_4 and T_5. The increase in yield might be due to easy assimilation of nutrients and balance in NPK ratio which affects the crop productivity. The spraying of water soluble nutrients increases uptake of nutrients and water, resulting in more photosynthesis and enhanced food accumulation in edible parts (Phandis, 2010). The present findings are found in agreement with Batra *et al.* (2006) and Rahman *et al.,* (2014).

Dry matter yield of cowpea was significantly influenced by foliar spray of water soluble fertilizers (Table 4). Treatment receiving banana pseudostem enriched sap @ 1% (T_6) registered significantly higher values of dry seed yield (1453 kg/ha) and plant yield (1658 kg/ha). But, it remained statistically at par with treatment T_1 in case of dry seed yield and T_1, T_2 and T_5 in case of dry plant yield. Significantly lower values of dry

seed yield (1180 kg/ha) and plant yield (1274 kg/ha) were recorded with water spray treatment (T_7). The efficient partitioning of photosynthates towards the sink might be the cause for enhanced biomass. Similar results were also reported by Salunkhe, (2010) and Kumar, (2013).

Economic

Economic benefits ultimately matters for vegetable growers. Among the treatments tested, 3 sprays of enriched sap @ 1% (T_6) achieved the highest net return of Rs. 149347 per ha with the benefit: cost ratio of 3.3:1 in cowpea cultivation and was closely followed by the treatment T_1 receiving of 3 sprays of mixed fertilizer (19:19:19) @ 0.5%, registered net return of Rs. 146260 per ha with the benefit: cost ratio of 3.4:1 (Table 4). The lowest net return with minimum benefit: cost ratio was found with water spray treatment (T_7). The results clearly announced that the use of water soluble fertilizers increased the okra yield and thereby gave remunerative return to the vegetables grower. Similar views in the direction of present findings were also expressed by Premsekhar and Rajshree, (2009).

Soil chemical properties (after harvesting)

In cowpea field, no significant effect of spraying of water soluble fertilizers were observed on soil properties *viz*. pH, EC, organic carbon content (OC) and available N, P_2O_5 and K_2O after harvest (Table 5). After harvest, the status of available N, P_2O_5 and K_2O were varied from 222 to 242, 38 to 42 and 247 to 262 kg/ha, respectively. Higher status of N, P_2O_5 and K_2O in soil was found with treatment receiving water spray. Similar results of soil chemical properties were reported by Gundrashiya, (2013). Incorporation of FYM along with fertilizers favored the conversion of organically bound nutrient to inorganic form (Panwar, 2008). Similar increase in available nutrient in soil due to addition of organics was reported by Sharma *et al.* (2013).

REFERENCES

Abusaleha and Shanmugavelu, K. G. 1988. Studies on the effect of organic v/s inorganic source of nitrogen on growth, yield and quality of okra (*Abelmoschus esculentus*). *Indian J. Hort.* **45(3&4):** 312-318.

Anonymous 2012. Anuual report 2012-2013, Department of Agriculture and Cooperation, ministry of Agriculture, Government of India Krishi Bhawan.

Batra, V. K., Dhankhar, S. K., Bhatia, A. K., Singh, V., Arora, S. K. and Singh, V. 2006. Response of brinjal to foliar feeding of water soluble fertilizers. *Haryana J. Hort. Sci.* **35**(**3&4):** 317.

Batra, V. K., Singh, V. and Singh, B. 2002. Response of bringal to foliar feeding of water soluble fertilizers. International conference on vegetables, at Bangalore. pp. 11-14

Chaurasia, S. N., Singh, K. P. and Rai, M. 2005. Effect of the foliar application of water soluble fertilizers on growth, yield and quality of tomato (*Lycopersicum esculentum* L.). *Sri Lankan J. Agri. Science.* **42:** 66-70.

Choudhary, G. L. and Yadav, L. R. 2011. Effect of fertility levels and foliar nutrition on cowpea productivity. *J. Legumes.* **24(1):** 67-68.

Garhwal, O. P., Fageria, M. S. and Mukherjee, S. 2007. Integrated nitrogen management in okra (*Abelmoschus esculentus* (L.) Moench.) hybrids. *Haryana J. Hort. Sci.* **36(1&2):** 129-130.

Gundrashiya, R. R. 2013. Study the effect of spraying of banana pseudostem based enriched sap at different concentration on growth and yield of different crops. *Ph. D. thesis Navsari Agricultural University. Navsari (Gujarat).*

Jackson, M. L. 1973. "Soil Chemical Analysis"., *Prentice-Hall of India Pvt. Ltd.,* New Delhi, India, pp. 39-415.

Jeyabal, A., Rao, M. M., Palaniapan, S. P. and Chelliah, S. 1998. Technical Bulletin on Specialty Fertilizers. *Nagarjuna Agricultural Research and Development Institute, Secunderabad.*

Jules, J. 1984. Foliar nutrition in tree plants. *Horti. Review.* **6:** 287- 355.

Karpagam, R., Kannan, M., Natarajan, S. and Srinivasan, K. 2004. Studies on the efficacy of foliar feeding of water soluble fertilizers on growth parameters and yield of brinjal (*Solanum melongena* L.) hybrid 'COBH-1'. *South Indian Hort.* **52(1-6):** 139-145.

Kumar, A. K. 2013. Effect of foliar application of NPK nutrients on growth and yield of chilli (*Capsicum annuum* L.). *J. Res. ANGRAU.* **41(1):** 1-4.

Manasa, V., Hebsur, N. S., Malligawad L. H., Kumar, L. S. and Ramakrishna, B. 2015. Effect of water soluble fertilizers on uptake of major and micro nutrients by groundnut and post harvest nutrient status in a *vertisol* of northern transition zone of Karnataka. *The Ecoscan.* **9(1-2):** 01-05.

Olsen, S. R., Cole, C. V., Watanabe, F. S. and Dean L. A. 1954. Estimation of available phosphorus in soils by the extraction with sodium bicarbonate. *U. S. D. A. Circ.* p. 939.

Panse, V. G. and Sukhatme, P. V. 1967. "Statistical Methods for Agricultural Workers", Indian Council of Agricultural Research, New Delhi, India, pp. 152-161.

Panwar, A. S. 2008. Effect of integrated nutrient management in maize (*Zea mays*)- mustard (*Brassica campestris* var. Toria) cropping system in mid hill altitude. *Indian J. Agricultural Science.* **78(1):** 27-31.

Phandis, B. P. 2010. P. K. Foliar fertilization. *IMMA News.* **3(2):** 11-14.

Premsekhar, M. and Rajashree, V. 2009. Performance of hybrid tomato as influenced by foliar feeding of water soluble fertilizer. *American-Eurasian J. Sustainable Agriculture.* **3(1):** 33-36.

Rahman, I. U., Afzal, A., Iqbal, Z., Ijaz, F., Manan, S., Ali, S. A., Khan, K., Karim, S. and Qadir, G. 2014. Growth and yield of Phaseolus vulgaris as influenced by different nutrients treatment in Mansehra. *International J. Agronomy and Agricultural Research.* **4(3):** 20-26.

Salunkhe, J. R. 2010. Feasibility of using banana pseudostem sap as liquid fertilizer in onion under drip irrigation. *M.Sc. thesis Navsari Agricultural University. Navsari (Gujarat).*

Sharma, G. D., Thakur, R., Raj, S., Kauraw, D. L. and Kulhare, P. S. 2013. Impact of integrated nutrient management on yield, nutrient uptake, protein content of wheat (*Triticum aestivum*) and soil fertility in a *Typic laplustert*. *The Bioscan.* **39(4):** 187-198.

Subbhiah, B. V. and Asija, G. L. 1956. A rapid procedure for the estimation for available nitrogen in soils. *Curr. Sci.* **25:** 259-260.

Venkatesh, M. S. and Basu, P. S. 2011. Effect of foliar application of urea on growth, yield and quality of chickpea under rainfed conditions. *J. Food Legumes.* **24(2):** 110-112.

Walkley, A. and Black, I. A. 1934. Rapid titration method of organic carbon of soils. *Soil Science.* **37:** 29-33.