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RESEARCH PAPER

Response of pigeonpea [*Cajanus cajan* (L.) Millsp.] to foliar nutrition under rainfed condition

SOORJAN YALAGAR, S. B. KALAGHATAGI AND S. B. PATIL

Department of Agronomy, College of Agriculture, Vijayapura
University of Agricultural Sciences, Dharwad -580 005, Karnataka, India
E-mail: kalaghatagisb@uasd.in

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Abstract: A field experiment was conducted to investigate the "response of foliar nutrition on yield attributes, yield and economics of pigeonpea under rainfed ecosystem" at Agricultural College Farm, Vijayapura during *Kharif,* 2019. The experiment was laid out in Randomized Complete Block Design with seventeen treatments replicated thrice. The result revealed that the treatment combination of RPP (25:50:00 kg N, P_2O_5 and K_2O per ha) + foliar spray of 19:19:19 @ 1% + Vermiwash @ 10% at flower initiation stage and peak flowering stage (T_{11}) recorded significantly higher number of pods plant^{-1} (198.43), grain weight plant^{-1} (88.84 g), grain yield (1592 kg ha^{-1}), stalk yield (2135 kg ha^{-1}), higher net return (₹ 65908 ha^{-1}) and BC ratio (3.49). Absolute control (T_1) with no ferilizers and foiar sprays recorded lower pods plant^{-1} (141.22), grain weight plant^{-1} (31.66 g), grain yield (615 kg ha^{-1}), stalk yield (1200 kg ha^{-1}), net return (₹ 22774 ha^{-1}) and BC ratio (2.76). The study can be concluded that application of recommended nutrients (25:50:00 kg N, P_2O_5 and K_2O per ha) to pigeonpea coupled with foliar spray of 19:19:19 @ 1% + Vermiwash @ 10% at flower initiation and peak flowering stage is optimum for higher grain yield, higher net returns and BC ratio.

Keywords: Economics, Foliar nutrition, Pigeonpea, Vermiwash

Introduction

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is one of the protein-rich legumes of the semi-arid tropics grown predominantly under rainfed conditions. It is the second most important pulse crop after chickpea. It is grown throughout the world's tropical and sub-tropical regions between 30°N and 35° S latitudes. However, the major area under pigeonpea in India is lying between 14° and 28° N latitudes. Pigeonpea belongs to the Leguminaceae family and native to Africa. It is deep-rooted, C_3, short-day plant and drought tolerant. It requires temperatures between 18-30 °C and sandy loam to clay loam soils are well suited.

In recent years, the area under pigeonpea is increasing in northern Karnataka. However, the average productivity is low in this region (368 kg ha^{-1}) against the national average yield of 646 kg ha^{-1}. To enhance productivity with the 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 problems like fixation and immobilization of nutrients. Hence, foliar nutrition is being recognized as an important method of fertilization in modern agriculture (Chaurasia *et al*., 2005). Changing climatic scenarios demands technologies that will help the crop to overcome them without significant yield loss. The moisture deficit situations in India's dryland tracts result in low productivity due to less availability of nutrients. This method results in the utilization of nutrients more efficiently and for correcting deficiencies rapidly. Recently, a new generation of special fertilizers has been introduced exclusively for foliar feeding and fertilization. The increased supply of nutrients and a good response by plants resulted in enhanced translocation of nutrients to reproductive structures, *viz*., pods, grains, *etc.* (Geetha and Velayutham, 2009).

Foliar fertilization is an economical way of supplementing the plant nutrients when they lack or are unavailable in the soil. One advantage of foliar nutrition is that it often brings about an immediate improvement in plant health and growth. Foliar fertilization or foliar feeding entails the supply of nutrients, plant hormones, stimulants and other beneficial substances in liquid form to plant through areal parts of the plants *viz.,* leaves, stems and other sites to realize enhanced yield and quality, resistance to a pest, improved drought tolerance, and also be used to aid plants in recovery from transplant shock, hail damage, or the results of other weather extremes. Fertilizer applied to the soil at the time of sowing may not be available in the required quantity to the plants as the crop approaches maturity due to various extraneous factors apart from initial uptake by the plants. Therefore, supplemental foliar application of nutrients through the foliar spray at appropriate stages of growth becomes important for their utilization and better crop performance (Anadhakrishnaveni *et al*., 2004). Information on the response of pigeonpea to specialty mixture as a foliar spray of water-soluble nutrients along with soil application is less. Hence, the present investigation was intended to standardize the foliar nutrients spray concentration and to assess the influence foliar nutrition on yield attributes, yield and economics of pigeonpea under the rainfed ecosystem.

Material and methods

A field experiment was conducted during *Kharif*, 2019 at Agricultural College Farm, Vijayapura, Karnataka, on vertisol having pH 8.24 and EC 0.32 dS m^{-1}. The soil was medium in organic carbon content (0.51%) and available P_2O_5 (28 kg ha^{-1}), low in available N (226 kg ha^{-1}) and high K content (415 kg ha^{-1}). The experimental site was located at a latitude of 16° 49' North and longitude of 75° 43' East with an altitude of 593.8 meters above mean sea level in the Northern Dry Zone of Karnataka (Zone 3). The variety TS-3R was used in this experiment. It is a short duration, red and bold seeded variety which matures in

145 to 150 days. It is resistant to both wilt and sterility mosaic. It is high yielding and has wide adaptability. It was released by the University of Agricultural Sciences, Raichur for general cultivation in the central and southern zone of India for the *Kharif* season.

There were 17 treatment combinations, including the foliar application of different nutrients at flower initiation and peak flowering stage (two common sprays). The treatment were Absolute control (T_1), Recommended Package of Practice (RPP) (T_2), RPP + Vermiwash @ 10% (T_3), RPP + Cow urine @ 10% (T_4), RPP + Pulse magic @ 1% (T_5), RPP + KNO_3 @ 1% (T_6), RPP + KNO_3 @ 1% + Vermiwash @ 10% (T_7), RPP + KNO_3 @ 1% + Cow urine @ 10% (T_8), RPP + KNO_3 @ 1% + Pulse magic @ 1% (T_9), RPP + 19:19:19 @ 1% (T_{10}), RPP + 19:19:19 @ 1% + Vermiwash @ 10% (T_{11}), RPP + 19:19:19 @ 1% + Cow urine @ 10% (T_{12}), RPP + 19:19:19 @ 1% + Pulse magic @ 1% (T_{13}), RPP + Urea @ 2% (T_{14}), RPP + Urea @ 2% + Vermiwash @ 10% (T_{15}), RPP + Urea @ 2% + Cow urine @ 10% (T_{16}) and RPP + Urea @ 2% + Pulse magic @ 1% (T_{17}). The experiment was laid out in randomized complete block design and replicated thrice. The land was ploughed once after the harvest of the previous crop, followed by two harrowings. At the time of sowing, the land was prepared to a fine seedbed and the plots were laid out. The fertilizer application was followed on the basis of the plant population occupied by crop. The full amount of fertilizer in the form of urea, ammonium phosphate, zinc sulphate (15 kg ha^{-1}) and gypsum (20 kg ha^{-1}) as per recommended package of practice (RPP) 25:50:00 kg N, P_2O_5 and K_2O per ha was applied. The crop was sown on 25th June 2019 with a spacing of 120 × 30 cm. During the crop growth due to non-receipt of rainfall, three protective irrigations were given to the crop at the seedling stage, at flowering stage and pod initiation stage through sprinklers. Due to the incidence of pod borer (*Helicoverpa armigera*) the spray of Fluebendiamide 480 SC (Fame) @ 0.15 ml per liter of water was taken up during the flower initiation and pod formation stage. The crop was harvested when pods have shown maturity symptoms. First pods were separated from the plants and then the stalk was cut close to the ground level and then, the stalk was sun-dried in the field for a week time then the stalk yield was recorded. Harvested pods were threshed manually, seeds were cleaned and grain and stalk yield were expressed in kilogram per hectare. The harvest index was calculated by using the formula suggested by (Donald, 1962).

$$\text{HI (\%)} = \frac{\text{Economic yield (kg ha}^{-1}\text{)}}{\text{Biological yield (kg ha}^{-1}\text{)}} \times 100$$

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

Yield and yield attributing characters

The data presented in Table 1 reveals that the variations in pigeonpea grain output were important compared to absolute control. In the present investigation, the seed and stalk yield of pigeonpea was significantly differed due to different foliar applications, but the harvest index was not significant. Significantly higher grain yield was recorded in the treatment receiving Recommended Package of Practice (RPP) + foliar spray of 19:19:19 @ 1% + Vermiwash @ 10% (T_{11}) at flower initiation and peak flowering stage (1592 kg ha^{-1}) as compared with that of T_1 (615 kg ha^{-1}) and T_2 (1299 kg ha^{-1}) treatments and was found be at far with rest of the treatments tested. The numerical superiority is in the order of T_{12} (1525 kg ha^{-1}), T_{13} (1508 kg ha^{-1}), T_{15} (1479 kg ha^{-1}), T_{16} (1465 kg ha^{-1}), T_{17} (1464 kg ha^{-1}) and T_7 (1457 kg ha^{-1}) when compared to other foliar spray and control treatment and extent of increase in the yield to the tune of 58.88, 47.96, 45.20, 40.48, 38.21, 38.04, 36.91 per cent, respectively. The increase in yield due to the application of nitrogen, phosphorus, potassium and vermiwash might be attributed to the cumulative effect of an increase in the number of pods $plant^{-1}$, pod weight $plant^{-1}$ and grain weight $plant^{-1}$. These results are also corroborating with the findings of Verma *et al*. (2018), who reported that the combined application of 100 per cent RDF + vermiwash in pigeonpea proved higher yields and it was at par with 100% RDF + cow urine @ 100 l ha^{-1} as compared to other treatments. Further, Rajesh (2011) also reported that foliar application of 1.0 per cent polyfeed (19:19:19) plus 1.0 per cent multi-K recorded maximum yield and yield attributes of pigeonpea. Similarly, Kalaghatagi and Wali (2019) studied the effect of foliar application of water-soluble nutrient mixtures on the growth and yield of rainfed pigeonpea. They reported that foliar application of water-soluble pulse wonder nutrient mixtures @ 1 per cent at flower initiation and pod formation stage gave a significantly higher number of pods $plant^{-1}$, seed weight $plant^{-1}$, grain yield and stalk yield, which was on par with treatment with pulse magic spray @ 1 per cent at grand growth, flower initiation and pod formation stage.

Significantly higher stalk yield was recorded with treatment receiving RPP + foliar spray of 19:19:19 @ 1% + Vermiwash @ 10% (T_{11}) at flower initiation stage and at peak flowering stage (2135 kg ha^{-1}), however it was statistically on par with T_{12}, T_{13}, T_{15}, T_{16}, T_{17} and T_7 which recorded 2109, 2104, 2098, 2059, 2035 and 1920 kg ha^{-1}, respectively. Significantly lower stalk yield (1200 kg ha^{-1}) was recorded in the absolute control (T_1). The increased stalk yield with RPP + foliar spray of 19:19:19 @ 1% + Vermiwash @ 10% might be due to an additional supply of nutrients through the foliar spray, which might have led to increased leaf area, leaf area index, the number of branches per plant and dry matter accumulation. Further, the enhancement

Table 2. Influence of different foliar nutrition on yield attributes of pigeonpea

Treatment	Number of pods $plant^{-1}$	Pod weight $plant^{-1}$ (g)	Grain weight $plant^{-1}$ (g)	100 grain weight (g)
T_1 : Absolute control	141.22	41.66	31.66	10.60
T_2 : RPP	168.20	64.68	59.84	10.76
T_3 : RPP + Vermiwash @ 10%	175.00	72.66	65.66	11.15
T_4 : RPP + Cow urine @ 10%	171.06	72.33	63.74	10.74
T_5 : RPP + Pulse magic @ 1%	170.23	69.59	61.26	10.75
T_6 : RPP + KNO_3 @ 1%	176.00	73.66	66.04	11.20
T_7 : RPP + KNO_3 @ 1% + Vermiwash @ 10%	179.33	80.00	75.82	11.59
T_8 : RPP + KNO_3 @ 1% + Cow urine @ 10%	178.66	79.66	71.97	11.58
T_9 : RPP + KNO_3 @ 1% + Pulse magic @ 1%	178.20	78.33	70.96	11.36
T_{10} : RPP + 19:19:19 @ 1%	177.30	75.84	70.00	11.34
T_{11} : RPP + 19:19:19 @ 1% + Vermiwash @ 10%	198.43	96.48	88.84	12.82
T_{12} : RPP + 19:19:19 @ 1% + Cow urine @ 10%	192.66	89.15	85.22	12.93
T_{13} : RPP + 19:19:19 @ 1% + Pulse magic @ 1%	191.33	88.22	83.63	12.48
T_{14} : RPP + Urea @ 2%	177.23	74.60	68.00	11.34
T_{15} : RPP + Urea @ 2%+ Vermiwash @ 10%	187.76	83.43	78.53	12.34
T_{16} : RPP + Urea @ 2% + Cow urine @ 10%	186.80	82.33	76.88	12.28
T_{17} : RPP + Urea @ 2% + Pulse magic @ 1%	180.33	81.53	76.00	12.24
S.Em.±	5.26	5.21	4.52	0.63
C.D.(P=0.05)	15.15	15.02	13.02	NS

RPP- Recommended package of practice (25:50:00 kg N, P_2O_5 and K_2O per ha) NS - Not significant

of stalk yield might also be due to the enhanced supply and subsequent mobilization of nutrients to plant parts. These results are in conformity with the findings of Mukunda Gowda *et al*. (2014) reported that in pigeonpea foliar spray of 19:19:19 @ 0.4 per cent recorded significantly higher seed yield (1296 kg ha^{-1}) and stalk yield (3421 kg ha^{-1}) followed by foliar spray of 0:0:50 at 0.3 per cent (1252 and 3249 kg ha^{-1}). The harvest index was not significantly influenced by different foliar nutrition. Numerically higher harvesting index was observed with RPP + foliar spray of pulse magic @ 1% (44.73 %) and lower values were recorded in absolute control (33.88 %). These results conform with Sritharam *et al.* (2005) and Verma *et al*. (2018) in pigeonpea, who reported the higher yield attributes in foliar application treatments.

It has been well established that seed yield finally depends on yield attributing characters**.** In the present investigation, the yield attributes of pigeonpea recorded after harvesting were significantly influenced by different foliar nutrition treatments except for 100 grain weight (Table 2). The treatment which received RPP + foliar spray of 19:19:19 @ 1% + Vermiwash @ 10% (T_{11}) at flower initiation stage and peak flowering stage registered significantly higher number of pods per plant (198.43), which was on par with T_{12}, T_{13}, T_{15} and T_{16} (192.66, 191.33, 187.76 and 186.80 $plant^{-1}$, respectively). The significantly lesser numbers of pods (141.22) were recorded in the absolute control (T_1). Similarly, higher pod and grain weight per plant were observed in treatment receiving RPP + foliar spray of 19:19:19 @ 1% + Vermiwash @ 10% (T_{11}) at flower initiation stage and peak flowering stage registered significantly higher pod weight per plant (96.48 and 88.84 g $plant^{-1}$, respectively) which was on par with T_{12} (89.15 and 85.22 g $plant^{-1}$, respectively), T_{13} (88.22 and 83.63 g $plant^{-1}$, respectively), T_{15} (83.43 and 78.53 g $plant^{-1}$,

Table 1. Influence of different foliar nutrition on grain yield, stalk yield and harvest index of pigeonpea

Treatment	Grain yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Harvest index (%)
T_1 : Absolute control	615	1200	33.88
T_2 : RPP	1299	1615	44.57
T_3 : RPP + Vermiwash @ 10%	1389	1749	44.26
T_4 : RPP + Cow urine @ 10%	1360	1700	44.44
T_5 : RPP + Pulse magic @ 1%	1356	1675	44.73
T_6 : RPP + KNO_3 @ 1%	1390	1800	43.57
T_7 : RPP + KNO_3 @ 1% + Vermiwash @ 10%	1457	1920	43.14
T_8 : RPP + KNO_3 @ 1% + Cow urine @ 10%	1436	1900	43.04
T_9 : RPP + KNO_3 @ 1% + Pulse magic @ 1%	1434	1878	43.29
T_{10} : RPP + 19:19:19 @ 1%	1417	1853	43.33
T_{11} : RPP + 19:19:19 @ 1% + Vermiwash @ 10%	1592	2135	42.71
T_{12} : RPP + 19:19:19 @ 1% + Cow urine @ 10%	1525	2109	41.96
T_{13} : RPP + 19:19:19 @ 1% + Pulse magic @ 1%	1508	2104	41.74
T_{14} : RPP + Urea @ 2%	1399	1851	43.04
T_{15} : RPP + Urea @ 2%+ Vermiwash @ 10%	1479	2098	41.34
T_{16} : RPP + Urea @ 2% + Cow urine @ 10%	1465	2059	41.57
T_{17} : RPP + Urea @ 2% + Pulse magic @ 1%	1464	2035	41.84
S.Em.±	52.26	89.54	1.79
C.D.(P=0.05)	155.2	230.36	NS

RPP- Recommended package of practice (25:50:00 kg N, P_2O_5 and K_2O per ha) NS - Not significant respectively) T_{16} (82.33 and 76.88 g plant^{-1}, respectively) and T_{17} (81.53 and 76.00 g plant^{-1}, respectively). The significant lesser pod and grain weight (41.66 and 31.66 g plant^{-1}, respectively) were recorded in the absolute control (T_1).

The higher yield attributing characters *viz.,* number of pods per plant, pod and grain weight per plant were obtained in RPP + foliar spray of 19:19:19 @ 1% + Vermiwash @ 10% might be attributed due to the application of nutrients and PGR (Nitrogen in vermiwash is present in the form of mucus, enzymes, nitrogenous excretory substances of worms and plant growth hormones) at the flowering and pod formation stage, which has helped in more translocation of photosynthates to the developing pods (Tripathi and Bhardwaj, 2004) which in turn helped in the better filing of grains, thus favoured the test weight (12.93 g) compared to absolute control (10.60 g) (Table 1). A significant increase in yield parameters was mainly due to increased nutrient uptake and improved growth parameters. The supply of nutrients through foliar application increased the nutrient assimilation and better utilization by the crop, which intern produced more photosynthates resulting in better partitioning of dry matter from source to sink. Foliar nutrition preferentially increased the metabolic processes like photosynthesis, enhanced nucleic acids, soluble proteins, and carbohydrates, which resulted in higher dry matter production and sink size. Enhanced growth with a foliar spray of vermiwash was chiefly due to the presence of growth regulatory substances such as IAA, GA, cytokinin, and essential plant nutrients and effective microorganisms in vermiwash (Maheshwari *et al*., 2016). The results of the present investigations are similar to the findings of Mukunda Gowda *et al*. (2014); they observed increased yield attributes with foliar application of 19:19:19 in pigeonpea.

The test weight of seeds was not influenced significantly. Still, numerically a higher test weight was observed in RPP + 19:19:19 @ 1% + Cow urine @ 10% (T_{11}) when compared to absolute control, which further increased the final seed yield to the extent of 58.88 per cent compared to unsprayed plots. The foliage applied macro and micronutrients at critical stages of the crop were effectively absorbed and translocated to the developing pods, producing more pods and better filling in soybean was reported by Jayabel *et al.* (1998).

Economics

A higher cost of cultivation (₹ 27231 ha^{-1}) was higher in treatment receiving RPP + foliar spray of KNO_3 @ 1% + Pulse magic @ 1% (T_9) and lower cost of cultivation (₹ 12896 ha^{-1}) was in absolute control (T_1) (Table 3). Gross returns differed significantly among treatments. Significantly higher gross returns were recorded in Recommended Package of Practice (RPP) + foliar spray of 19:19:19 @ 1% + Vermiwash @ 10 % (₹ 92336 ha^{-1}) and was on par with the treatments T_{12} (₹ 88450 ha^{-1}), T_{13} (₹ 87464 ha^{-1}), T_{15} (₹ 85782 ha^{-1}), T_{16} (₹ 84970 ha^{-1}), T_{17} (₹ 84912 ha^{-1}) and T_7 (₹ 84506 ha^{-1}), whereas lower values (₹ 35670 ha^{-1}) were recorded with absolute control (T_1). Higher gross returns with RPP + foliar spray of 19:19:19 @ 1% + Vermiwash @ 10 % were due to realization of higher seed yield.

Significantly higher net returns were recorded in RPP + foliar spray of 19:19:19 @ 1% + Vermiwash @ 10 % (T_{11}) (₹ 65908 ha^{-1}) and was on par with the treatments T_{12} (₹ 62472 ha^{-1}), T_{13} (₹ 60333 ha^{-1}), T_{15} (₹ 60282 ha^{-1}), T_{16} (₹ 59920 ha^{-1}), T_{17} (₹ 58709 ha^{-1}) and T_7 (₹ 57978 ha^{-1}), whereas lower net returns (₹ 22774 ha^{-1}) were recorded with absolute control (T_{11}) (Table 3). Benefit-cost (BC) ratio differed significantly among treatments. Significantly higher BC ratio (3.49) were

Table 3. Influence of different foliar nutrition on the cost of cultivation, gross returns, net returns and benefit-cost ratio of pigeonpea

Treatment	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	BC ratio
T_1 : Absolute control	12896	35670	22774	2.76
T_2 : RPP	24928	75342	50414	3.02
T_3 : RPP + Vermiwash @ 10%	25428	80562	55134	3.16
T_4 : RPP + Cow urine @ 10%	24978	78880	53902	3.15
T_5 : RPP + Pulse magic @ 1%	26131	78648	52517	3.00
T_6 : RPP + KNO_3 @ 1%	26028	80620	54592	3.09
T_7 : RPP + KNO_3 @ 1% + Vermiwash @ 10%	26528	84506	57978	3.18
T_8 : RPP + KNO_3 @ 1% + Cow urine @ 10%	26078	83288	57210	3.19
T_9 : RPP + KNO_3 @ 1% + Pulse magic @ 1%	27231	83172	55941	3.05
T_{10} : RPP + 19:19:19 @ 1%	25928	82186	56258	3.16
T_{11} : RPP + 19:19:19 @ 1% + Vermiwash @ 10%	26428	92336	65908	3.49
T_{12} : RPP + 19:19:19 @ 1% + Cow urine @ 10%	25978	88450	62472	3.40
T_{13} : RPP + 19:19:19 @ 1% + Pulse magic @ 1%	27131	87464	60333	3.22
T_{14} : RPP + Urea @ 2%	25000	81142	56142	3.24
T_{15} : RPP + Urea @ 2%+ Vermiwash @ 10%	25500	85782	60282	3.36
T_{16} : RPP + Urea @ 2% + Cow urine @ 10%	25050	84970	59920	3.39
T_{17} : RPP + Urea @ 2% + Pulse magic @ 1%	26203	84912	58709	3.24
S.Em.±	-	2818	2818	0.10
C.D.(P=0.05)	-	8140	8140	0.30

RPP- Recommended package of practice (25:50:00 kg N, P_2O_5 and K_2O per ha) recorded in RPP + foliar spray of 19:19:19 @ 1% + Vermiwash @ 10 % (T_{11}) and was on par with the treatments T_{12} (3.40), T_{13} (3.22), T_{14} (3.24) T_{15} (3.36), T_{16} (3.39), T_{17} (3.24) and T_8 (3.19), whereas lower BC ratio (2.76) were recorded with absolute control (T_1) (Table 3). The higher BC ratio with RPP + foliar spray of 19:19:19 @ 1% + Vermiwash @ 10% treatment combinations were mainly due to improved yield and yield attributes recorded with the pigeonpea. These results are in conformity with findings of Raudal *et al.* (1999), Ahlawat (2009) and Kalaghatagi and Wali (2019). These results are also in agreement with the findings of Mamathashree (2014) who conducted an experiment at Vijayapura on pigeonpea crop under medium black soil. The results revealed that foliar spray of 19:19:19 at 2% recorded significantly higher gross returns (₹ 53431ha^{-1}), net returns (₹ 33976 ha^{-1}) and BC ratio (2.7). Similar results were obtained by Verma *et al*. (2018) in pigeonpea with the treatment 100% RDF+ vermiwash @ 100 l ha^{-1} recorded significantly highest gross returns, net return (₹ 90355 ha^{-1}) and BC ratio (2.80).

Conclusion

Soil application of recommended nutrients (25:50:00 kg N, P_2O_5 and K_2O per ha) coupled with foliar spray of 19:19:19 @ 1% + Vermiwash @ 10% at flower initiation and peak flowering stage to pigeonpea crop was found usefule optimum for higher grain yield, higher net economic returns and BC ratio.

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