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Effect of conjunctive use of inorganic and organic sources of nutrient on growth parameters of pearl millet: Chickpea cropping sequence

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Abstract
A field experiment was conducted under loamy sand soil during *Kharif* 2019, *Rabi* 2019-20 & *Kharif* 2020, *Rabi* 2020-21 at Instructional farm, college of agriculture, Bikaner. Treatments were assigned in Randomized Block Design, respectively were replicated thrice. Pearl millet variety RHB- 177 and residual effect of treatments was observed on chickpea variety GNG-1581(Gangour) used as a test crop. Result showed that application of 60% RDF + 2.5 t ha^{-1} vermicompost + Azospirillum + PSB observed plant height, chlorophyll content at 40 DAS, which was remained at par with 80% RDF+1.25 t ha^{-1} vermicompost + Azospirillum + PSB, 60% RDF + 2.5 t ha^{-1} vermicompost + Azospirillum and 60% RDF + 2.5 t ha^{-1} vermicompost + PSB in 2019, 2020 and pooled mean basis. Residual effect of application of 60% RDF + 2.5 t ha^{-1} vermicompost + Azospirillum + PSB on chickpea recorded highest effective root nodules, which was remained at par with 80% RDF+1.25 t ha^{-1} vermicompost + Azospirillum + PSB and 60% RDF + 2.5 t ha^{-1} vermicompost + PSB.

Keywords: Growth attributes, root nodules, vermicompost, biofertilizers

1. Introduction
Pearl millet [*Penisetum glaucum* (L.)] is a drought tolerant warm season cereal crop. It can be grown in very hot, dry areas and soil having very poor organic matter, low water holding capacity and high infiltration. Rajasthan occupies first position in area and production of pearl millet in India. Rajasthan occupies first position in area and production of pearl millet in India. Chickpea or Bengal gram (*Cicer aretinium* L.) is an important pulse crop in arid regions taking into deliberation an essential source of protein (18-22%). Chickpea have capacity to convert atmospheric nitrogen into plant available form of nitrogen through symbiotic nitrogen fixation using rhizobium bacteria and enrich soil fertility.
Pearl millet inoculated with azospirillium recorded 11-12% increase yield in dry land condition. Azospirillum is free living N fixing bacteria closely associated with grasses fix N in non-symbiotic manner. The fixed phosphorus in the soil can be solubilized by phosphate solubilizing bacteria (PSB). Rhizobium a symbiotic biofertilizer for legume crop, rhizobium lupini inoculant used for chickpea. The appropriate strain can increase the crop yield up to 10-35 percent. Vermicompost is a rich source of both macro and micro nutrient. Incorporation of inorganic fertilizer with organic source of nutrient is able to maintain soil fertility and soil health by improving physical, chemical and biological properties of soil.

2. Materials and Methods
The experimental soils are characterized by deep, coarse sandy soil with low water holding capacity and poor fertility thereby low productivity. The experiment was laid out in Randomized block design (RBD) with three replications. Each replication consists of 10 treatments with inorganic fertilizers, vermicompost and liquid biofertilizers. A field experiment was conducted under loamy sand soil during *Kharif* 2019, *Rabi* 2019-20 & *Kharif* 2020, *Rabi* 2020-21 at Instructional farm, college of agriculture, Bikaner**.** The soil of experimental site containing 104.2, 18.5 and 179 kg ha^{-1} available nitrogen, phosphorus and potassium, respectively in 0-15 cm soil depth with pH 8.23 and organic carbon 0.13 per cent. The treatments comprising are T_1-absolute control, T_2- 100% RDF, T_3- 80% RDF + 1.25 t ha^{-1} vermicompost, T_4- 60% RDF + 2.5 t ha^{-1} vermicompost, T_5- 80% RDF+1.25 t ha^{-1} vermicompost + Azospirillum, T_6-80% RDF + 1.25 t ha^{-1} vermicompost + PSB, T_7- 80% RDF+1.25 t ha^{-1} vermicompost + Azospirillum + PSB, T_8- 60% RDF + 2.5 t ha^{-1}

vermicompost + Azospirillum, T_9- 60% RDF + 2.5 t ha^{-1} vermicompost + PSB and T_{10}- 60% RDF + 2.5 t ha^{-1} vermicompost + Azospirillum + PSB applied in soil at pearl millet crop and residual effect of treatments in chickpea crop and soil was observed. Treatments were assigned in Randomized Block Design, respectively were replicated thrice. Pearl millet variety RHB- 177 and residual effect of treatments was observed on chickpea variety GNG-1581(Gangour) used as a test crop.

3. Result and Discussions

3.1 Effect of conjunctive use of inorganic and organic sources of nutrients on plant height

The data presented in table 1 indicated that the plant height of pearl millet was significantly influenced due to different integrated nutrient management treatments during both the years of 2019, 2020 and pooled mean basis. Plant height was recorded highest at harvest with application of 60% RDF + 2.5 t ha^{-1} vermicompost + Azospirillum + PSB as compared to absolute control, 100% RDF, 80% RDF + 1.25 t ha^{-1} vermicompost, 60% RDF + 2.5 t ha^{-1} vermicompost, 80%RDF+1.25 t ha^{-1} vermicompost + Azospirillum and 80% RDF + 1.25 t ha^{-1} vermicompost + PSB, which were statistically at par with 80% RDF+1.25 t ha^{-1} vermicompost + Azospirillum + PSB, 60% RDF + 2.5 t ha^{-1} vermicompost + Azospirillum and 60% RDF + 2.5 t ha^{-1} vermicompost + PSB during both the years as well as pooled mean basis.

Yadav *et al.* (2019) [4] also found that highest plant height obtained under 75% RDN through urea+ 25% RDN through vermicompost and seed inoculation with Azotobacter. It supplied nutrients such as nitrogen and phosphorus through Azospirillum nitrogen fixation and PSB phosphorus availability throughout the crop growth stages, which aided in the production of new cells, cell division, cell elongation, and root development. The rapid expansion of the root system resulted in improved nutrient absorption and utilization from the soil solution, resulting in overall plant growth and, eventually, higher plant height. These findings are consistent with those of Lakum *et al*. (2011) [2].

3.2 Effect of conjunctive use of inorganic and organic sources of nutrients on chlorophyll content

The chlorophyll content differed with different integrated nutrient management treatments during both the years of 2019, 2020 and pooled mean basis (Table 1). Application of 60% RDF + 2.5 t ha^{-1} vermicompost + Azospirillum + PSB recorded maximum chlorophyll content (2.96, 2.95 and 2.96 mg g^{-1} in 2019, 2020 and pooled results, respectively) as compared to absolute control, 100% RDF, 80% RDF + 1.25 t ha^{-1} vermicompost and 60% RDF + 2.5 t ha^{-1} vermicompost, but it was statistically at par with 80% RDF+1.25 t ha^{-1} vermicompost + Azospirillum and 80% RDF + 1.25 t ha^{-1} vermicompost + PSB, 80% RDF+1.25 t ha^{-1} vermicompost + Azospirillum + PSB, 60% RDF + 2.5 t ha^{-1} vermicompost + Azospirillum and 60% RDF + 2.5 t ha^{-1} vermicompost + PSB during both the years as well as pooled mean basis.

Significant increases in chlorophyll content in leaves may have led in improved radiant energy absorption and utilization, resulting in a higher photosynthetic rate. It is well known fact that providing proper fertilization to crops, such as NPK, improves a variety of physiological and metabolic processes in the plant system. Because, nitrogen is a crucial component in the synthesis of proteins, chlorophyll, and other organic molecules in the plant system, it is the most important mineral nutrient (Singh and Sinsiwar, 2006) [3].

Table 1: Effect of conjunctive use of inorganic and organic sources of nutrients on plant height and chlorophyll content of pearl millet

Treatments	Plant height (cm)			Chlorophyll content (mg g^{1}) at 40 DAS		
	2019	2020	Pooled	2019	2020	Pooled
Absolute control	117.00	118.51	117.76	1.95	2.00	1.97
100% RDF	133.03	135.01	134.02	2.38	2.40	2.39
80%RDF + 1.25 t ha^{-1} vermicompost	139.95	144.19	142.07	2.58	2.59	2.58
60%RDF + 2.5 t ha^{-1} vermicompost	150.85	151.81	151.33	2.65	2.65	2.65
80%RDF+1.25 t ha^{-1} vermicompost + Azospirillum	154.96	156.38	155.67	2.78	2.79	2.78
80% RDF + 1.25 t ha^{-1} vermicompost + PSB	155.08	157.26	156.17	2.82	2.81	2.82
80%RDF+1.25 t ha^{-1} vermicompost + Azospirillum + PSB	170.06	171.75	170.91	2.90	2.90	2.90
60%RDF + 2.5 t ha^{-1} vermicompost + Azospirillum	162.16	163.27	162.71	2.82	2.81	2.82
60%RDF + 2.5 t ha^{-1} vermicompost + PSB	165.88	166.71	166.30	2.89	2.86	2.87
60%RDF + 2.5 t ha^{-1} vermicompost + Azospirillum + PSB	176.27	177.93	177.10	2.96	2.95	2.96
S. Em. ±	6.41	6.79	5.39	0.10	0.10	0.08
CD at 5%	19.06	20.18	15.65	0.30	0.29	0.24

3.3 Residual effect of conjunctive use of inorganic and organic sources of nutrients on number of effective root nodules plant^{-1}

Application of 60% RDF + 2.5 t ha^{-1} vermicompost + Azospirillum + PSB gave highest number of root nodules plant^{-1} (34.20, 34.53 and 34.37) in 2019, 2020 and pooled results, respectively), it was at par with 80% RDF+1.25 t ha^{-1} vermicompost + Azospirillum + PSB and 60% RDF + 2.5 t ha^{-1} vermicompost + PSB and which was higher by 95.40, 60.01, 40.80, 31.58, 39.94, 15.30, 31.08 and 11.27 per cent on pooled result basis as compared to absolute control, 100% RDF, 80% RDF + 1.25 t ha^{-1} vermicompost, 60% RDF + 2.5 t ha^{-1} vermicompost, 80% RDF+1.25 t ha^{-1} vermicompost + Azospirillum, 80% RDF + 1.25 t ha^{-1} vermicompost + PSB and 60% RDF + 2.5 t ha^{-1} vermicompost + Azospirillum, respectively.

Application of 60% RDF + 2.5 t ha^{-1} vermicompost + Azospirillum + PSB to the preceding pearl millet crop have significant residual effect on number of root nodules plant^{-1} of chick pea during 2019, 2020 and pooled results. The application of vermicompost increasing effective nodules in chickpea due to the different type of enzymes produced by organic fertilizers (vermicompost) that helped to improve nodulation in the plant (Bajracharya SK. and Rai SK. 2009) [1].

Table 2: Residual effect of conjunctive use of inorganic and organic sources of nutrients on number of effective root nodules of chick pea

Treatments	Number of effective root nodules plant^{-1}		
	2019- 20	**2020- 21**	**Pooled**
Absolute control	18.03	17.15	17.59
100% RDF	21.11	21.60	21.36
80% RDF + 1.25 t ha^{-1} vermicompost	24.15	24.66	24.41
60%RDF + 2.5 t ha^{-1} vermicompost	25.86	26.39	26.12
80%RDF+1.25 t ha^{-1} vermicompost + Azospirillum	24.54	24.58	24.56
80% RDF + 1.25 t ha^{-1} vermicompost + PSB	28.88	30.75	29.81
80%RDF+1.25 t ha^{-1} vermicompost + Azospirillum + PSB	32.67	33.11	32.89
60%RDF + 2.5 t ha^{-1}vermicompost + Azospirillum	25.90	26.54	26.22
60% RDF + 2.5 t ha^{-1} vermicompost + PSB	30.47	31.30	30.89
60%RDF + 2.5 t ha^{-1}vermicompost + Azospirillum + PSB	34.20	34.53	34.37
S. Em.±	1.55	1.51	1.25
CD at 5%	4.61	4.48	3.62

4. Conclusion

On the basis of 2 years field experiment results of pearl millet- chickpea cropping system, it seems quite logical to conclude that application of T_{10}-(60% RDF + 2.5 t ha^{-1} vermicompost + Azospirillum + PSB) significantly increased growth parameters of pearl millet and nodulation in chickpea crop, which was remained at par with T_7-(80% RDF+1.25 t ha^{-1} vermicompost + Azospirillum + PSB). Treatment T_{10} (60%RDF + 2.5 t ha^{-1} vermicompost + Azospirillum + PSB) is recommended for Pearl millet-Chickpea cropping sequence in Torripsamments of Western Rajasthan.

5. References

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