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# Effect of foliar application of premix liquid fertilizers on growth, yield and economics in chickpea

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**Abstract**
A field experiment was carried out at Research Farm, Department of Agronomy, G.H. Raisoni University, Chhindwara, Madhya Pradesh during *Rabi* season 2019, Effect of foliar application of premix liquid fertilizers on growth, yield and economics of chickpea. Five liquid fertilizers comprised of treatments only RDF of application RDF + Liquid fertilizers (premix) @ 500 ml $ha^{-1,}$ RDF + Liquid fertilizers (premix) @ 1.0 litre $ha^{-1,}$ RDF + Liquid fertilizers (premix) @ 1.5 litre $ha^{-1}$, RDF + Sea weed extract @ 500 ml $ha^{-1}$,Control (Only RDF). The experiment was laid out in randomized block design with thrice replication. The experimental results revealed that the growth attributing characters of chickpea crop *viz*., plant height and dry matter accumulation $plant^{-1}$, yield attributes (Pods $plant^{-1}$, dry weight of pods $plant^{-1}$, seed $pod^{-1}$ and seed index ), Maximum grain yield (1893 q $ha^{-1}$), straw yield (2784 q $ha^{-1}$), gross monetary returns (87847 Rs. $ha^{-1}$), net monetary returns (59542 Rs. $ha^{-1}$) and benefit cost ratio (3.10) were recorded under application of RDF + Liquid fertilizers (premix) at 1 litre $ha^{-1}$ as compared to rest of the treatments.

**Keywords:** Chickpea, growth, yield, economics and liquid fertilizers

## Introduction
Chickpea (*Cicer arietinum* L.) is considered as one of the most important seed legume worldwide. It is an important source of cheap protein with high energy and nutritive value; chickpea seeds consumed dry by parched or cooked in human diets, in sweet manufactures and recently in baby food blends (El-Karamany and Bahr, 1999) [4]. Chickpea is one of the major pulse crop in India and in many other countries and plays an important role in the diets of vegetarians around the world. Pulses are the primary source of nourishment and when combined with cereals, provide a nutritionally balanced food for human being. Frequent consumption of pulses is now recommended by most of the health organizations (Leterme, 2002) [8]. In addition, it is a good source of energy, protein, minerals, vitamins, fiber and also contains potentially health-beneficial phyto chemicals. It is a main source of vegetable protein in human diet as it contains 21% protein and 38-59% carbohydrates (Gupta, 1989) [5]. Besides, Chickpea is also credited with the ability of atmospheric nitrogen fixation through symbiotic process and it has been estimated that chickpea has the capacity to fix 140 kg N $ha^{-1}$in a growing season (Rupela and Saxena, 1987) [16]. The fixed N not only can meet the requirements of the legume for maximum grain formation, but can also be available for use by sub sequent crops, after mineralization of chickpea crop residues.

In India, Chickpea is grown on an area of 9.93million ha with annual production of 9.53 million tons with productivity of 960kg/ha in Rabi season. Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh and Rajasthan are the major chickpea growing states. In Madhya Pradesh stood first among all states in both area and production of chickpea as it is cultivated in 3.02 million hectares with a production 3.27 million tonnes but productivity 1082 kg $ha^{-1}$ is far below its yield potential (Anon, 2016).

Agronomic practices of chickpea are required to be standardized for realizing yield potential. 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. This method provides for utilization of nutrients more efficiently and for correcting deficiencies rapidly. Recently, new generation special fertilizers have been introduced exclusively for foliar feeding and fertilization. Speciality fertilizers are a better source for foliar application (Vibhute, 1998) [20]. These fertilizers havedifferent ratios of N, P and K which are highly water soluble and so amenable for foliar nutrition (Jayabal *et al.*, 1999) [7]. In almost all the pulses, the extent of flower drop determine the yield and yield attributing characters. The foliar application of urea at 50% flowering increased the yield and seed protein. In legumes, leaf senescence starts earlier before completion of maturity which break the source to sink relation, thereby reduces the yield. Nitrogen spray has been found to delay leaf senescence and improve yield. (Palta *et al.*, 2005 and Zeidan, 2003) [14, 21] The role of micronutrients is crucial in crop nutrition and thus important for achieving higher yields. Six micronutrients *i.e.*, Mn, Fe, Cu, Zn, B and Mo are known to be required for all higher plants. These have been well documented to be involved in photosynthesis, N-fixation, respiration and other biochemical pathways

Keeping these problems in view, a field experiment was conducted to study the Effect of foliar application of premix liquid fertilizers on growth, yield and economics of chickpea

## Materials and methods

The field experiment was conducted at Research Farm, Department of Agronomy, G.H. Raisoni University, Chhindwara, Madhya Pradesh during *Rabi* season 2019. The soil of the experimental field was red in texture, low in available nitrogen (193.00kg $ha^{-1}$) medium in available phosphorus (19.89kg $ha^{-1}$) potassium (475.78kg $ha^{-1}$) and was alkaline in reaction (pH 7.54). Chickpea variety Vijay was sown @75 kg seed $ha^{-1}$ at spacing of 30 cm between the lines, on 28rd November, 2019 and harvested on 14nd March, 2020. A full dose of phosphorus and potassium was applied as a basal application. The optimum plant population was maintained by gap filling, the crop was irrigated as per the requirements. According to the treatment of liquid fertilizers were sprayed at 30,60,90 DAS through knapsack sprayer with flat fan nozzle using 500 litres of water $ha^{-1}$. The experiment was laid out in randomized block design with five treatments and three replications. The gross and net plot size were 5 x 4 $m^2$and 4.8 x 3.8 $m^2$, respectively. The five treatment consisted of Control (Only RDF)., RDF + Liquid fertilizers (premix) @ 500 ml $ha^{-1,}$ RDF + Liquid fertilizers (premix) @ 1.0 litre $ha^{-1,}$ RDF + Liquid fertilizers (premix) @ 1.5 litre $ha^{-1}$, RDF + Sea weed extract @ 500 ml ha-$^{1}$,Control (Only RDF).

### Treatment details

| | | | |
|---|---|---|---|
| 1 | $T_1$ | : | RDF + Liquid fertilizers (premix) @ 500 ml $ha^{-1}$ |
| 2 | $T_2$ | : | RDF + Liquid fertilizers (premix) @ 1.0 litre $ha^{-1}$ |
| 3 | $T_3$ | : | RDF + Liquid fertilizers (premix) @ 1.5 litre $ha^{-1}$ |
| 4 | $T_4$ | : | RDF + Sea weed extract @ 500 ml ha-$^{1}$ |
| 5 | $T_5$ | : | Control (Only RDF) |

The liquid fertilizers (premix) contain different macro and micro nutrients and its composition is given below.

### Composition of Liquid fertilizers (premix

| | | | |
|---|---|---|---|
| 1 | Heterocyclic nitrogen | : | 20% |
| 2 | $P_2O_5$ | : | 6% |
| 3 | Iron | : | 5% |
| 4 | Sulphur | : | 10% |
| 5 | Inert ingredients | : | QS |

## Result and Discussion

### Plant height (cm)

Height of plant increased as the crop advanced in age attaining the mean height of 44.65 cm at harvest presented Table 1.

**Table 1:** Plant height as influenced by various treatments in chickpea

| Treatment | Plant height (cm) | | | |
|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | At harvest |
| $T_1$ - RDF + Liquid fertilizers (premix) @ 500 ml $ha^{-1}$ | 22.06 | 39.50 | 45.23 | 45.24 |
| $T_2$ - RDF + Liquid fertilizers (premix) @ 1.0 litre $ha^{-1}$ | 21.78 | 42.38 | 46.70 | 46.70 |
| $T_3$ - RDF + Liquid fertilizers (premix) @ 1.5 litre $ha^{-1}$ | 22.11 | 43.75 | 47.25 | 47.26 |
| $T_4$ - RDF + Sea weed extract @ 500 ml $ha^{-1}$ | 21.40 | 40.08 | 43.64 | 43.64 |
| $T_5$ - Control (Only RDF) | 21.77 | 37.50 | 40.41 | 40.41 |
| SE(m) | 0.72 | 0.88 | 0.87 | 0.87 |
| CD at 5% | NS | 2.71 | 2.69 | 2.69 |
| GM | 21.82 | 40.64 | 44.65 | 44.65 |

Plant height differed significantly due to different doses of liquid fertilizers. Significantly highest (43.75 cm) plant height was recorded at 60 DAS with RDF + Liquid fertilizers (premix) at 1.5 litre $ha^{-1}$ (T3) followed by RDF + Liquid fertilizers (premix) at 1 litre $ha^{-1}$ (T2), which were found to be statistically similar with each other. Significantly lowest (37.50 cm) plant height was recorded with control (T5). Increase in plant height might be due to the presence of macro and micro nutrients which help in enhancing photosynthesis, cell division and cell elongation which allow the plant grow faster. Similar results were obtained by Singhal *et al.*, (2015) [19] and Mudalagiriyappa *et al.*, (2016).

### Number of branches plant$^{-1}$

Significantly higher number of branches plant$^{-1}$ of 15.30 was recorded with RDF + Liquid fertilizers (premix) at 1.5 litre $ha^{-1}$ (T3) followed by RDF + Liquid fertilizers (premix) at 1 litre $ha^{-1}$ (T2) and RDF + Liquid fertilizers (premix) @ 500 ml $ha^{-1}$ (T1) respectively, which were found to be statistically similar with each other. The next better treatment was RDF + Seaweed extract @ 500 ml $ha^{-1}$ (T4). Lower number of branches plant$^{-1}$ was recorded with control (T5) at 60 DAS and similar result also recorded at 90 DAS. There was no further increased in number of branches plan$^{-1}$ at harvest from 90 DAS. This was due to the stop in growth. Increase in number of branches plant$^{-1}$ might be due to increase in rate of metabolic processes by plant due to presence of nutrients in liquid fertilizers. Similar results were obtained (Macwan, 2016) and Mudalagiriyappa *et al.*, (2016) [9]

**Table 2:** Number of branches per plant as influenced by various treatments in chickpea

| Treatment | Number of branches plant$^{-1}$ | | | |
|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | At harvest |
| $T_1$ - RDF + Liquid fertilizers (premix) @ 500 ml ha$^{-1}$ | 7.40 | 13.95 | 17.59 | 17.59 |
| $T_2$ - RDF + Liquid fertilizers (premix) @ 1.0 litre ha$^{-1}$ | 7.08 | 14.60 | 19.31 | 19.31 |
| $T_3$ - RDF + Liquid fertilizers (premix) @ 1.5 litre ha$^{-1}$ | 6.90 | 15.30 | 19.75 | 19.75 |
| $T_4$ - RDF + Sea weed extract @ 500 ml ha$^{-1}$ | 6.43 | 11.81 | 16.15 | 16.15 |
| $T_5$ - Control (Only RDF) | 7.33 | 9.63 | 13.01 | 13.01 |
| SE(m) | 0.22 | 0.54 | 0.66 | 0.66 |
| CD at 5% | NS | 1.66 | 2.04 | 2.04 |
| GM | 7.03 | 13.06 | 17.16 | 17.16 |

**Total dry matter plant$^{-1}$(g):** The data on total dry matter accumulation of plants as influenced by different treatments recorded periodically are presented in Table 13 and illustrated in Fig. 8.

**Table 3:** Total dry matter per plant as influenced by various treatments in chickpea

| Treatment | Total dry matter plant$^{-1}$ | | | |
|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | At harvest |
| $T_1$ - RDF + Liquid fertilizers (premix) @ 500 ml ha$^{-1}$ | 1.68 | 9.58 | 22.31 | 22.13 |
| $T_2$ - RDF + Liquid fertilizers (premix) @ 1.0 litre ha$^{-1}$ | 1.57 | 11.25 | 24.68 | 24.67 |
| $T_3$ - RDF + Liquid fertilizers (premix) @ 1.5 litre ha$^{-1}$ | 1.46 | 11.63 | 25.25 | 25.08 |
| $T_4$ - RDF + Sea weed extract @ 500 ml ha$^{-1}$ | 1.75 | 9.38 | 21.97 | 21.36 |
| $T_5$ - Control (Only RDF) | 1.52 | 7.81 | 17.75 | 17.67 |
| SE(m) | 0.15 | 0.58 | 0.90 | 0.87 |
| CD at 5% | NS | 1.79 | 2.77 | 2.68 |
| GM | 1.65 | 9.93 | 22.39 | 22.18 |

It could be seen from the data presented in the table that mean dry matter accumulation per plant of chickpea increased from 30 DAS to the harvest. The treatment variation due to different treatments was observed to be significant at all stages of crop growth except 30 DAS.

Treatments RDF + Liquid fertilizers (premix) at 1.5 litre ha$^{-1}$($T_3$) and RDF + Liquid fertilizers (premix) at 1 litre ha$^{-1}$($T_2$) were significantly superior over all other treatments at 60 DAS indicating the high total dry matter values of 11.63 g and 11.25 g respectively. However, RDF + Liquid fertilizers (premix) @ 500 ml ha$^{-1}$($T_1$) recorded next high value of dry matter accumulation. Minimum dry matter accumulation per plant was recorded with control (T5) which was at par with RDF + Seaweed extract @ 500 ml ha$^{-1}$ ($T_4$). Similar trend of total dry matter accumulation per plant was found at harvest as that of at 90 DAS. Total dry matter was significantly influenced mainly due to additional foliar application of liquid fertilizers which led to increased uptake of nutrients which in turn helped in increased plant height, number of branches, leaf area. These results are in confirmation with the findings of Mudalagiriyappa *et al.*(2016) [9], and Maheswari and Karthik (2017) [10] who reported that high total dry matter production had resulted in efficient translocation of assimilates.

## Growth analysis

### Absolute growth rate for height (AGR)

Data on absolute growth rate for height (cm day$^{-1}$) as influenced by various treatments are presented on Table 4. The mean absolute growth rate for height marginally increased to 0.63 cm day$^{-1}$ during 30-60 DAS and marginally decreased to 0.13 cm day$^{-1}$ between 60 DAS and 90 DAS.

**Table 4:** Absolute growth rate for height (cm day$^{-1}$) as influenced by various treatments in chickpea

| Treatment | AGR (cm day$^{-1}$) | |
|---|---|---|
| | 30-60 DAS | 60-90 DAS |
| $T_1$ - RDF + Liquid fertilizers (premix) @ 500 ml ha$^{-1}$ | 0.58 | 0.19 |
| $T_2$ - RDF + Liquid fertilizers (premix) @ 1.0 litre ha$^{-1}$ | 0.69 | 0.14 |
| $T_3$ - RDF + Liquid fertilizers (premix) @ 1.5 litre ha$^{-1}$ | 0.72 | 012 |
| $T_4$ - RDF + Sea weed extract @ 500 ml ha$^{-1}$ | 0.62 | 0.12 |
| $T_5$ - Control (Only RDF) | 0.52 | 0.10 |
| GM | 0.63 | 0.13 |

During 30-60 DAS, the AGR for height was maximum with RDF + Liquid fertilizers (premix) at 1.5 litre ha$^{-1}$($T_3$) i.e. 0.72 cm day$^{-1}$ followed by RDF + Liquid fertilizers (premix) at 1 litre ha$^{-1}$ ($T_2$). The lowest AGR for height was recorded in control ($T_5$) *i.e.* 0.52 cm day$^{-1}$. Between 60-90 DAS, RDF + Liquid fertilizers (premix) @ 500 ml ha$^{-1}$ ($T_1$) showed maximum AGR for height *i.e.* 0.19 cm day$^{-1}$ followed by RDF + Liquid fertilizers (premix) at 1 litre ha$^{-1}$ ($T_2$). Minimum AGR was recorded in control ($T_5$).

### Absolute growth rate for dry matter (AGR)

Data on absolute growth rate for dry matter (g day$^{-1}$) as influenced by various treatments are presented on Table 5. The peak value of mean absolute growth rate for dry matter of 0.39 g day$^{-1}$ was recorded between 60 DAS and 90 DAS and decreased thereafter.

**Table 5:** Absolute growth rate for dry matter (g day$^{-1}$) as influenced by various treatments in chickpea

| Treatment | AGR (g day$^{-1}$) | |
|---|---|---|
| | 30-60 DAS | 60-90 DAS |
| $T_1$ - RDF + Liquid fertilizers (premix) @ 500 ml ha$^{-1}$ | 0.26 | 0.36 |
| $T_2$ - RDF + Liquid fertilizers (premix) @ 1.0 litre ha$^{-1}$ | 0.32 | 0.47 |
| $T_3$ - RDF + Liquid fertilizers (premix) @ 1.5 litre ha$^{-1}$ | 0.34 | 0.44 |
| $T_4$ - RDF + Sea weed extract @ 500 ml ha$^{-1}$ | 0.25 | 0.37 |
| $T_5$ - Control (Only RDF) | 0.21 | 0.33 |
| GM | 0.28 | 0.39 |

Overall, control (T5) recorded lowest AGR for dry matter during every interval. However, maximum AGR for dry matter of 0.34 g day$^{-1}$ was recorded with RDF + Liquid fertilizers (premix) at 1.5 litre ha$^{-1}$ (T3) followed by RDF + Liquid fertilizers (premix) at 1 litre ha$^{-1}$ ($T_2$) during 30-60 DAS. During 60-90 DAS, the highest AGR for dry matter was observed in treatment RDF + Liquid fertilizers (premix) at 1 litre ha$^{-1}$ ($T_2$) followed by RDF + Liquid fertilizers (premix) at 1.5 litre ha-1($T_3$). However, lowest AGR for dry matter was observed in control ($T_5$).

**Relative growth rate (RGR)**

Data on relative growth rate (g g$^{-1}$ day$^{-1}$)as influenced by various treatments are presented in Table 6.

**Table 6:** Relative growth rate (g g$^{-1}$day$^{-1}$) as influenced by various treatments in chickpea

| Treatment | AGR (g g$^{-1}$ day$^{-1}$) | |
|---|---|---|
| | 30-60 DAS | 60-90 DAS |
| $T_1$ - RDF + Liquid fertilizers (premix) @ 500 ml ha$^{-1}$ | 0.058 | 0.025 |
| $T_2$ - RDF + Liquid fertilizers (premix) @ 1.0 litre ha$^{-1}$ | 0.065 | 0.028 |
| $T_3$ - RDF + Liquid fertilizers (premix) @ 1.5 litre ha$^{-1}$ | 0.069 | 0.026 |
| $T_4$ - RDF + Sea weed extract @ 500 ml ha$^{-1}$ | 0.055 | 0.026 |
| $T_5$ - Control (Only RDF) | 0.055 | 0.027 |
| GM | 0.060 | 0.026 |

Relative growth rate as an index of rate of increase in biomass unit of existing biomass (g g$^{-1}$ day$^{-1}$) was computed during various growth stages of chickpea. It was highest during 30-60 DAS interval and declined gradually at 90 DAS to harvest stage. During 30-60 DAS, the treatment RDF + Liquid fertilizers (premix) at 1.5 litre ha$^{-1}$ ($T_3$) showed maximum relative growth rate i.e. 0.069 g g$^{-1}$ day$^{-1}$ followed by RDF+ Liquid fertilizers (premix) at 1 litre ha$^{-1}$ ($T_2$). The lowest RGR was observed with RDF + Seaweed extract @ 500 ml ha$^{-1}$ ($T_4$) and control ($T_5$).During 60-90 DAS, the highest RGR was recorded with RDF + Liquid fertilizers (premix) at 1 litre ha$^{-1}$ ($T_2$). The similar values of RGR were recorded with RDF + Liquid fertilizers (premix) at 1.5 litre ha$^{-1}$ ($T_3$) and RDF + Seaweed extract @ 500 ml ha$^{-1}$ ($T_4$)

**Yield attributes**

Data on yield attributes *viz.*, mean number of pods per plant, mean pod weight per plant, grain weight per plant and 100 seed weight as influenced by various treatments are shown in the Table 7. Mean values of number of pods per plant, pod weight per plant, grain weight per plant and 100 seed weight were observed that yield attributes significantly influenced due to various treatments.

**Table 7:** Yield attributes as influenced by various treatments in chickpea

| Treatment | Number of pods plant$^{-1}$ | Pod wt. plant$^{-1}$ (g) | Seed wt. plant$^{-1}$(g) | 100 seed wt. (g) |
|---|---|---|---|---|
| $T_1$ - RDF + Liquid fertilizers (premix) @ 500 ml ha$^{-1}$ | 45.25 | 10.86 | 8.67 | 24.13 |
| $T_2$ - RDF + Liquid fertilizers (premix) @ 1.0 litre ha$^{-1}$ | 49.13 | 12.82 | 10.94 | 24.49 |
| $T_3$ - RDF + Liquid fertilizers (premix) @ 1.5 litre ha$^{-1}$ | 48.45 | 12.31 | 9.79 | 24.49 |
| $T_4$ - RDF + Sea weed extract @ 500 ml ha$^{-1}$ | 43.38 | 10.72 | 7.90 | 23.78 |
| $T_5$ - Control (Only RDF) | 39.50 | 8.78 | 5.98 | 23.53 |
| SE(m) | 1.23 | 0.60 | 0.61 | 0.38 |
| CD at 5 % | 3.80 | 1.85 | 1.86 | NS |
| GM | 45.14 | 11.10 | 8.66 | 24.06 |

The treatment, RDF + Liquid fertilizers (premix) at 1 litre ha$^{-1}$ ($T_2$) recorded higher (49.13) number of pods per plant followed by RDF + Liquid fertilizers (premix) at 1.5 litre ha$^{-1}$ ($T_3$), which were found to be statistically similar with each other. Rahman (2017) [15].

It was observed that pod weight per plant was significantly influenced due to various treatments. The mean weight of pod per plant was 11.10 g.The highest pod weight per plant of 12.82 g was recorded with RDF + Liquid fertilizers (premix) at 1 litre ha$^{-1}$($T_2$) followed by RDF + Liquid fertilizers (premix) at 1.5 litre ha$^{1}$ ($T_3$), which were found to be statistically similar with each other. Shruthi (2013) [18].

The mean grain weight per plant was 8.66 g.Significantly higher seed weight per plant of 10.94 g was recorded with RDF + Liquid fertilizers (premix) at 1 litre ha$^{-1}$ ($T_2$) followed by RDF + Liquid fertilizers (premix) at 1.5 litre ha$^{-1}$ ($T_3$), which were found to be statistically similar with each other. Mandic *et al.*(2015) and Rahman (2017) [15].

The mean 100 seed weight was 24.06 g. Foliar application of liquid fertilizers recorded statistically non significant effects in 100 seed weight of chickpea. It might be due to 100 seed weight character of any crop is a genetically controlled and as a result it was not influenced with spray of liquid fertilizers.All the yield attributes were found best results in ($T_2$) may because of better translocation of photo assimilates

toward reproductive parts instead of vegetative parts. However, in ($T_3$) comparable low yield attributes were foundthan ($T_2$) only due diversion of more energy towards vegetative parts.

**Yield studies**

The data on grain yield (kg $ha^{-1}$), straw yield (kg $ha^{-1}$), biological yield (kg $ha^{-1}$) and harvest index (%) as influenced by various treatments are presented in Table 8.

**Table 8:** Seed yield, straw yield, biological yield and harvest index as influenced by various treatments in chickpea

| Treatment | Seed yield (kg $ha^{-1}$) | Straw yield (kg $ha^{-1}$) | Bio yield (kg $ha^{-1}$) | Harvest index (%) | % increase over control |
|---|---|---|---|---|---|
| $T_1$ - RDF + Liquid fertilizers (premix) @ 500 ml $ha^{-1}$ | 1721 | 2617 | 4338 | 39.68 | 11.96 |
| $T_2$ - RDF + Liquid fertilizers (premix) @ 1.0 litre $ha^{-1}$ | 1893 | 2784 | 4677 | 40.45 | 23.15 |
| $T_3$ - RDF + Liquid fertilizers (premix) @ 1.5 litre $ha^{-1}$ | 1843 | 2861 | 4704 | 39.19 | 19.93 |
| $T_4$ - RDF + Sea weed extract @ 500 ml $ha^{-1}$ | 1695 | 2613 | 4308 | 39.39 | 10.28 |
| $T_5$ - Control (Only RDF) | 1537 | 2519 | 4055 | 37.91 | - |
| SE(m) | 50.65 | 65.98 | 78.11 | 0.95 | - |
| CD at 5 % | 156.06 | 203.32 | 240.67 | NS | - |
| GM | 1755 | 2672 | 4427 | 39.64 | - |

Significantly highest seed yield of 1893 kg $ha^{-1}$ was recorded with RDF + Liquid fertilizers (premix) at 1 litre $ha^{-1}$ ($T_2$) followed by RDF + Liquid fertilizers (premix) at 1.5 litre $ha^{-1}$($T_3$), which were found to be statistically similar with each other. Significantly inferior seed yield was recorded in control ($T_5$). The treatment, RDF + Liquid fertilizers (premix) at 1 litre $ha^{-1}$ ($T_2$) gave significantly higher yield per hectare over control to extent of 23.15 per cent and was at par with RDF + Liquid fertilizers (premix) at 1.5 litre $ha^{-1}$ ($T_3$) where yield was higher with 19.93 per cent than control ($T_5$). These results in accordance with the results reported Singhal *et al.,* (2015) [19] and Rahman (2017) [15].

Significantly highest straw yield of 2861 kg $ha^{-1}$ was reported with RDF + Liquid fertilizers (premix) at 1.5 litre $ha^{-1}$ ($T_3$) followed by RDF + Liquid fertilizers (premix) at 1 litre $ha^{-1}$ ($T_2$) which were at par with each other. Significantly inferior straw yield of 2519 kg $ha^{-1}$ was recorded with control ($T_5$). The increase in straw yield with foliar application of liquid fertilizers might be due to higher rate of metabolic activities due to presence of macro and micro nutrients in the liquid fertilizers which resulted in more number of branches and dry matter accumulation. These results in accordance with the results reported by Deepak Kumar (2015) [3] and Akhila *et al*., (2017) [2].

**Biological yield (kg $ha^{-1}$)**

The data as regards biological yield as influenced by different treatments are presented in Table 8. The mean biological yield was 4427 kg $ha^{-1}$.Significantly higher biological yield of 4704 kg $ha^{-1}$ was recorded with RDF + Liquid fertilizers (premix) at 1.5 litre $ha^{-1}$ ($T_3$) followed by RDF + Liquid fertilizers (premix) at 1 litre $ha^{-1}$($T_2$) which were at par with each other. The lowest biological yield of 4055 kg $ha^{-1}$ was observed in control ($T_5$). These results are in confirmation with the findings of Sarbandi and Madani (2014) [17].

**Harvest index (%)**

The data in Table 8 showed that harvest index was not significantly influenced by various treatments. The mean harvest index was 39.64 %. Whereas highest harvest index was recorded with spray of liquid fertilizers (premix) at 1 litre $ha^{-1}$($T_2$)

**Economic studies**

Data in respect to gross monetary returns, net monetary returns and B:C ratio after harvest of the crop as influenced by various treatments are presented in Table 9.

**Table 9:** Economics as influenced by various treatments in chickpea

| Treatment | Cost of cultivation (Rs. $ha^{-1}$) | GMR (Rs. $ha^{-1}$) | NMR (Rs. $ha^{-1}$) | B:C |
|---|---|---|---|---|
| $T_1$ - RDF + Liquid fertilizers (premix) @ 500 ml $ha^{-1}$ | 27405 | 80122 | 52717 | 2.92 |
| $T_2$ - RDF + Liquid fertilizers (premix) @ 1.0 litre $ha^{-1}$ | 28305 | 87847 | 59542 | 3.10 |
| $T_3$ - RDF + Liquid fertilizers (premix) @ 1.5 litre $ha^{-1}$ | 29605 | 86000 | 56395 | 2.90 |
| $T_4$ - RDF + Sea weed extract @ 500 ml $ha^{-1}$ | 28024 | 79028 | 51004 | 2.82 |
| $T_5$ - Control (Only RDF) | 26365 | 72028 | 45725 | 2.73 |
| SE(m) | - | 2112.11 | 2112.11 | - |
| CD at 5 % | - | 6508.04 | 6508.04 | - |
| GM | 27940 | 81017 | 53077 | 2.90 |

**Gross monetary returns (Rs. $ha^{-1}$)**

Data in Table 9 revealed that gross monetary returns Rs. $ha^{-1}$ were significantly influenced due to various treatments and average gross monetary returns was 81017 Rs. $ha^{-1}$. The maximum gross monetary returns of 87847 Rs. $ha^{-1}$ was recorded with RDF + Liquid fertilizers (premix) at 1 litre $ha^{-1}$ (T2) followed by RDF + Liquid fertilizers (premix) at 1.5 litre $ha^{-1}$ (T3) which were at par with each other. The lowest gross monetary returns of 72089 kg $ha^{-1}$ was observed in control (T5). Similar results were obtained by Gowda *et al.,* (2015) [6] and Navaz *et al.* (2017) [13].

**Net monetary returns (Rs. $ha^{-1}$)**

Data given in Table 9 stated that the average NMR received from one hectare chickpea crop was Rs. 53077. Significantly maximum net monetary returns of 59542 Rs. $ha^{-1}$ was recorded with RDF+ Liquid fertilizers (premix) at 1 litre $ha^{-1}$ ($T_2$) followed by RDF + Liquid fertilizers (premix) at 1.5 litre $ha^{-1}$ ($T_3$) which were at par with each other. The lowest net monetary returns was recorded in control ($T_5$). Similar results were obtained by Akhila *et al.* (2017) [2] and Navaz *et al.* (2017) [13].

**Benefit: cost ratio**

Data as regards benefit: cost ratio revealed that the average benefits: cost obtained from cultivation of one hectare of chickpea crop was 2.90. The data presented in Table 9 showed that, benefit: cost ratio was maximum with RDF + Liquid fertilizers (premix) at 1 litre $ha^{-1}$ ($T_2$) *i.e.* 3.10 followed by RDF + Liquid fertilizers (premix) @ 500 ml $ha^{-1}$ ($T_1$). The lowest benefit to cost ratio was recorded with control ($T_5$). The difference in B:C ratio is due to the cost of liquid fertilizers and productivity of the crop.

**Conclusion**

On the basis of the results obtained in this study, it is concluded that the application of RDF + Liquid fertilizers (premix) @ 1.0 litre $ha^{-1}$ treatment gave maximum plant height, highest number of branches per plant, dry weight per plant, maximum dry weight of pod, maximum number of grain per pod, maximum number of pod per plant, maximum seed yield and maximum harvest index, net monetary returns and B:C ratio.

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