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RESEARCH PAPER

Response of chickpea (*Cicer arietinum* L.) to foliar application of organics under rainfed condition

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Abstract: A field experiment was conducted to study the effect of foliar nutrition in chickpea through organics under rainfed condition in medium black soils at the Regional Agricultural Research Station, Vijayapur, during *Rabi,* 2020-21. The results revealed that the foliar application of jeevamrutha @ 25% both at pre flowering and at pod initiation stages recorded significantly higher number of pods plant^{-1} (46.5), grain weight plant^{-1} (9.45 g), grain yield (2198 kg ha^{-1}), haulm yield (2954 kg ha^{-1}), higher net returns (₹ 73,619 ha^{-1}) and BC ratio (3.74). While, lower pods plant^{-1} (30.9), grain weight plant^{-1} (6.79 g), grain yield (1277 kg ha^{-1}), haulm yield (2126 kg ha^{-1}), net returns (₹ 33,662 ha^{-1}) and BC ratio (2.35) were recorded in treatment receiving foliar application of bio digester filtrate @ 25% at pre flowering stage. The foliar application of either jeevamrutha @ 25% or cowurine @ 10% both at pre flowering and at pod initiation stages helped to increase growth and yield parameters, seed yield and maximum net returns and benefit cost ratio in chickpea.

Key words: Chickpea, Foliar nutrition, Jeevamrutha, Organics, Vermiwash

Introduction

Chickpea (*Cicer arietinum* L.) is one of the most prominent pulse crops not only in India but also in the world next to beans and peas, it also bears synonyms such as gram or bengal gram and popularly referred as chana in several places of the country. Chickpea is a cool season quantitative long-day legume crop belongs to Family: fabaceae and Subfamily: faboideae. 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} (Indiastat, 2020). Chickpea is widely cultivated in Northern Karnataka and from which Gulbarga occupies the first position later on followed by Vijayapura, Bidar, Gadag, Dharwad, Belagavi, Bagalkot, Raichur and Yadgir.

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. 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. Hence, the present investigation was intended to find the influence of foliar nutrients spray of organic sources and stage of application on yield attributes, yield and economics of chickpea under rainfed condition.

Material 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^{O} 77' North, longitude of 75^{O} 74' East and an altitude of 516.29 meters above mean sea level in Northern Dry Zone of Karnataka (Zone 3). During the year 2020-21, a total rainfall of 865.5 mm was received in 51 rainy days from April 2020 to March 2021 as against the normal rainfall of 594.4 mm which was received in 38 rainy days. The highest rainfall of 267.3 mm was received in the month of September followed by July (187.6 mm). The total rainfall received during cropping period (October-2020 to February-2021) was 126.8 mm.

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. 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 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*) the spray of emamectin benzoate 5 % SG @ 0.5 g per liter of water was taken up to control the pest. Harvesting was done at physiological maturity of the crop. The net plot area as per the treatments was harvested by cutting the plants to the ground level. After harvesting, the plants were bundled and allowed for sun drying. After complete sun drying, the crop was threshed by beating with wooden sticks. The separated seeds were winnowed, cleaned and grain and haulm yield were expressed in kilogram per hectare. The harvest index was calculated by using the formula suggested by (Donald, 1962).

The yield attributes and yield observations were recorded from the net plots and grain yield was converted to hectare basis in kilograms. The economics of each treatment was computed with prevailing market prices of the corresponding year. The yield was further computed for gross and net returns as well BC ratio to assess the profitability. The benefit-cost ratio was worked out by dividing the gross returns by the total cost of cultivation of respective treatments. 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 per cent probability level if the F test will found to be significant.

Results and discussion

Effect of organics on yield and yield attributing characters

The yield and yield attributes of chickpea were greatly influenced by foliar application of organic sources. The number of pods per plant of chickpea was significantly differed due to organic sources and stage of application. The higher number of pods per plant (42.73) was reported with foliar application of jeevamrutha @ 25% over other organic sources which is depicted in Table 1.

Among stage of application, foliar spray both at pre flowering and at pod initiation stage recorded significantly higher number of pods per plant (42.83) as compared alone spray either at pre flowering or at pod initiation stage. Interaction effect showed that foliar application of jeevamrutha @ 25% both at pre flowering and at pod initiation stage recorded significantly higher pods per plant (46.53) as compared to other treatment combinations.

This increase in both hundred grain weight and number of pods per plant is mainly because of total dry matter accumulation of plant is the indication of extent and persistence of photosynthetic capacity of plant and its translocation to different parts helps in getting higher hundred grain weight and number of pods per plant as reported by Patil *et al.* (2012) which is similar to the results of Devakumar *et al.* (2014).

Grain weight per plant differed significantly due to foliar spray of organic sources, stage of application and their interactions but the hundred grain weight was not significant (Table 1). Significantly highest grain weight (8.76 g) and hundred grain weight (21.87 g) was documented with jeevamrutha @ 25% over the other organic sources, but it was on par with cow urine @ 10% (8.11 g and 21.85 g).

Among the stage of application, foliar spray both at pre flowering and at pod initiation stage (8.60 g) recorded significantly highest grain weight per plant and numerically higher hundred grain weight (21.97 g) as compared alone spray at pre flowering (7.25 g) or at pod initiation (7.78 g) stage. The

Table 1. Yield attributes of chickpea at harvest as influenced by foliar spray of organic sources, stage of application and their interactions

Treatments	Number of pods plant^{-1}	Grain weight plant^{-1}(g)	Hundred grain weight (g)
Organic sources (M)			
M_1 : Vermiwash @ 10%	39.66	7.66	21.65
M_2 : Cow urine @ 10%	40.48	8.11	21.85
M_3 : Jeevamrutha @ 25%	42.73	8.76	21.87
M_4 : Bio digesters filtrate @ 25%	34.64	7.21	21.59
M_5 : Urea @ 2%	37.76	7.64	21.69
S.Em ±	1.53	0.29	0.82
C.D. at 5 %	4.98	0.96	NS
Stage of application (S)			
S_1 : Pre flowering	35.83	7.25	21.59
S_2 : Pod initiation	38.51	7.78	21.64
S_3 : Pre flowering and Pod initiation	42.83	8.60	21.97
S.Em ±	0.38	0.09	0.27
C.D. at 5 %	1.13	0.25	NS
Interactions (M×S)			
$M_1 S_1$	37.20	7.04	21.69
$M_1 S_2$	38.60	7.61	21.44
$M_1 S_3$	43.19	8.36	21.83
$M_2 S_1$	37.80	7.35	21.84
$M_2 S_2$	37.23	7.78	21.72
$M_2 S_3$	46.40	9.21	22.00
$M_3 S_1$	38.53	8.05	21.57
$M_3 S_2$	43.13	8.77	21.65
$M_3 S_3$	46.53	9.45	22.40
$M_4 S_1$	30.87	6.79	21.20
$M_4 S_2$	36.00	7.01	21.71
$M_4 S_3$	37.04	7.80	21.86
$M_5 S_1$	34.73	6.81	21.65
$M_5 S_2$	37.58	7.95	21.69
$M_5 S_3$	40.98	8.17	21.75
S.Em ±	1.68	0.33	0.95
C.D. at 5 %	5.39	1.06	NS

NS - Non Significant

interaction of foliar application of organic sources and stages of application had shown significantly higher grain weight per plant (9.45 g) and hundred grain weight (22.40 g) with jeevamrutha @ 25% sprayed both at pre flowering and at pod initiation stage over other interactions. However, it was on par with jeevamrutha @ 25% spray at pod initiation (8.77 g) and cow urine @ 10% sprayed both at pre flowering and pod initiation (9.21 g). Lowest grain weight per plant was observed with application of bio digester filtrate @ 25% at pre flowering (6.79 g).

The increase in pods per plant may be explained due to increase in number of branches under higher nutrient application at different growth stages. With the application of higher rates of fertilizer and foliar nutrition, the tissue differentiations from the somatic to reproductive, meristematic activity and the development of floral primordia might have been enhanced causing greater production of flowers which later developed to pod. Similar results were also reported by Sudhanshu *et al.* (2018) and Shinde and Hunje (2020).

Significantly higher grain yield per hectare was recorded with foliar application of jeevamrutha @ 25% (1945 kg ha^{-1}) compared to bio digester filtrate @ 25% (1567 kg ha^{-1}) and urea @ 2% (1733 kg ha^{-1}). However, it was on par with foliar application of vermiwash @ 10% (1765 kg ha^{-1}) and cow urine @ 10% (1841 kg ha^{-1}) (Table 2). Foliar application of Jeevamrutha @ 25% recorded 10.89% increase in grain yield per hectare over urea @ 2% application. Among stage of application, foliar application of organics at both pre flowering and pod initiation stage produced significantly higher grain yield (1979 kg ha^{-1}) as compared to single spray either at pre flowering (1603 kg ha^{-1}) or at pod initiation (1728 kg ha^{-1}) stage. The foliar application at both pre flowering and pod initiation documented 15.81% increment in grain yield per hectare as compared to alone application either at pre flowering or at pod initiation. The interaction effects of different organics sources and stage of application differed significantly with each other with respect to grain yield per hectare and significantly higher grain yield was recorded with jeevamrutha @ 25% (2198 kg ha^{-1}) applied both at pre flowering and at pod initiation stages over other interactions, however, it was on par with application of vermiwash @ 10%, cow urine @ 10% and bio digester filtrate @ 25% each both at pre flowering and at pod initiation (2018, 1937 and 1939 kg ha^{-1}, respectively) stage. The grain yield of chickpea is the product of various yield attributing characters like number of pods, grain weight per plant and test weight and these are differed significantly due foliar application of organic sources.

This increment is mainly due to enrichment of soil with fertilizer and plant with foliar spray of jeevamrutha both helped in providing the essential plant nutrients to the crop throughout the crop life cycle. Also due to combined addition of these organics helped in better photosynthetic capacity of plant which in turn increased translocation of photosynthates to sink. Similar results were also reported by Mudalagiriyappa *et al.* (2016) and Sritharan *et al.* (2005).

Haulm yield is primarily a function of vegetative growth and development of the crop in relation to plant height, number of primary branches per plant and total dry matter accumulation. The data on haulm yield of chickpea was significantly influenced by foliar spray of different organic sources. Foliar application of jeevamrutha @ 25% recorded substantially higher haulm yield (2686 kg ha^{-1}) compared to bio digester filtrate @ 25% (2350 kg ha^{-1}), but it was on par with vermiwash @ 10%, cow urine @ 10% and urea @ 2% (2520, 2591 and 2512 kg ha^{-1}, respectively).

Among stage of application, foliar application of organics both at pre flowering and at pod initiation recorded significantly highest haulm yield (2746 kg ha^{-1}) compared to alone application either at pre flowering (2359 kg ha^{-1}) or at pod initiation (2490 kg ha^{-1}). Interaction effect showed that foliar application of jeevamrutha @ 25% both at pre flowering and at pod initiation had shown significantly higher haulm yield (2954 kg ha^{-1}) as compared to other interactions except vermiwash @ 10% (2783 kg ha^{-1}) and cow urine @ 10% (2722 kg ha^{-1}) applied at both stages which were on par with each other.

Table 2. Grain yield, haulm yield and harvest index of chickpea as influenced by foliar application of organic sources, stage of application and their interactions

Treatments	Grain yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest index (%)
Organic sources (M)			
M_1 : Vermiwash @ 10%	1765	2520	41.07
M_2 : Cow urine @ 10%	1841	2591	41.55
M_3 : Jeevamrutha @ 25%	1945	2686	41.96
M_4 : Bio digesters filtrate @ 25%	1567	2350	39.76
M_5 : Urea @ 2%	1733	2512	40.81
S.Em ±	60	62	1.18
C.D. at 5 %	194	203	NS
Stage of application (S)			
S_1 : Pre flowering	1603	2359	40.31
S_2 : Pod initiation	1728	2490	40.90
S_3 : Pre flowering and Pod initiation	1979	2746	41.87
S.Em ±	34	29	0.54
C.D. at 5 %	99	85	NS
Interactions (M×S)			
$M_1 S_1$	1634	2374	40.64
$M_1 S_2$	1644	2402	40.53
$M_1 S_3$	2018	2783	42.02
$M_2 S_1$	1779	2486	41.72
$M_2 S_2$	1806	2564	41.33
$M_2 S_3$	1937	2722	41.61
$M_3 S_1$	1719	2426	41.51
$M_3 S_2$	1919	2677	41.71
$M_3 S_3$	2198	2954	42.66
$M_4 S_1$	1277	2126	37.49
$M_4 S_2$	1485	2243	39.84
$M_4 S_3$	1939	2681	41.95
$M_5 S_1$	1605	2382	40.21
$M_5 S_2$	1789	2564	41.10
$M_5 S_3$	1805	2590	41.11
S.Em ±	85	81	1.53
C.D. at 5 %	265	255	NS

NS - Non Significant

Table 3. Gross returns, cost of cultivation, net returns and BC ratio of chickpea as influenced by foliar application of organic sources, stage of application and their interactions

Treatments	Gross returns (₹ ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net returns (₹ ha^{-1})	BC ratio
Organic sources (M)				
M_1: Vermiwash @ 10%	80690	25681	55075	3.16
M_2: Cow urine @ 10%	84130	24681	59449	3.41
M_3: Jeevamrutha @ 25%	88910	26015	62895	3.42
M_4: Bio digesters filtrate @ 25%	71674	25015	46659	2.87
M_5: Urea @ 2%	79241	24428	54813	3.24
S.Em ±	2672	-	2672	0.11
C.D. at 5 %	8713	-	8713	0.37
Stage of application (S)				
S_1: Pre flowering	73308	24960	48348	2.94
S_2: Pod initiation	79023	24960	54063	3.17
S_3: Pre flowering and Pod initiation	90456	25572	64924	3.55
S.Em ±	1512	-	1512	0.06
C.D. at 5 %	4461	-	4461	0.17
Interactions (M×S)				
$M_1 S_1$	74717	25348	49369	2.95
$M_1 S_2$	75166	25348	49818	2.97
$M_1 S_3$	92187	26348	66039	3.57
$M_2 S_1$	81313	24598	56715	3.30
$M_2 S_2$	82567	24598	57969	3.36
$M_2 S_3$	88511	24848	63663	3.56
$M_3 S_1$	78583	25598	52985	3.07
$M_3 S_2$	87679	25598	62081	3.46
$M_3 S_3$	100467	26848	73619	3.74
$M_4 S_1$	58510	24848	33662	2.35
$M_4 S_2$	67932	24848	43084	2.73
$M_4 S_3$	88580	25348	63232	3.53
$M_5 S_1$	73416	24408	49008	3.01
$M_5 S_2$	81772	24408	57364	3.35
$M_5 S_3$	82535	24468	58067	3.37
S.Em ±	3842	-	3842	0.15
C.D. at 5 %	11912	-	11912	0.48

Foliar application of liquid organic manures significantly enhanced the growth rate of plant since it contain the favorable micro and macro nutrients and plant hormones and enzymes present in concoctions helps in rapid cell division and multiplication which improves the translocation of photosynthates from leaves via stem to sink *i.e.* pods and seeds resulted in bigger pods and more number of seed and highest hundred grain weight. These results are in close conformity with the findings of Yogananda *et al.* (2015), Saraswathi (2020) and Kiran *et al.* (2016).

Effect of organics on economics

Foliar application of jeevamrutha @ 25% recorded significantly higher gross returns (₹ 88,910 ha^{-1}), net returns (₹ 62,895 ha^{-1}) and BC ratio (3.42) than other organic sources (Table 3). Among the different stage of application, foliar application both at pre flowering and at pod initiation recorded significantly highest gross returns (₹ 90,456 ha^{-1}), net returns (₹ 64,924 ha^{-1}) and BC ratio (3.55) as compared to alone application either at pre flowering or at pod initiation stage. Foliar application of jeevamrutha @ 25% both at pre flowering and at pod initiation documented significantly higher gross returns (₹ 1,00,467 ha^{-1}), net returns (₹ 73,619 ha^{-1}) and BC ratio (3.74) than other treatment combinations which was on par with foliar application of cow urine @ 10% both at pre flowering and at pod initiation stage.

Conclusion

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 and yield parameters, seed yield, maximum net returns and benefit cost ratio in chickpea.

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