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RESPONSE OF CHICKPEA (*CICER ARIETINUM* L.) TO FOLIAR APPLICATION OF ORGANIC CONCOCTIONS IN THE NORTHERN DRY ZONE OF KARNATAKA, INDIA

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ABSTRACT

A research was conducted to review the influence of foliar application in chickpea through organics under rainfed situation in medium black soils during *Rabi* season (October - February, 2020-21) at Regional Agricultural Research Station, Vijayapura situated in the Northern Dry zone of Karnataka. Fifteen treatments, consisting of five organic sources in main plots and three stage of application in sub plots were evaluated in split plot design with three replications. Treatment receiving jeevamrutha @ 25% at pre flowering and at pod initiation stage recorded higher growth attributes viz. plant height (28.3 cm), Number of branches plant^{-1} (5.20), Leaf area (2.09 dm^2 plant^{-1}), Leaf area index (0.47) and Absolute growth rate (0.37 g plant^{-1} day^{-1}). Total uptake of major nutrients (90.23, 15.07 and 56.63 NPK kg ha^{-1}, respectively) at harvest and available soil NPK (174.28, 34.25 and 345.08 kg ha^{-1}, N, P_2O_5, K_2O, respectively) were also higher in treatments receiving foliar application of jeevamrutha @ 25% at both pre flowering and at pod initiation stage when assessed with alone application of organic sources. The correlation between the growth attribute and nutrient uptake shows positive effect with respect to yield components. The foliar application of liquid concoctions either jeevamrutha @ 25% or vermiwash @ 10% both at pre flowering and at pod initiation stages helped to increase growth and yield parameters, crop nutrient uptake and soil nutrient balance.

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

Introduction

The chickpea, or *Cicer arietinum* L., is the most widely grown pulse crop in the world, second only to beans and peas. It is also known by other names, like Bengal gram or gram, and is called chana in many parts of the country. A quantitative long-day legume crop of the fabaceae family and faboideae subfamily, chickpeas are grown during the chilly season. With an area of 10.56 million hectares and a production of 11.17 million tonnes, India leads the globe in chickpea production, with a productivity of 1077 kg ha^{-1} (Kumar *et al.*, 2019). With 8.64 lakh hectares of land, 6.75 lakh tonnes of annual production, and an average productivity of 782 kg ha^{-1}, Karnataka is the fourth-most productive state in India for chickpea agriculture (Anonymous, 2022). Gulbarga holds the top spot in terms of chickpea cultivation in Northern Karnataka, followed by Vijayapura, Bidar, Gadag, Dharwad, Belagavi, Bagalkot, Raichur and Yadgir.

Foliar fertilization, also known as foliar feeding, encourages the source of nutrients, growth regulators, stimulants, as well as other useful substances in form of liquid to plants through aerial parts of the plants, such as leaves, stems and other parts of the plants, in order to achieve greater production, quality, resistance to pests, increased abiotic stress tolerance and also to help the plants retrieve from transplant stress, hail damage or the effects of other weather extremes (Shinde and Hunje 2020). As the crop matures, fertilizers added to the soil

at the time of planting are no longer entirely accessible to the plants. Nutrient fertilizers applied as foliar spray perform better in rainfed conditions where soil moisture is low. Supplemental foliar spray is one of the several application strategies on hand that makes them easily available. Nutrient application by foliar applications at the right phases of growth is critical for their use and assists the crop performs better (Anandhakrishnaveni *et al*., 2004).

Organic farming is founded on four fundamental principles: the principle of health, the principle of ecology, the principle of fairness and the principle of care. These principles are closely tied to the concept of soil health management (Bhagyasri *et al*., 2023). Soil organic carbon holds significant importance in both organic farming and overall soil health management. It plays a pivotal role in soil ecosystem services and the productive capacity of the soil. As a result, it is crucial to prioritize the preservation of soil health within organic production systems (Shahane and Shivay, 2022).

Among the numerous different fertilizer application methods available, foliar spray is the most important because it allows for easy and quick nutrient consumption by perforating the stomata or leaf cuticle to pass through the cell membrane (Naik *et al*., 2014 and Joshi *et al*., 2022). Foliar feeding is a method of applying nutrients fertilizers effectively to the crop canopy, whether it be in solution or suspension. Beejamrutha, jeevamrutha and panchagavya are organic manure solutions made from cow dung, cow urine, milk, curd, ghee, pulse flour and jaggery (Yadav *et al*., 2023). In addition, macronutrients, important micronutrients, several vitamins, basic amino acids, growth promoters such as indole acetic acid and gibberellic acid, and helpful bacteria may be found in vermiwash and cow urine (Maheshwari *et al*., 2016). There is an opportunity for increasing pulse yield and quality by raising soil fertility and productivity by increased ability of conservation of soil organic carbon and soil moisture as reported by Palekar (2006) and Shyamrao *et al*. (2016).

Materials and Methods

An investigation undertaken on farm 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}) and high in available K_2O content (342 kg ha^{-1}). The experimental site was located at a latitude of $16^0$77' North, longitude of $75^0$74' East and an altitude of 516.29 meters above the 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 against the average rainfall of 594.4 mm received in 38 rainy days. The highest rainfall of 267.3 mm was recorded in the month of September followed by July (187.6 mm). The total amount of rainfall documented during cropping period (October-2020 to February-2021) was 126.8 mm.

The experiment was conducted in split plot experimental design with three replications. There were fifteen treatment combinations, consisting five organic sources (M_1 – M_5) in main plots and three stage of application (S_1 – S_3) in sub plots (M_1S_1: Vermiwash @ 10% at Pre flowering, M_1S_2: Vermiwash @ 10% at Pod initiation, M_1S_3: Vermiwash @ 10% at Pre flowering and Pod initiation, M_2S_1: Cow urine @ 10% at Pre flowering, M_2S_2: Cow urine @ 10% at Pod initiation, M_2S_3: Cow urine @ 10% at Pre flowering and Pod initiation, M_3S_1: Jeevamrutha @ 25% at Pre flowering, M_3S_2: Jeevamrutha @ 25% at Pod initiation, M_3S_3: Jeevamrutha @ 25% at Pre flowering and Pod initiation, M_4S_1: Bio digesters filtrate @ 25% at Pre flowering, M_4S_2: Bio digesters filtrate @ 25% at Pod initiation, M_4S_3: Bio digesters filtrate @ 25% at Pre flowering and Pod initiation, M_5S_1: Urea @ 2% at Pre flowering, M_5S_2: Urea @ 2% at Pod initiation and M_5S_3: Urea @ 2% at Pre flowering and Pod initiation).

The field was cultivated immediately after the harvest of the preceding crop (Sorghum) and after that harrowing was done twice to bring the soil to fine tilth condition which was ready for sowing operations. 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 was grown with the residual moisture of monsoon rains without any protective irrigation. At physiological maturity of the crop, harvesting was done. The treatments consisting of net plot area was harvested up to ground level. The plants were tied together and kept under sun remove moisture after harvesting. The grain was threshed with wooden sticks after it had dried completely under sun. The separated seeds were sorted for impurities, cleaned and grain and haulm yield were expressed in kilogram per hectare. The harvest index of the crop was computed using Donald (1962) formula.

The yield parameters and other findings were

documented from the net plots, and grain yield was converted to kg ha^{-1}. The costs of individual treatment were determined using present market pricing from the current year. To determine profitability, the yield was also calculated for total and profit, as well as the BC ratio. The profit to invested ratio was examined by dividing the amount got during selling obtained yield by the total amount incurred in the cultivation of individual plots. Gomez and Gomez (1984) provided statistical analysis of the data acquired from the investigation at various development stages and then at harvest. P=0.05 was selected as the level of statistical significance for the 'F' and't' tests. If the F test is determined to be significant, critical difference (CD) values were generated at a 5% probability level. Correlation studies were performed using R software v4.3.2 using a "psych" package developed by Revelle (2017).

Results and Discussion

Influence of foliar application of organics at different stage on growth attributes of chickpea at peak flowering stage

Statistically higher growth attributes *viz*. plant height (28.3 cm), Number of branches plant^{-1} (5.20), Leaf area (2.09 dm^2 plant^{-1}), Leaf area index (0.47) and Absolute growth rate (0.37 g plant^{-1} day^{-1}) were observed at early stage of the crop which influenced by the spray of jeevamrutha both at pre flowering and pod initiation further by the foliar application to get higher plant growth parameters (Table 1). This increased plant growth might be due to the better availability of nutrients from basal fertilizers and foliar source of nutrients and effective conversion of nutrients from organics such as Fe, Mg and Zn available at the site of photosynthesis (Fig. 1). Kinetin and other enzymes in the liquid organic manures might have increased the chlorophyll content of the leaves. Thus it might have led to higher leaf area production and capture of more solar radiation resulting in higher photosynthesis and consequent improvement in all growth attributes and these results were also supported by the Kiran *et al*. (2016) and Jadhav and Kulkarni (2016).

A descriptive statistical associations pertaining to yield attributes *viz*. Grain yield (kg ha^{-1}), Haulm yield (kg ha^{-1}), Hundred grain weight (g), Total dry matter production (g plant^{-1}), No of root nodules plant^{-1} and crop nutrient uptake ability comprising Nitrogen uptake (kg ha^{-1}), Phosphorous uptake (kg ha^{-1}) and Potassium uptake (kg ha^{-1}) depicted high level of significance for all the estimates (Fig. 1). An in-depth analysis of these traits illustrates the fact that the parameters considered were much appropriate and substantially explains the major

Table 1 : Growth attributes of chickpea at peak flowering stage as influenced by foliar spray of different organic sources, stage of application and their interactions.

Treatments	Plant height (cm)	Number of branches plant^{-1}	Leaf area (dm^2 plant^{-1})	Leaf area index	Absolute growth rate (g plant^{-1} day^{-1})
$M_1 S_1$	27.1	4.13	2.02	0.447	0.337
$M_1 S_2$	27.9	4.40	2.01	0.442	0.360
$M_1 S_3$	28.1	4.93	2.03	0.456	0.358
$M_2 S_1$	27.1	4.20	2.00	0.440	0.327
$M_2 S_2$	27.5	4.67	2.03	0.450	0.344
$M_2 S_3$	28.1	5.20	2.07	0.461	0.378
$M_3 S_1$	27.9	4.67	2.05	0.455	0.350
$M_3 S_2$	28.0	5.07	2.03	0.456	0.359
$M_3 S_3$	28.3	5.20	2.09	0.473	0.370
$M_4 S_1$	26.3	4.20	1.99	0.442	0.331
$M_4 S_2$	27.7	4.33	1.99	0.442	0.340
$M_4 S_3$	27.6	4.93	2.07	0.461	0.366
$M_5 S_1$	27.6	4.53	1.99	0.443	0.317
$M_5 S_2$	27.6	4.60	2.05	0.455	0.341
$M_5 S_3$	27.6	4.67	2.07	0.460	0.363
S.Em ±	1.25	0.13	0.09	0.020	0.015
CD at 5 %	NS	0.40	NS	NS	NS

NS – Non significant

Note: M_1: Vermiwash @ 10%, M_2: Cow urine @ 10%, M_3: Jeevamrutha @ 25%, M_4: Bio digesters filtrate @ 25%, M_5: Urea @ 2%, S_1: Pre flowering, S_2: Pod initiation, S_3: Pre flowering and Pod initiation.

Table 2 : Balance sheet of N (kg ha^{-1}) as influenced by foliar spray of different organic sources under various stage of application in chickpea at harvest.

Treatments	Initial status (kg ha^{-1}) A	Addition of manures + Fertilizer (kg ha^{-1}) B	Total (kg ha^{-1}) A+B = C	Crop removal (kg ha^{-1}) D	Expected balance (kg ha^{-1}) C-D = E	Actual balance (kg ha^{-1}) F	Gain/ Loss over initial status (kg ha^{-1}) A-F = G	Net loss/ Gain (kg ha^{-1}) F-E = H
$M_1 S_1$	168	10.09	178.09	62.47	115.62	171.53	3.53	55.91
$M_1 S_2$	168	10.09	178.09	75.93	102.16	172.32	4.32	70.16
$M_1 S_3$	168	10.18	178.18	79.43	98.75	173.69	5.69	74.94
$M_2 S_1$	168	10.55	178.55	61.40	117.15	171.29	3.29	54.14
$M_2 S_2$	168	10.55	178.55	72.90	105.65	173.07	5.07	67.42
$M_2 S_3$	168	11.10	179.10	83.45	95.65	173.12	5.12	77.47
$M_3 S_1$	168	11.69	179.69	75.17	104.52	172.31	4.31	67.79
$M_3 S_2$	168	11.69	179.69	78.79	100.90	173.53	5.53	72.63
$M_3 S_3$	168	13.38	181.38	90.23	91.15	174.28	6.28	83.13
$M_4 S_1$	168	10.59	178.59	68.62	109.97	171.32	3.32	61.35
$M_4 S_2$	168	10.59	178.59	66.41	112.18	171.82	3.82	59.64
$M_4 S_3$	168	11.18	179.18	75.23	103.95	172.93	4.93	68.98
$M_5 S_1$	168	14.60	182.6	63.93	118.67	172.89	4.89	54.22
$M_5 S_2$	168	14.60	182.6	74.77	107.83	172.98	4.98	65.15
$M_5 S_3$	168	19.20	187.2	78.65	108.55	173.78	5.78	65.23

independent and dependent traits responsible in chickpea studies. Further studies about direct, indirect and residual effects offers a means to select potential traits and suggests the requirement of other distinct traits if there are any.

Influence of foliar application of organics at different stage on soil nutrient (NPK) balance

The greater nitrogen content in soil after the harvesting was documented compared to the initial nutrient level among all the treatment combinations (Table 2). The calculated nitrogen balance had shown negative values among all the treatments. The highest negative balance value was observed with foliar spray of jeevamrutha @ 25% both at pre-flowering and at pod initiation (83.13 kg ha^{-1}) stage. This inexplicable nitrogen may have come from nitrogen fixation through symbiotic association.

Positive phosphorous balance was documented with all individual treatments. The positive balance calculated was less with foliar spray of jeevamrutha @ 25% both at pre flowering and at pod initiation (-7.60 kg ha^{-1}) over other treatments in the experiment (Table 3). This positive balance value might be owing to the delayed mobilization of phosphorous in the soil, which means that any phosphorous applied will not be taken up by the plant and will instead be fixed in the soil. However, as compared to other treatment combinations, foliar spray of jeevamrutha @ 25% had the lowest positive phosphorus balance both at pre-flowering and pod commencement, indicating improved P mining.

The lesser potassium status of the soil after harvest was documented over initial status except for foliar spray of vermiwash @ 10%, cow urine @ 10% and bio digester filtrate @ 25% applied at pre flowering stage. The maximum negative K balance was recorded in jeevamrutha @ 25% applied at both pre flowering and pod initiation (Table 4). Lowest negative balance was recorded with application of cow urine @ 10% at pre flowering stage. Due to increasing K content in the whole plant, improved biological production and better potassium mining in the soil, there is an unaccountable potassium negative balance. Growing chickpeas was shown to have either sustained or improved the soil available nutrients like NPK in the soil. The results are inline with Patil *et al*. (2012).

Influence of foliar application of organics at different stage on major nutrient uptake after harvest of chickpea

The total major nutrients uptake of N (90.23 kg ha^{-1}), P (15.07 kg ha^{-1}) and K (56.63 kg ha^{-1}) at harvest was significantly higher in treatments receiving jeevamrutha @ 25% as foliar spray over other organics both at pre flowering and pod initiation stage. The significant variation in N uptake may be due to the significant variation of

Table 3 : Balance sheet of P_2O_5 (kg ha^{-1}) as influenced by foliar spray of different organic sources under various stage of application in chickpea at harvest.

Treatments	Initial status (kg ha^{-1}) A	Addition of manures + Fertilizer (kg ha^{-1}) B	Total (kg ha^{-1}) A+B = C	Crop removal (kg ha^{-1}) D	Expected balance (kg ha^{-1}) C-D = E	Actual balance (kg ha^{-1}) F	Gain/ Loss over initial status (kg ha^{-1}) A-F = G	Net loss/ Gain (kg ha^{-1}) F-E = H
$M_1 S_1$	31	25.16	56.16	9.75	46.41	31.66	0.66	-14.75
$M_1 S_2$	31	25.16	56.16	11.81	44.35	32.32	1.32	-12.03
$M_1 S_3$	31	25.32	56.32	15.02	41.3	33.69	2.69	-7.61
$M_2 S_1$	31	25.11	56.11	10.29	45.82	31.32	0.32	-14.5
$M_2 S_2$	31	25.11	56.11	11.90	44.21	33.14	2.14	-11.07
$M_2 S_3$	31	25.23	56.23	14.22	42.01	33.12	2.12	-8.89
$M_3 S_1$	31	25.46	56.46	12.05	44.41	32.65	1.65	-11.76
$M_3 S_2$	31	25.46	56.46	13.58	42.88	33.2	2.20	-9.68
$M_3 S_3$	31	25.92	56.92	15.07	41.85	34.25	3.25	-7.6
$M_4 S_1$	31	25.37	56.37	10.34	46.03	31.32	0.32	-14.71
$M_4 S_2$	31	25.37	56.37	12.23	44.14	31.82	0.82	-12.32
$M_4 S_3$	31	25.76	56.76	14.70	42.06	32.73	1.73	-9.33
$M_5 S_1$	31	25.00	56.00	11.48	44.52	31.98	0.98	-12.54
$M_5 S_2$	31	25.00	56.00	12.94	43.06	32.15	1.15	-10.91
$M_5 S_3$	31	25.00	56.00	13.27	42.73	32.3	1.30	-10.43

Table 4 : Balance sheet of K_2O (kg ha^{-1}) as influenced by foliar spray of different organic sources under various stage of application in chickpea at harvest.

Treatments	Initial status (kg ha^{-1}) A	Addition of manures + Fertilizer (kg ha^{-1}) B	Total (kg ha^{-1}) A+B = C	Crop removal (kg ha^{-1}) D	Expected balance (kg ha^{-1}) C-D = E	Actual balance (kg ha^{-1}) F	Gain/ Loss over initial status (kg ha^{-1}) A-F = G	Net loss/ Gain (kg ha^{-1}) F-E = H
$M_1 S_1$	342	0.19	342.19	40.63	301.56	341.93	-0.07	40.37
$M_1 S_2$	342	0.19	342.19	45.48	296.71	342.84	0.84	46.13
$M_1 S_3$	342	0.38	342.38	49.39	292.99	345.08	3.08	52.09
$M_2 S_1$	342	0.91	342.91	39.35	303.56	341.66	-0.34	38.10
$M_2 S_2$	342	0.91	342.91	47.54	295.37	343.94	1.94	48.57
$M_2 S_3$	342	1.81	343.81	49.17	294.64	345.68	3.68	51.04
$M_3 S_1$	342	0.47	342.47	47.21	295.26	343.87	1.87	48.61
$M_3 S_2$	342	0.47	342.47	42.96	299.51	344.51	2.51	45.00
$M_3 S_3$	342	0.93	342.93	56.63	286.3	345.08	3.08	58.78
$M_4 S_1$	342	0.32	342.32	39.60	302.72	341.85	-0.15	39.13
$M_4 S_2$	342	0.32	342.32	42.69	299.63	343.26	1.26	43.63
$M_4 S_3$	342	0.63	342.63	49.11	293.52	344.60	2.60	51.08
$M_5 S_1$	342	0	342.00	41.06	300.94	342.24	0.24	41.30
$M_5 S_2$	342	0	342.00	45.10	296.90	343.72	1.72	46.82
$M_5 S_3$	342	0	342.00	48.06	293.94	344.31	2.31	50.37

grain and straw yields as influenced by different treatments. Higher growth attributing qualities and maximum dry matter production in the above-mentioned treatment resulted in higher absorption of essential minerals, which affected the transformation of yield contributing parameters and which yields greater chickpea production. These outcomes are in conformity with the outcomes of Siddappa *et al.* (2016) in green gram and

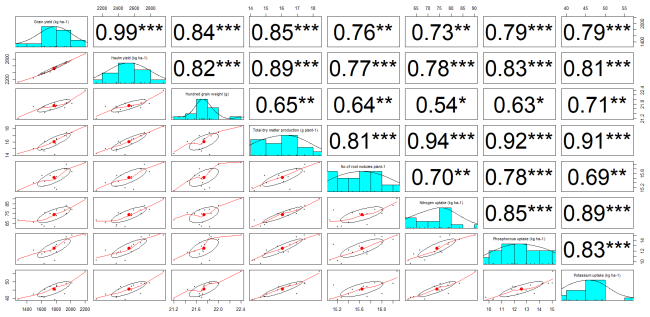

Fig. 1 : Character association for yield attributes and nutrient uptake ability in chickpea obtained across various treatments.

Kumar *et al*. (2015).

Influence of different organic sources and stage of application on available soil nutrient status

The results pertaining to available nitrogen, phosphorus and potassium were substantially superior with foliar application of jeevamrutha @ 25% both at pre flowering and pod initiation stage were superior (174.28, 34.25 and 345.08 kg ha^{-1}, N, P_2O_5, K_2O, respectively) over other treatment combinations. The higher amount of available soil nitrogen might be due to direct enhancement of available pool of nitrogen through fertilizers. Chickpea being a leguminous crop fixes the atmospheric nitrogen by biological nitrogen fixation with the help of nitrogenase enzyme. The higher phosphorous in soil with these organic treatments may be attributed to higher buildup of phosphorous on account of faster release of nutrients through rapid mineralization by higher microbial activity. Equivalent influential effects on the soil available K_2O content through manures through various organic sources were reported by Babalad *et al*. (2012) and Kiran *et al*. (2016).

Conclusion

The greater increase of soil NPK nutrients compared to initial and higher plant nutrient uptake was recorded with the treatment jeevamrutha @ 25% both at pre flowering and at pod initiation stage as compared to other treatments. Further, chickpea cultivation either sustains or enhances the accessible nutrients status in the soil. The application of either jeevamrutha or vermiwash as foliar nutrition along with the recommended fertilizer helps in increase in yield and economics of the crop.

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