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Effect of Foliar Nutrition in Chickpea (*Cicer arietinum* L.) through Organics under Rainfed Condition

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ABSTRACT

Foliar nutrition is designed to eliminate the problems like fixation and immobilization of nutrients. Hence, foliar nutrition is being recognized as an important method of fertilization in modern agriculture. The liquid organic manures are the source of macro nutrients, essential micro nutrients, many vitamins, essential amino acids, growth promoting substances and beneficial microorganisms. A field experiment was conducted during *rabi*, 2020-21 at Regional Agricultural Research Station, Vijayapur, (Karnataka) India. The experiment was laid out in split plot design with three replications. There were fifteen treatment combinations, consisting five organic sources (vermiwash @ 10%, cowurine @ 10%, jeevamrutha @ 25%, biodigester filtrate @ 25% and urea @ 2%) in main plots and three stage of application (pre flowering, pod initiation and pre flowering + pod initiation) in sub plots. Foliar application of liquid organic manures, either jeevamrutha @ 25% or cow urine @ 10% both at pre-flowering and at pod initiation stages helped to increase growth, growth attributes like branches per plant, dry matter accumulation, crop growth rate and relative growth rate, gross and net returns of chickpea.

Keywords Chickpea, Foliar nutrition, Organics, Jeevamrutha, Cicer arietinum.

INTRODUCTION

Chickpea represents 32% of world pulse's area and 25% of world's pulse production. India ranks first in area (10.56 million ha) and production (11.17 million tonnes) of chickpea in the world, with productivity of 1077 kg ha^{-1} (Kumar *et al*. 2019). In India, Karnataka ranks fourth in the cultivation of chickpea with an area of 8.64 lakh ha and annual production of 6.75 lakh tonnes and productivity was 782 kg ha^{-1} (India stat 2020). Application of nutrients through foliar sprays along with soil application has several advantages in supplementing the nutritional requirements of crops. Foliar nutrition is designed to eliminate the problems like fixation and immobilization of nutrients. Hence, foliar nutrition is being recognized as an important method of fertilization in modern agriculture. Changing climatic scenario demands technologies

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Table 1. Effect of different organic sources and stage of application on growth attributes of chickpea at harvest. NS – Non significant.

Treatments	Plant height (cm)	Number of branches plant^{-1}	Dry matter accumulation (g plant^{-1})		
			Leaves	Stem	Reproductive parts
Organic sources (M)					
M_1 : Vermiwash @ 10%	32.9	5.53	2.84	4.27	8.99
M_2 : Cow urine @ 10%	32.7	5.67	2.91	4.41	9.03
M_3 : Jeevamrutha @ 25%	33.2	6.00	3.17	4.61	9.49
M_4 : Bio digesters filtrate @ 25%	32.7	5.47	2.78	4.11	8.72
M_5 : Urea @ 2%	32.9	5.53	2.92	4.22	8.79
SEm ±	1.18	0.11	0.06	0.09	0.15
CD at 5%	NS	0.35	0.20	0.28	0.50
Stage of application (S)					
S_1 : Pre flowering	32.5	5.37	2.65	4.02	8.32
S_2 : Pod initiation	32.9	5.63	2.94	4.24	8.98
S_3 : Pre flowering and Pod initiation	33.2	5.92	3.18	4.71	9.72
SEm ±	0.32	0.08	0.03	0.05	0.06
CD at 5%	NS	0.23	0.10	0.15	0.19
Interactions (M×S)					
$M_1 S_1$	32.6	5.27	2.50	3.81	8.31
$M_1 S_2$	32.9	5.47	2.84	4.31	9.22
$M_1 S_3$	33.3	5.87	3.19	4.70	9.44
$M_2 S_1$	31.8	5.13	2.45	4.04	8.19
$M_2 S_2$	32.8	5.67	2.99	4.28	8.80
$M_2 S_3$	33.3	6.20	3.27	4.92	10.10
$M_3 S_1$	32.9	5.70	2.97	4.28	8.78
$M_3 S_2$	33.3	6.00	3.25	4.36	9.57
$M_3 S_3$	33.3	6.27	3.29	5.17	10.13
$M_4 S_1$	32.4	5.07	2.44	3.82	8.10
$M_4 S_2$	32.5	5.40	2.69	4.03	8.51
$M_4 S_3$	33.2	5.93	3.21	4.48	9.46
$M_5 S_1$	32.9	5.67	2.87	4.15	8.20
$M_5 S_2$	32.9	5.60	2.93	4.22	8.79
$M_5 S_3$	32.9	5.33	2.96	4.29	9.48
SEm ±	1.32	0.18	0.09	0.13	0.19
CD at 5%	NS	0.54	0.27	0.40	0.61

that will help crop to overcome them without significant yield loss. The moisture deficit situations in dry land tracts of India results in less productivity due to less availability of nutrients. This method results in utilization of nutrients more efficiently and for correcting deficiencies rapidly. Recently, new generation special fertilizers have been introduced exclusively for foliar feeding and fertilization. The increased supply of nutrients and good response by plants resulted in enhanced translocation of nutrients to reproductive structures viz., pods, grains (Geetha and Velayutham 2009).

Foliar fertilization is the most economical way of supplying the plant nutrients when they lack or hardly available in the soil. Main advantage of foliar nutrition is that it often brings about immediate improvement in plant growth and development. Foliar fertilization or foliar feeding encourages the supply of nutrients, plant hormones, stimulants, and other beneficial substances in liquid form to plant through aerial parts of the plants viz., leaves, stems and other plant parts to realize enhanced yield, quality, pest resistance, improved drought tolerance, and also helps the plants to recover from transplant shock, hail damage, or the results of other weather extremes. Supplemental foliar application is one of the many techniques to supply nutrients at critical stages.

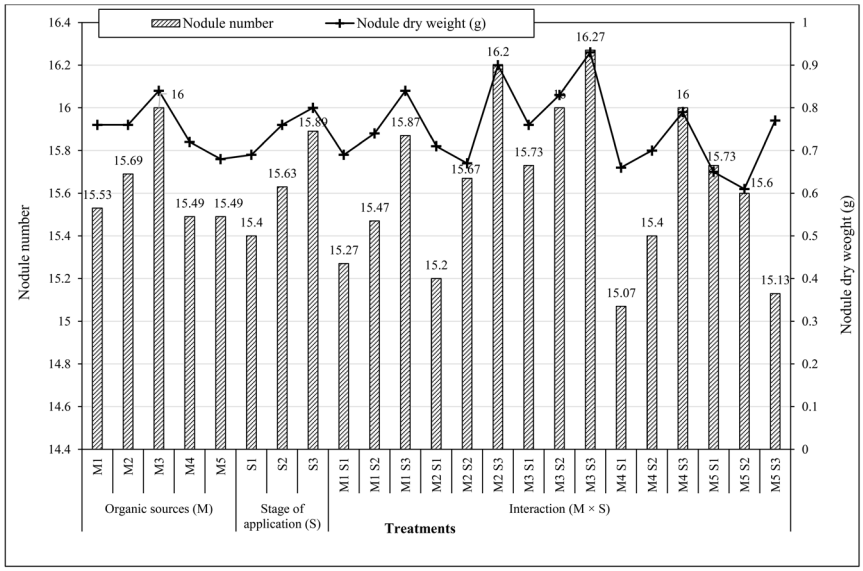

Fig. 1. Number of root nodules and nodule dry weight of chickpea at 60 days after sowing as influenced by foliar spray of different organic sources, stage of application and their interactions.

Application of nutrients through the foliar spray at appropriate stages of growth becomes important for their utilization and better performance of the crop (Anadhakrishnaveni *et al.* 2004).

In addition, liquid organic manures also fulfill the crop nutrient requirements with higher nutrient availability during peak growing periods and their application check their deficiencies under organic production systems. The liquid organic solutions like beejamrutha, jeevamrutha and panchagavya are prepared from cow dung, urine, milk, curd, ghee, legume flour and jaggery. Also, vermiwash and cow urine are the source of macro nutrients, essential micro nutrients, many vitamins, essential amino acids, growth promoting factors like Indole acetic acid, gibberellic acid and beneficial microorganisms.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* 2020-21 at Regional Agricultural Research Station, Vijayapur, Karnataka on *Vertisol* having pH 8.32 and EC 0.24 dS m^{-1}. The soil was medium in organic carbon content (0.51 %) and available P_2O_5 (31 kg ha^{-1}), and low in available N (168 kg ha^{-1}) with high available K_2O content (342 kg ha^{-1}). The experimental site was located at a latitude of 16˚ 77′ North, longitude of 75˚ 74′ East and an altitude of 516.29 meters above mean sea level in Northern Dry Zone of Karnataka (Zone 3).

Experimental design and treatment combination

The experiment was laid out in split plot design with three replications. There were fifteen treatment combinations, consisting five organic sources (vermiwash @ 10%, cowurine @ 10%, jeevamrutha @ 25%, biodigester filtrate @ 25% and urea @ 2%) in main plots and three stage of application (pre flowering, pod initiation and pre flowering + pod initiation) in sub plots.

Crop management

The land was ploughed once after the harvest of the previous crop, followed by two harrowing. At the time of sowing, the land was prepared to a fine seedbed and the plots were laid out. The variety JG-11 was used and fertilizer application was followed on the basis of the plant population occupied by crop. The full amount of fertilizer in the form of urea and di ammonium sulphate as per recommended package of practice 10:25:00 kg N, P_2O_5 and K_2O per ha was applied. The crop was sown on 24th October 2020

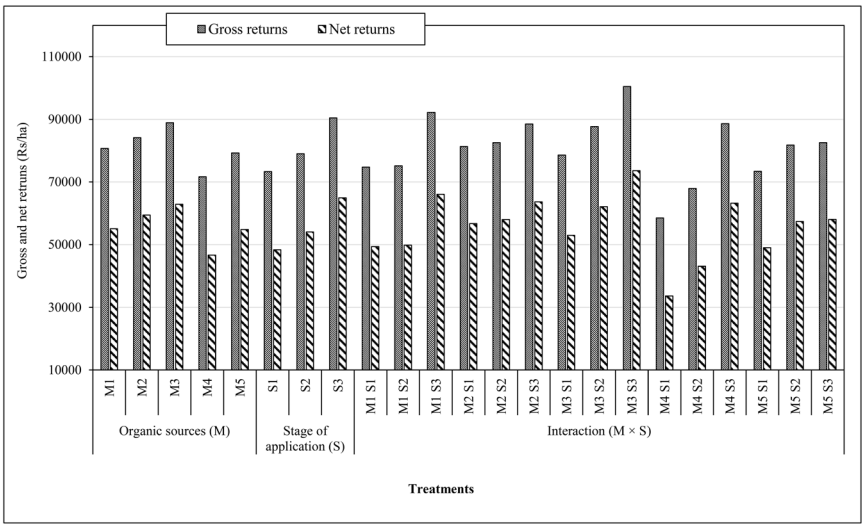

Fig. 2. Gross and net returns of chickpea as influenced by different organic sources, stage of application and their interactions.

with a spacing of 45 × 30 cm. The crop grown with the residual moisture of monsoon rains without any protective irrigations. Due to the incidence of pod borer (*Helicoverpa armigera* Hubner) the spray of emamectin benzoate 5% SG @ 0.5 g per liter of water was taken up to control the pest. Intercultivation was done to remove all weeds from the field in order to check crop weed competition.

Statistical analysis

The data collected from the experiment at different growth stages and at harvest were subjected to statistical analysis as described by Gomez and Gomez (1984). The level of significance used for 'F' and 't' tests was P=0.05. Critical Difference (CD) values were calculated at 5% probability level if the F test will found to be significant.

RESULTS AND DISCUSSION

Foliar application of jeevamrutha @ 25% both at pre flowering and at pod initiation recorded taller plant (33.3 cm) and significantly higher number of branches (6.27) as compared to alone application either at pre flowering and at pod initiation (Table 1). Foliar application both at pre flowering and at pod initiation, in which twice application doubles the content of nutrients applied on the plant canopy at different growth stage. Jeevamrutha which was being rich source of plant growth promoting hormones, supports for cell elongation and cell division, which leads to enhancement of plant height and number of branches per plant in chickpea. Similar results was reported by Mudalagiriyappa *et al.* (2016) and Sritharan *et al.* (2005).

The leaf, stem and reproductive parts dry weight was significantly more with foliar application of jeevamrutha @ 25% both at pre flowering and at pod initiation (3.29, 5.17 and 10.13 g, respectively) and the lowest dry weight recorded under application of bio digester filtrate @ 25% (2.44, 3.82 and 8.10 g, respectively) (Table 1). Similar results was reported by Patil *et al*. (2012). In the present investigation foliar application of nutrient influenced the dry matter accumulation which increased as the growth progressed and maximum value was observed at harvest. Dry matter accumulation is the sum total effect of overall growth of the plant like plant height, nodule count and leaf area indicating higher chlorophyllic area with improved photosynthetic efficiency of the plants which in turn resulted in higher dry matter accumulation, and also pods and grains inside the pods contribute to dry matter accumulation.

Table 2. Crop growth rate (CGR) and Relative growth rate (RGR) at different growth stages as influenced by foliar spray of different organic sources, stage of application and their interactions. DAS – Days after sowing, NS – Non significant.

Treatments	Crop growth rate (mg dm^{-2} day^{-1}) 30–60 DAS	60 – 90 DAS	Relative growth rate (mg g^{-1} day^{-1}) 30–60 DAS	60–90 DAS
Organic sources (M)				
M_1 : Vermiwash @ 10%	34.15	78.15	26.01	15.64
M_2 : Cow urine @ 10%	33.45	77.76	24.87	15.62
M_3 : Jeevamrutha @ 25%	39.07	79.88	26.60	16.35
M_4 : Bio digesters filtrate @ 25%	29.86	76.83	23.31	14.61
M_5 : Urea @ 2%	33.37	75.65	24.81	15.19
SEm ±	1.49	2.96	0.56	0.67
CD at 5%	4.85	NS	1.84	NS
Stage of application (S)				
S_1 : Pre flowering	28.13	73.87	22.99	15.36
S_2 : Pod initiation	34.23	77.52	25.45	14.65
S_3 : Pre flowering and Pod initiation	39.58	81.58	26.93	16.43
SEm ±	0.53	0.80	0.39	0.20
CD at 5 %	1.58	2.35	1.14	0.59
Interactions (M×S)				
M_1 S_1	26.42	74.86	22.40	15.19
M_1 S_2	33.04	79.98	26.36	16.06
M_1 S_3	42.99	79.60	27.71	17.23
M_2 S_1	24.94	72.67	22.29	13.86
M_2 S_2	37.51	76.54	26.01	14.42
M_2 S_3	37.90	82.20	26.30	15.20
M_3 S_1	32.37	77.73	25.01	15.81
M_3 S_2	38.86	79.73	27.08	14.59
M_3 S_3	45.98	84.07	29.27	17.38
M_4 S_1	24.96	73.56	21.83	13.42
M_4 S_2	28.25	75.51	22.62	16.47
M_4 S_3	36.37	81.43	25.49	17.00
M_5 S_1	31.98	70.52	23.40	14.74
M_5 S_2	33.48	75.85	25.16	15.26
M_5 S_3	34.67	80.57	25.88	15.58
SEm ±	1.78	3.30	0.90	0.77
CD at 5%	5.64	NS	NS	2.45

Crop growth rate (Table 2) and relative growth rate indicates the change in dry weight or logarithmic growth of plant over a period of time. Foliar application of jeevamrutha @ 25% both at pre flowering and at pod initiation recorded significantly higher CGR at 30–60 DAS (45.98 mg dm^{-2} day^{-1}) and numerically higher value of 84.07 mg dm^{-2} day^{-1} at 60–90 DAS recorded due to the foliar application of organics manures which contains macro and micro nutrients along with that vitamins and plant growth promoting substances and beneficial organisms. Relative growth rate at 30–60 DAS recorded numerically higher value (29.27 mg g^{-1} day^{-1}) and at 60-90 DAS showed significantly higher RGR of 17.38 mg g^{-1} day^{-1} as compared to alone application of organics either at pre flowering or at pod initiation.

As chickpea is a leguminous crop, number of root nodules and its dry weight are indicative of N fixing ability. Number of root nodules recorded at 60 DAS was significantly higher with foliar application of jeevamrutha @ 25% (16.00) over other organic sources (Fig. 1). Among different stage of application of organic sources, foliar spray at both pre flowering and pod initiation resulted in significantly higher root nodules (15.89) as compared to alone application either at pre flowering or at pod initiation. The treatment combination of jeevamrutha @ 25% applied at both pre flowering and pod initiation stages recorded significantly higher number of root nodules (16.27) over other treatment combinations.

Dry weight of root nodules is an indicative of effectiveness of root nodules, significantly higher dry weight of root nodules recorded with jeevamrutha @ 25% (0.84 g) over other organic sources. Among different stage of application, foliar application at both pre flowering and pod initiation (0.80 g) recorded significantly higher dry weight as compared to alone application. Similarly, foliar application of jeevamrutha @ 25% at both pre flowering and pod initiation (0.93 g) resulted significantly higher dry weight of nodules at 60 DAS indicating better effective nodulation. Similar increase in nodulation and nodule dry weight due to application of organic sources of nutrients was reported by Elayaraja and Angayarkanni (2005) in black gram.

Economic gain is one of the main factors in any technology's success and will not be embraced by the farming community unless it is economically viable. Remarkably greater economic returns were recognized with foliar application of organic sources

at both pre flowering and pod initiation stage which is depicted in Fig. 2. The foliar application of jeevamrutha @ 25% recorded significantly higher gross returns (Rs 88910 ha^{-1}) and net returns (Rs 62895 ha^{-1}) than other organic sources. This was attributed to higher grain yield and haulm yield of chickpea due to foliar application of nutrients. Among the different stage of application, foliar application at both pre flowering and pod initiation recorded significantly highest gross returns (90456 ha^{-1}) and net returns (64924 ha^{-1}) as compared to alone application at pre flowering or pod initiation. Among the interaction of organic sources and stage of application, foliar application of jeevamrutha @ 25% at both pre flowering and pod initiation documented significantly higher gross returns (100467 ha^{-1}) and net returns (Rs 73619 ha^{-1}) than other combinations. Similar results were also reported by Saraswathi (2020) and Patil *et al.* (2012). Foliar application of either jeevamrutha @ 25% or cow urine @ 10% both at pre flowering and at pod initiation stage improved the growth, growth attributes like branches per plant, dry matter accumulation, crop growth rate and relative growth rate, gross and net returns of chickpea.

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