Effect of Phosphorus and Vermicompost on Growth and Productivity of Black gram (*Vigna mungo* L.)

Abstract

A field experiment was conducted at experimental farm, Department of Agronomy, A field experiment was conducted at experimental farm, Department of Agronomy, Faculty of Agriculture and Veterinary Sciences, Mewar University Gangrar, Chittorgarh (Rajasthan) during Rabi season of 2023-24 to effect of Phosphorus and vermicompost on growth and productivity by of black gram variety "Pratap Urd-1" was used in this study. The result revealed that the maximum plant height (50.25 cm), dry matter accumulation (13.25/plant), number of nodules per plant (40.15), fresh weight of nodules per plant (71.02 mg/plant), dry weight of nodules per plant (51.02 mg/plant), leaf area index (3.52) and yield parameter such as number of pods per plant (35.15), number of seed per pod (7.15), grain yield (11.85 q/ha), straw yield (22.45 q/ha) and biological yield (34.30 q/ha) with application of T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1}. The maximum net return (59501/ha) and B:C ratio (1.89) also recorded with T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-}**.**

Key words: - Productivity; Black gram; Vermicompost; Phosphorus; Nutrients

1. Introduction

Our country is predominantly vegetarian and pulses are the main source of quality protein and essential amino acids. Black gram (*Vigna mungo* L.) is important pulse crop among the grain legumes grown in India. It contains 24 % protein, 60 % carbohydrate, 1.3 % fat and is richest in phosphoricacid among the pulses being five to ten times richer than in others. It is commonly known as "urd" or "urd bean" (Singh *et al.* (2022). Black gram plays an important role in maintaining and improving the soil fertility through its ability to fix atmospheric nitrogen in the soil through root nodules which possesses *Rhizobium* bacteria. This imbalanced nutrient supply adversely affects the seed yield of black gram, soil health, and even the profit to the farmers (Laddha *et al*. 2006). The supply of phosphorus to legumes is more important than of nitrogen because, nitrogen is being fixed by symbiosis with *Rhizobium* bacteria (Singh and Singh, 2021). The beneficial effects of phosphorus on nodulation, growth, yield and general behavior of legume crop have been well established because it plays an important role in root development. Phosphorus application to legumes not only benefits the particular crop but also improves the soil nitrogen content for the succeeding non-legume crops requiring lower doses of nitrogen application (Yadav, 2011). Phosphorus stimulates seed setting, hastens maturity and enhanced protein content. It plays an important role in the nutrition of legumes and also improves biological nitrogen fixation and quality of grains (Kumar *et al.* 2009).

Vermicompost has been emerging as an important source in supplementing chemical fertilizer in agriculture in view of sustainable development after Rio Conference, vermicompost is a bio fertilizer enriched with all beneficial soil microbes and also contains all the essential plant nutrients like N, P and K (Patel *et al.* 2017). Vermicompost that is prepared through conventional method has standard values of total nitrogen: 0.94%, Phosphorous: 0.47% and potassium: 0.70% it is also enriched with various micronutrients such as Mg (0.46%), Fe (7563 ppm), Zn (278 ppm), Mn (475 ppm), B (34 ppm), Cu (27 ppm). Thus, eliminate usage of any further artificial chemical inputs. Due to absence of toxic enzymes, it is also eco-friendly and has beneficial effect on the biochemical activities of the soil. It also increases the quality, fertility and mineral content of the soil structure. It enhances soil aeration, texture and silt thereby reducing soil compaction (Serawat *et al.* 2018).

2. Materials and Methods

A field experiment was conducted during Rabi season of 2022-23 at experimental farm, Department of Agronomy, Faculty of Agriculture and Veterinary Sciences, Mewar University Gangrar, Chittorgarh (Rajasthan). Soil of the experimental field was sandy loam intexture, saline in reaction with a pH value of 7.6, poor in organic carbon (0.32%), deficient inavailable zinc (0.48 ppm) and iron (1.2 ppm) low in available nitrogen (176 kg/ha) and phosphorus (20.2 kg/ha) but medium in available potassium (320 kg/ha). The experiment was laid out in randomized block design with three replications consisting of nine treatments *viz.* The experiment was laid out in randomized block design with three replications and nine treatments *i.e.* T_1-Control, T_2-20 kg P_2O_5 ha^{-1}, T_3-40 kg P_2O_5 ha^{-1}, T_4-1.25 t vermicompost ha^{-1}, T_5-2.5 t vermicompost ha^{-1}, T_6-20 kg P_2O_5 ha^{-1} + 1.25 t vermicompost ha^{-1}, T_7-20 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1}, T_8-40 kg P_2O_5 ha^{-1} + 1.25 t vermicompost ha^{-1} and T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1}. The required quantities of fertilizers as per treatments were applied. The doses of NPK were applied in the form of urea, diammonium phosphate, murate of potash respectively. The half dose of nitrogen gives basal dose and remain two split doses after irrigation and full dose of phosphorus and potassium at basal dose. Vermicompost apply in field at field preparation before sowing.

3. Results and Discussion

3.1 Growth attributes

Data revealed (Table 1.0) at 35 DAS that the maximum plant height was recorded with T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} (29.85 cm). The minimum plant height recorded with control treatment (23.33 cm). At 50 DAS that the maximum plant height was recorded with T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} (42.78 cm). The minimum plant height recorded with control treatment (35.52 cm). At harvest that the maximum plant height was recorded with T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} (50.25 cm). The minimum plant height recorded with control treatment (44.88 cm). Similar findings also reported by Tagore *et al*. (2013), Gajera *et al.* (2014), Jha *et al.* (2015), Meena *et al*. (2016) and Singh *et al.* (2016).

Data revealed (Table 1.0) at 35 DAS that the maximum dry matter accumulation was recorded with T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} (4.89 g). The minimum dry matter accumulation recorded with control treatment (3.15 g). At 50 DAS that the maximum dry matter accumulation was recorded with T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} (9.85). The minimum dry matter accumulation recorded with control treatment (6.36 g). At harvest that the maximum dry matter accumulation was recorded with T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} (13.25 g). The minimum dry matter accumulation recorded with control treatment (9.45 g). this result also confirmed by Saxena *et al.* (2016), Mohammad *et al.* (2017), Kumar *et al*. (2017) and Nissa *et al.* (2017).

Data revealed (Table 2.0) at 40 DAS that the maximum number of nodules per plant was recorded with T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} (40.15), it was at par with T_8-40 kg P_2O_5 ha^{-1} + 1.25 t vermicompost ha^{-1} (38.63). The minimum number of nodules per plant recorded with control treatment (25.12). Data revealed at 40 DAS that the maximum fresh weight of nodules per plant was recorded with T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} (71.02 mg/plant), it was at par with T_8-40 kg P_2O_5 ha^{-1} + 1.25 t vermicompost ha^{-1} (68.63 mg/plant). The minimum fresh weight of nodules per plant recorded with control treatment (52.36 mg/plant). Data revealed at 40 DAS that the maximum dry weight of nodules per plant was recorded with T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} (51.02 mg/plant), it was at par with T_8-40 kg P_2O_5 ha^{-1} + 1.25 t vermicompost ha^{-1} (48.65 mg/plant). The minimum dry weight of nodules per plant recorded with control treatment (34.36 mg/plant). The increase in nodulation due to application of P might be due to P helps in early root development and formation of lateral fibrous and healthy roots. Similar results were reported by Rani *et al.* (2016) revealed that, the application of 40 kg P

ha^{-1} increased the number of nodules per $plant^{-1}$ over control. This might be due to better root development with increasing levels of P in black gram. Similar findings also reported by Patel *et al.* (2017), Verma *et al.*, (2017), Dubey *et al.* (2018), Masih *et al.* (2020) and Reddy and Dawson (2021).

3.2 Yield attributes and yield

Data revealed (Table 3.0) that the maximum number of pods per plant was recorded with T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} (35.15), it was at par with T_7-20 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} and T_8-40 kg P_2O_5 ha^{-1} + 1.25 t vermicompost ha^{-1} (33.20 and 32.02). The minimum number of pods per plant recorded with control treatment (20.25). Data revealed that the maximum number of seed per pod was recorded with T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} (7.15), it was at par with T_7-20 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} and T_8-40 kg P_2O_5 ha^{-1} + 1.25 t vermicompost ha^{-1} (6.85 and 6.65). The minimum number of seed per pod recorded with control treatment (5.05). These investigate also support by Sharma *et al.* (2012), Singh *et al.* (2015), Tiwari *et al.* (2015) and Rani *et al*. (2016).

Data revealed (Table 3.0 and Figure 1.0) that the maximum grain yield was recorded with T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} (11.85 q/ha), it was at par with T_7-20 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} and T_8-40 kg P_2O_5 ha^{-1} + 1.25 t vermicompost ha^{-1} (11.08 and 10.45 q/ha). The minimum grain yield recorded with control treatment (8.75 q/ha). Data revealed that the maximum straw yield was recorded with T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} (22.45 q/ha), it was at par with T_7-20 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} and T_8-40 kg P_2O_5 ha^{-1} + 1.25 t vermicompost ha^{-1} (20.12 and 19.86 q/ha). The minimum straw yield recorded with control treatment (16.02 q/ha). Data revealed that the maximum biological yield was recorded with T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} (34.30 q/ha), it was at par with T_7-20 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} and T_8-40 kg P_2O_5 ha^{-1} + 1.25 t vermicompost ha^{-1} (31.20 and 30.31 q/ha). The minimum biological yield recorded with control treatment (24.77 q/ha). Similar results were reported by Choudhary *et al*. (2017) that, the significant increase in straw of black gram due to phosphorus along with vermicompost. Sipai *et al*. (2016) concluded that, the straw yield of black gram increased with levels of P up to 40 kg ha^{-1}. In general, overall improvement in yield attributing characters because of P increased which helps to develop a more extensive root system and thus, enables the plant to extract more water and nutrients from soil depth. Similar data result reported by Khan *et al*. (2017), Mehera *et al.* (2022) and Singh *et al.* (2022).

3.3 Economics

Data revealed (Table 4.0) that the maximum cost of cultivation was recorded with T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} (31500 ₹/ha). The minimum cost of cultivation recorded with control treatment (24500 ₹/ha). The maximum gross return was recorded with T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} (91001 ₹/ha). The minimum gross return recorded with control treatment (62414 ₹/ha). The maximum net return was recorded with T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} (59501 ₹/ha). The minimum net return recorded with control treatment (37917 ₹/ha). The maximum B:C ratio was recorded with T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} (1.89). The minimum B:C ratio recorded with control treatment (1.55). Similar result also found by Kumar *et al.* (2017), Venkatarao (2017), Gohain and Jamir (2022) and Singh *et al.* (2022)

Conclusion

The findings of present investigation revealed that significant effect of phosphorus and vermicompost application on the growth, yield and economics of the black gram. Among different T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} registered the maximum productivity with higher net return. So, it was concluded that the treatment T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1} superior among all treatments.

Table 1.0 Effect of phosphorus and vermicompost on plant height and dry matter accumulation at different days interval of black gram

Treatments	Plant height (cm)			Dry matter accumulation (g)		
	35 DAS	35 DAS	35 DAS	35 DAS	90 DAS	At harvest
T_1-Control	23.33	35.52	44.88	3.15	6.36	9.45
T_2-20 kg P_2O_5 ha^{-1}	24.66	36.85	45.25	3.22	7.02	10.45
T_3-40 kg P_2O_5 ha^{-1}	25.15	37.12	46.14	3.35	7.36	10.85
T_4-1.25 t vermicompost ha^{-1}	27.02	37.96	46.78	3.48	7.58	11.30
T_5-2.5 t vermicompost ha^{-1}	27.85	38.78	47.68	3.75	7.98	11.85
T_6-20 kg P_2O_5 ha^{-1} + 1.25 t vermicompost ha^{-1}	27.52	38.52	47.02	3.58	7.75	11.45
T_7-20 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1}	29.05	39.44	49.05	4.30	8.78	12.52
T_8-40 kg P_2O_5 ha^{-1} + 1.25 t vermicompost ha^{-1}	28.02	39.02	48.15	4.15	8.50	11.65
T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1}	29.85	42.78	50.25	4.89	9.85	13.25
S. Em. (±)	0.61	1.28	0.71	0.25	0.46	0.55
C.D. at 5%	1.85	3.86	2.13	0.76	1.39	1.64

Table 2.0 Effect of phosphorus and vermicompost on growth attributes of black gram

Treatments	Number of nodules per plant at 40 DAS	Fresh weight of nodules per plant at 40 DAS (mg/plant)	Dry weight of nodules per plant at 40 DAS (mg/plant)
T_1-Control	25.12	52.36	34.36
T_2-20 kg P_2O_5 ha^{-1}	31.63	58.63	40.12
T_3-40 kg P_2O_5 ha^{-1}	34.96	62.14	43.25
T_4-1.25 t vermicompost ha^{-1}	29.36	56.78	37.12
T_5-2.5 t vermicompost ha^{-1}	32.25	60.45	40.74
T_6-20 kg P_2O_5 ha^{-1} + 1.25 t vermicompost ha^{-1}	33.45	61.96	42.28
T_7-20 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1}	35.15	65.74	45.96
T_8-40 kg P_2O_5 ha^{-1} + 1.25 t vermicompost ha^{-1}	38.63	68.63	48.65
T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1}	40.15	71.02	51.02
S. Em. (±)	0.51	0.80	0.81
C.D. at 5%	1.55	2.39	2.45

Table 3.0 Effect of phosphorus and vermicompost on yield attributes and yield of black gram

Treatments	Number of pods per plant	Number of seed per pod	Grain yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)
T_1-Control	20.25	5.05	8.75	16.02	24.77
T_2-20 kg P_2O_5 ha^{-1}	26.36	5.75	9.15	18.10	27.25
T_3-40 kg P_2O_5 ha^{-1}	28.02	6.00	9.45	18.40	27.85
T_4-1.25 t vermicompost ha^{-1}	30.15	6.15	9.52	18.85	28.37
T_5-2.5 t vermicompost ha^{-1}	32.32	6.32	9.84	19.18	29.02
T_6-20 kg P_2O_5 ha^{-1} + 1.25 t vermicompost ha^{-1}	31.45	6.45	9.90	19.00	28.9
T_7-20 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1}	33.20	6.85	11.08	20.12	31.20
T_8-40 kg P_2O_5 ha^{-1} + 1.25 t vermicompost ha^{-1}	32.02	6.65	10.45	19.86	30.31
T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1}	35.15	7.15	11.85	22.45	34.30
S. Em. (±)	1.05	0.17	0.47	0.88	1.27
C.D. at 5%	3.17	0.53	1.42	2.65	3.80

Table 4.0 Effect of phosphorus and vermicompost on economics

Treatment	Cost of cultivation (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio
T_1-Control	24500	62414	37914	1.55
T_2-20 kg P_2O_5 ha^{-1}	25500	65860	40360	1.58
T_3-40 kg P_2O_5 ha^{-1}	26500	71770	45270	1.71
T_4-1.25 t vermicompost ha^{-1}	27000	72333	45333	1.68
T_5-2.5 t vermicompost ha^{-1}	29500	80638	51138	1.73
T_6-20 kg P_2O_5 ha^{-1} + 1.25 t vermicompost ha^{-1}	28000	75358	47358	1.69
T_7-20 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1}	30500	82268	51768	1.70
T_8-40 kg P_2O_5 ha^{-1} + 1.25 t vermicompost ha^{-1}	29000	82870	53870	1.86
T_9-40 kg P_2O_5 ha^{-1} + 2.5 t vermicompost ha^{-1}	31500	91001	59501	1.89

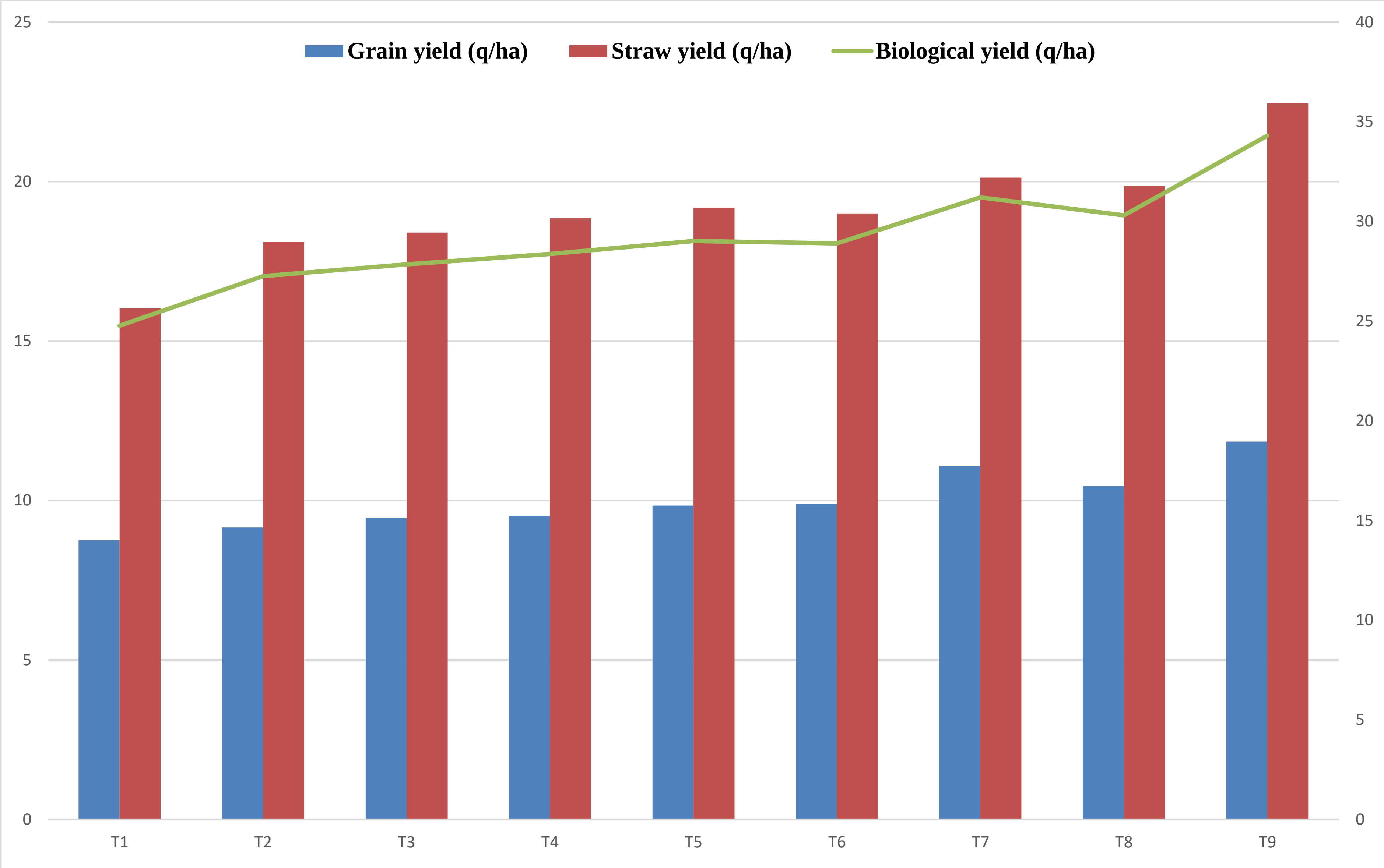

Figure 1.0 Effect of phosphorus and vermicompost on yields of black gram

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