Original Research Article

Effect of Different Levels of NPK and Zinc on Soil Health in Black gram (*Vigna mungo* L.)

ABSTRACT

An experiment was conducted during in *Zaid* season (March 2022-June 2022) to study the ~~"E~~effect of ~~Different~~ different ~~Levels~~ levels of NPK and Zinc on ~~Soil~~ soil ~~Health~~ health in ~~Black~~ black gram (*Vigna mungo* L.)" on central research farm of Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. A randomized block design was used to set up the experiment, with three levels of NPK (0%, 50%, and 100% NPK) and three levels of zinc (0%, 50%, and 100% zinc). The outcome demonstrates that inorganic fertilizer application had a non-significant ~~(BD, PD, pH, EC and OC)~~effect on soil physical-chemical parameters(BD, PD, pH, EC and OC)and significant increase in pore space, water holding capacity, available nitrogen, phosphorus, potassium and zinc in treatment T_9 [NPK at 100% + zinc at 100%] than other treatments.

Key word: NPK, Soil health, Zincetc.

Comment [S1]: Add 3-5 more key words

Introduction

Comment [S2]: Write about the crop with response to impact of nutrients

A natural body made up of solids (minerals and organic matter), liquid, and gases, soil is defined as "a natural body that occurs on the land surface, occupies space, and is ~~characterised~~characterized by one or both of the following: horizons, or layers, that are distinguishable from the initial material as a result of additions, losses, transfers, and transformations of energy and matter, or the ability to support rooted plants in a natural environment." As per the United States Department of Agriculture (USDA).

Fertilizers containing nitrogen are crucial for raising crop productivity and enhancing soil fertility. The crop's biomass and grain production rise when nitrogen fertilizer is used. It increases the soil's residual N by 18 to 34%. The effects of sole residue integration or combination with N fertilizer on plant development and production as well as

the ~~Physico~~physico-chemical ~~characteristics~~ properties of the soil are favorable. A crucial component that plants need is nitrogen. It enhances the amount of protein in pulses and the growth and development of all biological tissues. The synthesis of amino acids, chlorophyll, and other organic chemicals that serve as the building blocks of proteins as well as promoting plant growth make nitrogen one of the most important nutrients (Sarvade et al., 2019; Ghosh *et al.*, 2022; Thakur et al., 2023).

One of the three main macronutrients that plants need for the greatest growth and development is phosphorus (P), which is a crucial nutrient element. Photosynthesis, respiration, energy storage, root growth, cell elongation, and crop quality are all impacted by phosphorus. Plants with deficiencies may have erect, thin stems that are wiry, and their leaves may turn a bluish green tint. The growth of root nodules is boosted, and Rhizobium activity is improved. As a result, it aids in the root nodules' ability to fix more nitrogen from the atmosphere.(Ghosh *et al.*, 2022).

It has been said that potassium is a "quality element" and a "master cation" that is essential for the growth and development of the plant. Numerous crucial enzymes, including those involved in protein synthesis, sugar transport, disease resistance, drought tolerance, N and C metabolism, and photosynthesis, are activated by it. Potassium is crucial for improving quality and raising output (Subba Rao and Tilak, 1977; Balasubramanian, 1999; Gangwar *et al.*, 2013; Pathariya *et al.*, 2022).

Formatted: Font: Italic

Formatted: Font: Italic

The most deficient micronutrient in Indian soils is zinc, which is also considered to be the third-most crucial component for crop productivity after nitrogen and phosphorus. Due to zinc's significant effects on yield qualities and its significance in metabolic processes, the rise in yield may be explained by these factors. According to Hafeez Z *et al.* (2013), zinc contributes to the synthesis of auxin, the activation of dehydrogenase enzymes, and the stabilization of ribosomal fractions.

Materials and Methods

A field experiment to study theEffect of Different Levels of NPK and Zinc on Soil Health in Black Gram (*Vigna mungo* L.) was conducted at central research farm department of Soil Science and Agricultural Chemistry, SHUATS, Prayagraj. This area normally falls under the subtropical belt in the southeast of Uttar Pradesh, where the summers are quite hot and the winters are moderately chilly. The location's highest temperature occasionally drops below 4^0C

or 5^0C and can reach up to 46^0C to 48^0C. Between 20 to 94% the relative humidity was present. Around 1100 mm of rain precipitation occurs yearly on average in this region. The experimental site is located 98 meters above sea level at 25^0 57'N latitude and 81^0 59'E longitude. The soil in the experimental region is classified as Inceptisol, and its texture is sandy loam (sand content: 62.71%; silt content: 23.10%; clay content: 14.1%). The experiment was set up using a ~~randomised~~randomized block design (RBD), which included nine treatments and three doses of NPK (0, 50, and 100%) and Zn (0, 50, and 100%). Three replicates of the treatment have been made. There were 27 plots in total. Black gram~~me~~ was ~~planted~~ sownin 2 x 2 m plots during the *Z~~z~~aid* season, with a spacing of 30 x 10 cm. ~~Using a soil auger, s~~Soil samples were taken from each plot both before and after the experiment at a depth of 0–30 cmby using a soil auger. The soil samples were air-dried, put through a 2 mm screen, and then had their different soil qualities examined. M.L. Jackson (1958) assessed the soil pH with a pH meter, and Wilcox (1950) measured the electrical conductivity (EC) with a conductivity meter. The available nitrogen (N) was calculated using the Subbiah and Asija method (1956), the phosphorus (P) was calculated using the Olsen et al. method (1954), the potassium (K) was calculated using the Toth and Prince method (1949), and the zinc (Zn) was estimated using the Lindsay and Norvell method (1978). The soil organic carbon (SOC) was estimated using the Walkley and Black method (1947).

Formatted: Font: Italic

RESULT AND DISCUSSION

Comment [S3]: This part is not written well. Need to write results and discussion in detail

Tables 1, 2, and 3 show the impact of NPK and Zn on soil properties. The use of NPK and Zn to soil properties was demonstrated by the findings.

Physico-chemical properties

The response of NPK and Zn levels on the soil's bulk density and particle density was found to be non-significant. The maximum bulk density of soil was found 1.288 Mg m^{-3} and 1.296 Mg m^{-3}in treatment T_9 (NPK @ 100% + Zn @ 100%)and the minimum was 1.243 Mg m^{-3} and 1.250 Mg m^{-3}found at soil depths of 0-15 and 15-30 cmin treatment T_1 (NPK @ 0 % + Zn @ 0 %).The maximum particle density was 2.518 Mg m^{-3} and 2.526 Mg m^{-3}found in T_9 (NPK @ 100 % + Zn @ 100 %) and the minimum was 2.475 Mg m^{-3} and 2.482 Mg m^{-3} found at soil depths of 0-15 and 15-30 cmin treatment T_1 (NPK @ 0 % + Zn @ 0 %). The maximum organic

carbon of soil was found 0.407 and 0.396 in T_9 (NPK @ 100 % + Zn @ 100 %) andminimum was measured0.375 mg kg^{-1} and 0.368 mg kg^{-1} at soil depths 0-15 and 15-30cm in treatment T_1(NPK @ 0 % + Zn @ 0 %).The maximum availablenitrogen324.78 kg ha^{-1} and 318.54 kg ha^{-1}, available phosphorus23.48 kg ha^{-1} and 20.86 kg ha^{-1} were found in T_9 (NPK @ 100 % + Zn @ 100 %)at soil depths 0-15 and 15-30cm.Themaximum potassium availability insoil was measured 210.45 kg ha^{-1} and 206.72 kg ha^{-1}at 0-15 and 15-30 cm in T_9 (NPK @ 100 % + Zn @ 100 %) while maximum availability of zinc was measured 0.354 mg kg^{-1} and 0.359 mg kg^{-1}at 0-15 and 15-30 cm in T_9 (NPK @ 100 % + Zn @ 100 %).

Conclusion

According to the trial, the fertilizers [Urea (46% N), + SSP (16% P_2O_5), + MOP (60% K_2O), + ZnSO4 (36.5% Zn)] used at different levels of NPK and Zn from different sources produced the best results in treatment T_9 (NPK @ 100% + Zn @ 100%), which was followed by treatment T_8. In T_9, the soil health parameters retained the appropriate soil properties. Therefore, for increased farm revenue and sustainable agriculture, it might be advised that farmers receive the finest combination treatment (T_9).

Table 1: Effect of NPKand Zn on soil physical properties

Treatment	BD (Mg m^{-3})		PD (Mg m^{-3})		Pore space (%)		Water holding capacity (%)	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
NPK @ 0 % + Zn @ 0 %	1.243	1.250	2.475	2.482	41.60	37.42	34.55	32.48
NPK @ 0 % + Zn @ 50 %	1.248	1.255	2.480	2.487	41.86	37.60	35.07	33.60
NPK @ 0 % + Zn @ 100 %	1.254	1.262	2.486	2.492	42.08	38.15	35.76	35.18
NPK @ 50 % + Zn @ 0 %	1.260	1.268	2.490	2.497	42.42	39.08	36.04	35.26
NPK @ 50 % + Zn @ 50 %	1.265	1.274	2.495	2.504	43.88	39.72	36.61	35.92
NPK @ 50 % + Zn @ 100 %	1.272	1.278	2.501	2.509	44.22	40.52	37.30	36.22
NPK @ 100 % + Zn @ 0 %	1.276	1.285	2.507	2.515	44.61	41.18	38.84	36.09
NPK @ 100 % + Zn @ 50 %	1.282	1.290	2.512	2.520	45.60	41.56	39.51	37.85
NPK @ 100 % + Zn @ 100 %	1.288	1.296	2.518	2.526	46.58	42.27	40.26	38.71
F-Test	NS	NS	NS	NS	S	S	S	S
S.Ed. (±)	-	-	-	-	0.62	0.48	0.68	0.55
C.D. at 0.5%	-	-	-	-	1.32	0.99	2.06	1.65

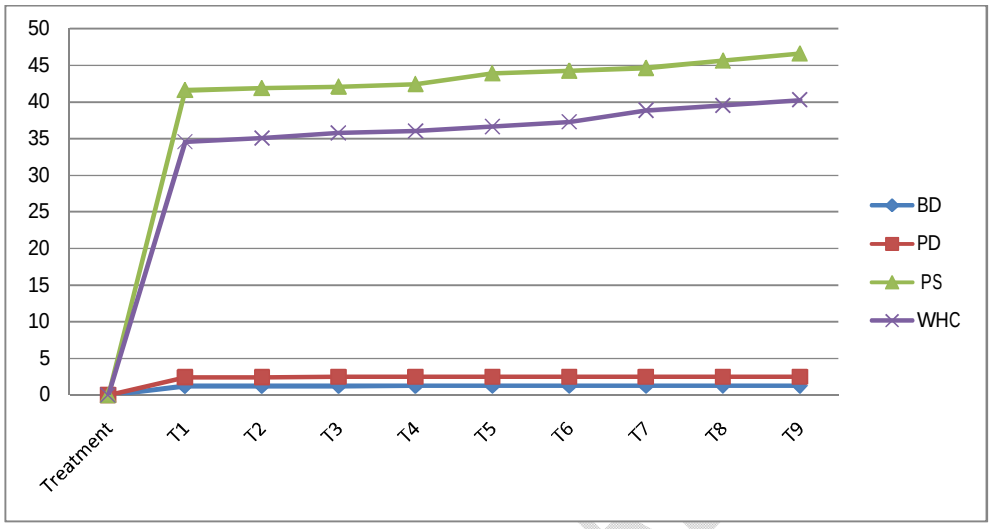

Fig. 1 Effect of different levels of NPK and Zn on BD, PD, PS, and WHC of soil depth (0-15 cm)

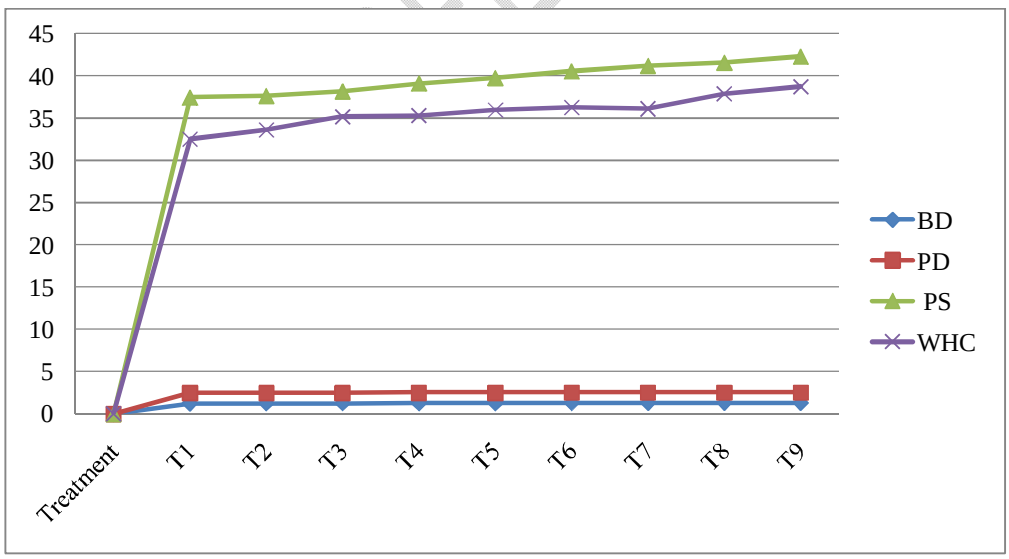

Fig. 2 Effect of different levels of NPK and Zn on BD, PD, PS, and WHC of soil depth (15-30 cm)

Table 2: Effect of NPKand Zn on soil chemical properties

Treatment	pH		EC (dSm^{-1})		Organic carbon (%)	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
NPK @ 0 % + Zn @ 0 %	6.50	6.56	0.442	0.446	0.375	0.368
NPK @ 0 % + Zn @ 50 %	6.57	6.62	0.447	0.449	0.380	0.372
NPK @ 0 % + Zn @ 100 %	6.64	6.68	0.451	0.453	0.384	0.376
NPK @ 50 % + Zn @ 0 %	6.70	6.75	0.454	0.456	0.389	0.379
NPK @ 50 % + Zn @ 50 %	6.76	6.82	0.458	0.463	0.392	0.381
NPK @ 50 % + Zn @ 100 %	6.81	6.86	0.462	0.467	0.395	0.386
NPK @ 100 % + Zn @ 0 %	6.89	6.91	0.465	0.471	0.398	0.390
NPK @ 100 % + Zn @ 50 %	6.94	6.97	0.470	0.475	0.403	0.393
NPK @ 100 % + Zn @ 100 %	7.06	7.14	0.474	0.480	0.407	0.396
F-Test	NS	NS	NS	NS	NS	NS
S.Ed. (±)	-	-	-	-	-	-
C.D. at 0.5%	-	-	-	-	-	-

Table 3: Effect of NPK and Zn on soil chemical properties

Treatment	**Available Nitrogen (kg ha^{-1})**		**Available Phosphorus (kg ha^{-1})**		**Available Potassium (kg ha^{-1})**		**Available Zinc (mg kg^{-1})**	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
NPK @ 0 % + Zn @ 0 %	292.61	288.34	16.41	14.45	185.24	181.56	0.288	0.290
NPK @ 0 % + Zn @ 50 %	293.47	289.06	17.27	16.63	187.42	184.80	0.340	0.352
NPK @ 0 % + Zn @ 100 %	295.38	291.88	17.89	14.85	190.59	187.52	0.354	0.359
NPK @ 50 % + Zn @ 0 %	299.70	293.62	22.18	18.12	192.10	189.77	0.326	0.332
NPK @ 50 % + Zn @ 50 %	302.64	296.29	20.25	17.26	194.54	191.89	0.348	0.337
NPK @ 50 % + Zn @ 100 %	306.82	300.50	18.52	15.08	197.70	194.42	0.336	0.343
NPK @ 100 % + Zn @ 0 %	312.04	306.23	23.48	20.86	202.83	198.61	0.320	0.347
NPK @ 100 % + Zn @ 50 %	319.32	312.35	23.02	19.43	206.97	202.56	0.328	0.324
NPK @ 100 % + Zn @ 100 %	324.78	318.56	22.72	17.89	210.45	206.72	0.343	0.329
F-Test	S	S	S	S	S	S	S	S
S.Ed. (±)	2.18	1.80	1.10	0.68	1.75	1.41	0.12	0.15
C.D. at 0.5%	4.42	3.62	2.23	1.40	3.28	1.85	0.27	0.32

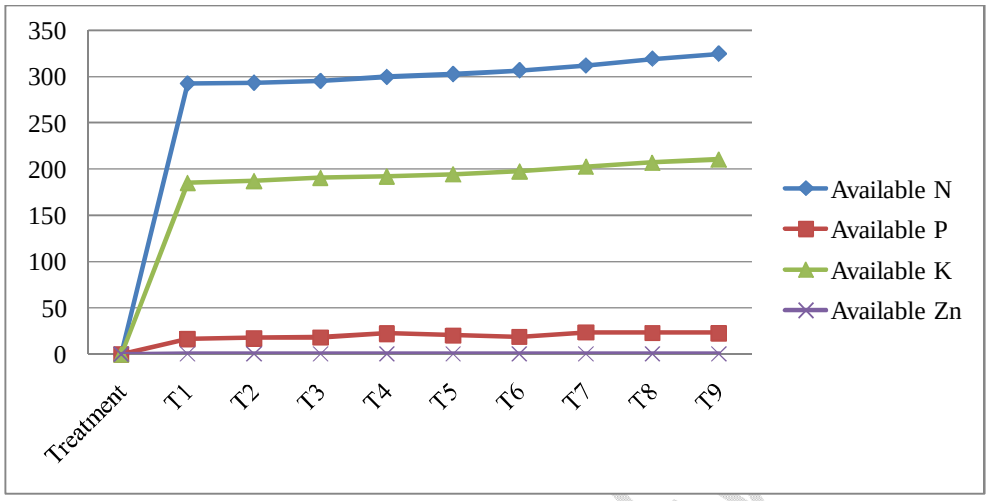

Fig. 3 Effect of different levels of NPK and Zn on Available N, P, K, and Zn of soil depth (0-15 cm)

Comment [S4]: Give units on graph axis

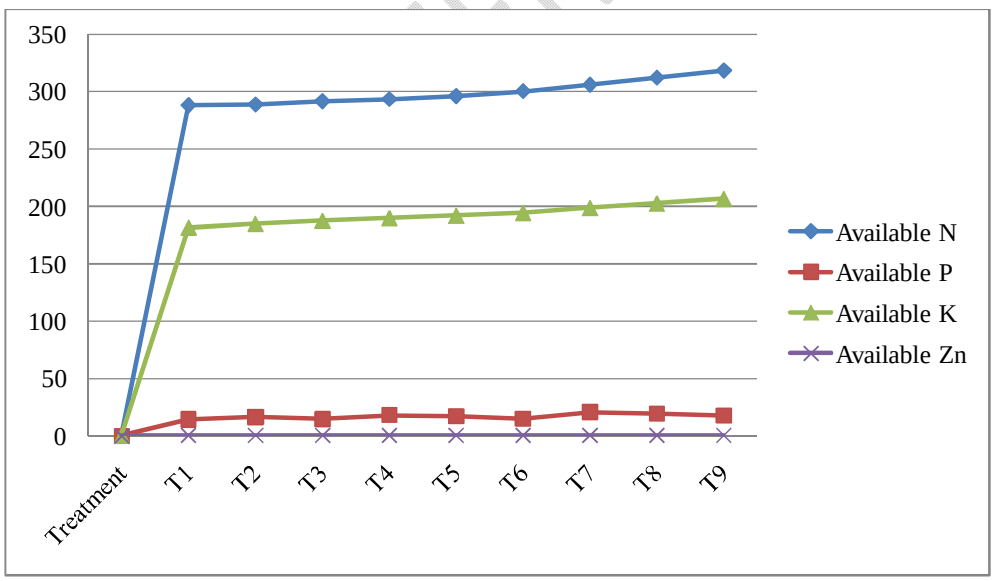

Fig. 4 Effect of different levels of NPK and Zn on Available N, P, K, and Zn of soil depth (15-30 cm)

Comment [S5]: Give units on graph axis

References

Balasubramanian(1999) Role of phosphorus on the interaction of vesicular arbuscular mycorrhiza (Glomusmosseae) and root-knot nematode (Meloidogyne incognita) on black gram (Vigna mungo*). Indian Journal of ~~Nematology.,~~Nematology.***29**(1): 105-108.

Fisher, R.A. (1960) Statistical methods and scientific induction. *Journal of the royal statistical society series.***17**: 69-78.

Gangwar, A., Jadhav, T.A., Sarvade, S. (2013). Productivity,nutrient removal and quality of urdbean varieties plantedon different dates. *Bioinfole*. **10(1A)**:139-142.

Ghosh, K., Swaroop, N., Thomas, T. and Jadhav, R. (2022) Soil Physico-chemical Properties as Influenced by Combined use of NPK and Zinc at Varying Levels under Black gram (*Vigna mungo* L.) Cultivation in an Inceptisol of Prayagraj, Uttar Pradesh, India. *International Journal of Plant & Soil Science.***34**(22): 1172-1182.

Hafeez, Z. and Khanif, Y. M. (2013) Role of Zinc in plant nutrition-A Review-*American Journal of Experimental Agriculture*. **3**(2): 374–391.

Jackson, M. L. (1958)*Soil chemical analysis Prentice Hall of India Ltd*. New Delhi. 219-221.

Lindsay, W. L. and Norvell, W. A. (1978) Development of DTPA soil test for zinc, iron, manganese and copper. *Soil Science Society of America Journal*~~.~~**42**: 421-428.

Muthuvel, P., Udayasoorian, C., Natesan, R. and Ramaswamy, P. P. (1992) Introduction to Soil Analysis, *Tamil Nadu Agricultural University Coimbatore*-641002.

Olsen, S. R., Cole, C. V., Watanabe, F. S. and Dean, L. A., (1954) Estimation of available phosphorus in soils by extraction with sodium bicarbonate ($NaHCO_3$), *U.S.D.A. Circular*. **939**: 1-19.

Pathariya, P., Dwivedi, B.S., Dwivedi, A.K., Thakur, R.K., Singh, M. and Sarvade, S. (2022). Potassium balance under soybean–wheat cropping system in a 44-year old long-term fertilizer experiment on a Vertisol. *Communications inSoil Science and Plant Analysis.***53(2)**: 214–226.

Sarvade, S., Gautam, D.S., Upadhyay, V.B., Sahu, R.K., Shrivastava, A.K., Kaushal, R., Singh, R. and Yewale, A.G. (2019). Agroforestry and soil health: an overview. In Dev,

Comment [S6]: Follow journal patern

Formatted: Font: Bold

Formatted: Font: Italic

Formatted: Font: Bold

Formatted: Font: Bold

Formatted: Indent: Left: 0", Hanging: 0.59"

Formatted: Font: Italic

Formatted: Font: Bold

Formatted: Font: Bold

Formatted: Indent: Left: 0", Hanging: 0.49"

I, Ram, A, Singh, R, Kumar, D, Kumar, N, Chaturvedi, OP, Handa, AK and Uthappa, AR (eds), Agroforestry for Climate Resilience and Rural Livelihood. Jodhpur, India: Scientific Publishers India, pp. 275–297.

Subba Rao and Tilak, A. (1977) in Biochemical Methods for Agricultural Sciences, Wiley Eastern Limited, New Delhi, pp. 26-27.

Subbiah, B. V. and Asiija, E. C. (1956)A rapid procedure for estimation of available nitrogen in soil. *Current Science*.,**25**(8): 259-260.

Thakur,R.K., Bisen,N.K., Shrivastava,A.K., Rai,S.K., Sarvade,S. (2023),Impact of integrated nutrient management on crop productivity and soil fertility under rice (*Oryza sativa*)–chickpea (*Cicer arietinum*) cropping system in Chhattisgarh plain agro-climatic zone. *Indian Journal of Agronomy*,**68** (1): 9-13.

Toth, S. J. and Prince, A. L. (1949) Estimation of cation exchange capacity and exchangeable Ca, K and Na content of soil by flame photometer technique. *Soil Sci.*,**67**: 439-445.

Walkley, A. and Black, I. A., (1947) Estimation of soil organic carbon by the chromic acid titration method. *Soil Science*. 47: 29-38.

Wilcox, L. V., (1950) Electrical conductivity Am. water work, Association 42: 775-776.

Formatted: Font color: Black

Formatted: Font: Bold

Formatted: Font: Bold

Formatted: Font: Bold

Formatted: Font: Italic

Formatted: Font: Italic

Formatted: Font: Italic

Formatted: Font: Bold