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# Effect of integrated nutrient management on soil properties and their impact on available nutrients under blackgram (*Vigna mungo* L.) growing soils

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## Abstract
The inception of integrated nutrient management directs to the maintenance or enhancement of soil fertility and nutrient supply to an optimum level so as to sustain the anticipated crop productivity by optimising the perks from all potential sources of nutrients in a conjunctive approach. A field experiment was conducted at Advance Centre for Rainfed Agriculture at Rakh Dhiansar, Sher-e-Kashmir university of Agricultural Sciences and Technology-Jammu, during two consecutive years 2016 and 2017 to study the effect of phosphorus, molybdenum and organics (*Rhizobium* and phosphorus solubilizing bacteria). The results revealed that application of different treatments did not yield any significant result on soil pH and EC during both the years. Water holding capacity and soil porosity significantly improved by the incorporation of farmyard manure along with inorganics and biofertilizers. Further, available N, P, K and Mo significantly enhanced after harvesting of blackgram due to the integrated application of organics and inorganics under treatment $T_{13}$ (40 kg P + 0.5 kg Mo + PSB + Rhizobium + FYM) over $T_1$ (control) during both the years of study.

**Keywords:** Farmyard manure, Rhizobium, PSB, Blackgram, physico-chemical properties

## Introduction
Blackgram (Vigna mungo) is one of the important pulse crops grown throughout India. Proper fertilization is essential to improve the productivity of blackgram. Leguminous plants have a high requirement of phosphorus and its deficiency is probably the major limitation to the growth of legumes [1]. Phosphorus (P) is among the most needed elements for crop production in most tropical soils, which tend to be P deficient. It is the most important single factor responsible for poor yields of pulses. The use of biological nitrogen fixation (BNF) technology in the form of Rhizobium inoculants in grain legumes can be an alternative of nitrogenous fertilizer. Blackgram, like other legumes improves soil fertility by fixing atmospheric nitrogen through the process of symbiosis with roots of legume crops and makes nitrogen (N) available to plant. Without proper fertilization by phosphorus, rhizobial activities and nitrogen fixation is depressed because it promotes early root formation and the formation of lateral, fibrous and healthy roots. It is very important for nodule formation and to fix atmospheric nitrogen. Leguminous crops meet up their N requirement through BNF depending on proper growth, development and also leghaemoglobin content of the root nodules [2]. Emphasis has been also given to use phosphorus solubilizing biofertilizer which have been found useful in enhancing phosphorus availability to plant through solubilisation, converting low grade rock phosphate as fertilizer and increasing the seed yield [3].

Mo is directly involved in nitrogen fixing enzymes nitrogenise and N reduction enzyme, nitrate reductase especially for legumes forming root nodules. Its application can play a vital role in increasing mungbean yield through its effect on the plant itself and also on the nitrogen fixation process by Rhizobium. Sharma *et al.*, (1988) [4] observed that molybdenum was responsible for the formation of nodule tissue and increase in nitrogen fixation and without adequate quantities of molybdenum, nitrogen fixation could not occur and microbial activity was depressed. Farmyard manure (FYM) is known to play an important role in improving the fertility and productivity of soils through its positive effects on soil physical, chemical and biological properties and balanced plant nutrition [5].

[5]. FYM is good organic manure, which contains relatively higher amount of plant nutrients compared to conventional organic manures. Use of farmyard manure and other organic sources are best remedies for maintaining of soil health as well as productivity and partial replacement of mineral fertilizer. Research work done so far had given indication that information on phosphorus, molybdenum and organics. It is necessary to examine the integrated effect of these nutrients in terms of soil physico-chemical properties and uptake of blackgram and thus, the present study was undertaken.

## Materials and Methodology

The experiments were conducted at the Advance Centre for Rainfed Agriculture at Rakh Dhiansar, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu (32º39′ N latitude and 74º58′ E longitude). The soil of the experimental site was sandy loam in texture, low in organic carbon and low in available nitrogen, medium in available phosphorus and potassium contents. The experiment was conducted during two consecutive years, viz. 2016 and 2017, and comprised of 13 treatments laid out in Randomized Complete Block Design encompassing different combinations of chemical fertilizers, organic manure, and biofertilizers, viz. ($T_1$) control, ($T_2$) 20 kg P + PSB (Phosphorus solubilizing bacteria), ($T_3$) 20 kg P + PSB + Rhizobium, ($T_4$) 20 kg P + PSB + Rhizobium+ FYM, ($T_5$) 20 kg P + 0.5 kg Mo + PSB, ($T_6$) 20 kg P + 0.5 kg Mo + PSB + Rhizobium, ($T_7$) 20 kg P + 0.5 kg Mo + PSB + Rhizobium + FYM, ($T_8$) 40 kg@ P + PSB, ($T_9$) 40 kg P + PSB + Rhizobium, ($T_{10}$) 40 kg P + PSB + Rhizobium+ FYM, ($T_{11}$) 40 kg P + 0.5 kg Mo + PSB, ($T_{12}$) 40 kg P + 0.5 kg Mo + PSB + Rhizobium, and ($T_{13}$) 40 kg P + 0.5 kg Mo + PSB + Rhizobium + FYM. The seed of blackgram were inoculated with Rhizobium and PSB just as per treatment before sowing. The FYM was incorporated 15 days prior to sowing in the soil as per treatment. Phosphorus was applied through ammonium phosphate and molybdenum as ammonium moly date.

## Soil analysis

Soil chemical properties like pH was estimated by using 1:2.5 soil and water suspension with the help of glass electrode pH meter [6]. The electrical conductivity of soil was estimated in 1:2.5 soil: water suspension with EC meter as given by Jackson [6]. The soil organic carbon was estimated by Walkley and Black [7]. The available soil nitrogen was estimated by using alkaline potassium permanganate method [8]. The available phosphorus was determined by the method delineated by Olsen *et al*., (1956) [9]. 1 N $NH_4OAc$ was used as extractant and the available potassium content was determined by feeding the extract to flame photometer [6]. The statistical analysis were performed using analysis of variance (ANOVA) and data were analysed using SPSS software.

## Results and Discussion

### Physico-chemical properties

The perusal of data presented in Table 1 with respect to soil pH and EC after harvesting of blackgram indicated that different combination of treatments did not show any significant results during both the years. However, slight decrease in soil pH was observed under FYM amended plots and this might be due to the formation of organic acids during the decomposition of organic manure [10].

Bulk density (Mg $m^{-3}$) after harvesting of blackgram (Table 2) revealed highest under treatment $T_2$ (1.55) and lowest under $T_4$ (1.48) during 2016 whereas bulk density (Mg $m^{-3}$) was found to be highest in treatment $T_2$ (1.56) and lowest in T4 (1.47) during 2017. It was observed that bulk density decreased with addition of FYM along with inorganics and bio-fertilizers including phosphorus solubilizing bacteria and *Rhizobium* during both the years. The decrease in bulk density under organic manure amended plots could be attributed to the addition of farmyard manure that promotes the porosity of the soil as the microbial decomposition products of organic manure such as polysaccharides and bacterial gums are known to act as soil particle binding agents. These binding agents increase the porosity and decrease bulk density of the soil. Similar findings were obtained by Khan *et al.,* (2017) [11].

**Table 1:** Effect of different treatments on soil pH and electrical conductivity (EC) after harvesting of blackgram

| Treatments | Soil pH | | EC (DS $m^{-1}$) | |
|---|---|---|---|---|
| | 2016 | 2017 | 2016 | 2017 |
| $T_1$ | $6.68^d$ | $6.64^d$ | $0.27^e$ | $0.25^e$ |
| $T_2$ | $6.64^d$ | $6.61^d$ | $0.26^e$ | $0.24^e$ |
| $T_3$ | $6.61^d$ | $6.59^d$ | $0.24^e$ | $0.23^e$ |
| $T_4$ | $6.48^d$ | $6.46^d$ | $0.21^e$ | $0.20^e$ |
| $T_5$ | $6.67^d$ | $6.63^d$ | $0.27^e$ | $0.23^e$ |
| $T_6$ | $6.62^d$ | $6.59^d$ | $0.25^e$ | $0.23^e$ |
| $T_7$ | $6.46^d$ | $6.45^d$ | $0.22^e$ | $0.21^e$ |
| $T_8$ | $6.64^d$ | $6.61^d$ | $0.26^e$ | $0.25^e$ |
| $T_9$ | $6.63^d$ | $6.58^d$ | $0.26^e$ | $0.23^e$ |
| $T_{10}$ | $6.45^d$ | $6.42^d$ | $0.23^e$ | $0.21^e$ |
| $T_{11}$ | $6.61^d$ | $6.59^d$ | $0.26^e$ | $0.24^e$ |
| $T_{12}$ | $6.56^d$ | $6.60^d$ | $0.25^e$ | $0.23^e$ |
| $T_{13}$ | $6.47^d$ | $6.43^d$ | $0.24^e$ | $0.22^e$ |

Values followed by the same alphabet do not differ significantly ($p < 0.05$)

It is apparent from Table 2 that incorporation of FYM, inorganics and bio-fertilizers brought significant change in water holding capacity during both the years. The water holding capacity after harvesting of blackgram reflected minimum under $T_1$ (control) and maximum under treatment $T_7$ (P20 + 0.5Mo + PSB + Rhizobium + FYM) during 2016 and 2017. The improvement in water holding capacity in response to the addition of farmyard manure along with inorganic and bio-fertilizers could be due to better environment for root development, improved soil structure and water stable aggregates, as well as moisture retention capacity by increasing the total number of storage pores. These results are in accordance with the findings of Datt *et al.*, (2013) [12] and Bhattacharyya *et al.*, (2004) [13].

The soil porosity (%) after harvesting of blackgram (Table 2) was recorded maximum in treatment $T_4$ (44.57) and minimum in $T_2$ (42.08) during 2016 while as during 2017, soil porosity was noted maximum in treatment $T_4$ (44.94) and minimum in $T_2$ (41.57). The soil porosity was observed significantly higher due to combined application of organic, inorganic and bio- fertilizers during 2016 and 2017. The treatment $T_4$, $T_7$, $T_{13}$ and $T_{10}$ represents 5.32, 4.42, 3.54 and 2.67 percent and 5.26, 4.38, 3.49 and 2.62 percent increase in soil porosity over control during 2016 and 2017, respectively. The increased porosity in farmyard manure plus inorganic and bio-fertilizer treated plots might be due to aggregation of the soil particles by the action of microorganisms in the farmyard manure which produced polysaccharides providing a cementing action between the soil particles. These results are in conformity with those reported by Parthasarathi *et al.*, (2008) [14].

**Table 2:** Effect of different treatments on soil physico-chemical properties after harvesting of blackgram

| Treatments | Bulk density (Mg m$^{-3}$) | | Water holding capacity (%) | | Soil porosity (%) | |
|---|---|---|---|---|---|---|
| | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| $T_1$ | 1.54 | 1.53 | 30.58 | 30.54 | 42.32 | 42.70 |
| $T_2$ | 1.55 | 1.56 | 30.65 | 30.67 | 42.08 | 41.57 |
| $T_3$ | 1.53 | 1.52 | 30.72 | 30.78 | 42.48 | 42.64 |
| $T_4$ | 1.48 | 1.47 | 35.06 | 35.48 | 44.57 | 44.94 |
| $T_5$ | 1.54 | 1.55 | 30.63 | 30.67 | 42.32 | 41.95 |
| $T_6$ | 1.53 | 1.52 | 30.76 | 30.81 | 42.69 | 43.07 |
| $T_7$ | 1.49 | 1.48 | 35.13 | 35.49 | 44.19 | 44.57 |
| $T_8$ | 1.54 | 1.55 | 30.62 | 30.59 | 42.32 | 41.95 |
| $T_9$ | 1.53 | 1.54 | 30.71 | 30.74 | 42.26 | 42.32 |
| $T_{10}$ | 1.51 | 1.50 | 34.82 | 35.30 | 43.45 | 43.82 |
| $T_{11}$ | 1.54 | 1.56 | 30.61 | 30.59 | 42.30 | 41.57 |
| $T_{12}$ | 1.55 | 1.54 | 30.69 | 30.72 | 42.08 | 42.32 |
| $T_{13}$ | 1.50 | 1.49 | 34.89 | 35.31 | 43.82 | 44.19 |
| S.E.(m) ± | 0.01 | 0.01 | 0.43 | 0.043 | 0.14 | 0.27 |
| C.D. ($p$ = 0.05) | 0.02 | 0.03 | 1.27 | 1.28 | 0.42 | 0.80 |

### Available Nutrients
The available N, P, K and Mo in soil significantly increased under integrated application of organics and inorganics. Higher values of N (Table 3) were registered due to combined application under $T_{13}$ (40 kg P + 0.5 kg Mo + PSB + Rhizobium + FYM) over $T_1$ (control). The significant increase in available N could be due to addition of farmyard manure and also due to conversion of organically bound N to inorganic form. These results are in line with those reported by Patidar and Mali (2004) [15] and Singh *et al.*, (2012) [16]. Also, the increase in P availability might be due to the mineralization of organic P and release of P from Al-P and Fe-P fractions. Molybdate ($MoO_4^{-2}$) ions also release phosphate ions ($PO4^{-3}$) from the soil colloidal complex through anion exchange phenomena. Moreover, the increase in available P could be ascribed to retardation of soil P fixation by organic anions formed during farmyard manure decomposition. These findings are in conformity with those reported by Singh *et al.*, (2012) [16].

Further, the improvement in availability of potassium under different treatments might be due to the built of K in the soils leading to the beneficial effect of P fertilization along with other sources on the root proliferation and Rhizobium inoculation as reported by Mathan *et al.*, (1996) [17]. Combined application of inorganics and organics including *Rhizobium* and PSB under treatment T13 over T1 (control) brought about significant improvement in available molybdenum. The increase in available Mo might be attributed to the release of $MoO_4^{-2}$ ions from soil complex in exchange for $OH^{-1}$ ions in soil solution. Similar results were reported by Ebhin Masto (2000) [18].

**Table 3:** Effect of different treatments on available nutrients after harvesting of blackgram

| Treatments | Available N (kg ha$^{-1}$) | | Available P (kg ha$^{-1}$) | | Available K (kg ha$^{-1}$) | | Available Mo (mg kg$^{-1}$) | |
|---|---|---|---|---|---|---|---|---|
| | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| $T_1$ | 93.63 | 93.08 | 8.79 | 8.13 | 111.98 | 111.20 | 0.223 | 0.212 |
| $T_2$ | 95.52 | 96.91 | 9.90 | 10.61 | 113.14 | 113.59 | 0.261 | 0.272 |
| $T_3$ | 99.23 | 102.17 | 10.11 | 10.77 | 114.08 | 114.51 | 0.267 | 0.278 |
| $T_4$ | 102.94 | 104.96 | 11.76 | 12.45 | 115.46 | 116.16 | 0.279 | 0.287 |
| $T_5$ | 100.66 | 102.73 | 10.83 | 11.40 | 113.66 | 114.06 | 0.298 | 0.305 |
| $T_6$ | 107.91 | 109.32 | 10.96 | 11.63 | 114.38 | 114.79 | 0.303 | 0.314 |
| $T_7$ | 110.21 | 112.21 | 12.94 | 13.48 | 115.84 | 116.36 | 0.317 | 0.327 |
| $T_8$ | 97.89 | 99.27 | 12.19 | 12.70 | 115.21 | 115.45 | 0.282 | 0.293 |
| $T_9$ | 111.91 | 114.87 | 12.37 | 12.86 | 116.08 | 116.60 | 0.289 | 0.298 |
| $T_{10}$ | 113.63 | 116.71 | 13.87 | 14.24 | 117.45 | 118.15 | 0.299 | 0.313 |
| $T_{11}$ | 112.77 | 115.53 | 13.18 | 13.50 | 116.38 | 116.88 | 0.314 | 0.329 |
| $T_{12}$ | 118.14 | 120.08 | 13.35 | 13.78 | 116.86 | 117.35 | 0.319 | 0.334 |
| $T_{13}$ | 120.38 | 121.30 | 14.43 | 15.02 | 117.73 | 118.28 | 0.322 | 0.344 |
| S.E.(m) ± | 0.69 | 0.87 | 0.17 | 0.26 | 0.24 | 0.26 | 0.006 | 0.004 |
| C.D. ($p$ = 0.05) | 2.03 | 2.56 | 0.49 | 0.79 | 0.70 | 0.77 | 0.018 | 0.013 |

### Conclusion
Our current results indicate the significant influence of FYM, inorganic fertilization and biofertilizer inoculation on different physico-chemical properties of soils. The appraised treatment combinations did not show any significant imprints on soil pH and EC during both the years. However, slight decrease in soil pH was observed under FYM amended plots. The incorporation of FYM, inorganics and bio-fertilizers imposed a significant change in soil bulk density, water holding capacity as well as soil porosity. In addition, a significant increase in available nutrients comprising N, P, K and Mo in soil was marked under T13 (40 kg P + 0.5 kg Mo + PSB + Rhizobium + FYM), receiving integrated application of organic and inorganic nutrient sources.

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