Research Article

Biozote-N performance in peas production under the influence of compost application

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Abstract

The major challenge faced by the smallholder farmers of Balochistan is low soil fertility and productivity. Recently, more emphasis is being inflicted on sustainable agriculture and the use of biofertilizer is considered as one of the main driving factors for it. For this purpose, a field study was carried out at experimental station of Agriculture Research Institute Sariab Quetta during 2015-16. The Biozote-N was investigated in five set of treatments including T₁ = control (Recommended dose of PK Fertilizer), T₂ = Biozote-N, T₃ = Biozote-N + T₁, T₄ = Compost @ 5 t ha⁻¹ + T₁ and T₅ = Biozote-N + T₄ which based in Randomized Complete Block Design with four replications. The results showed that Biozote-N in combination with compost and recommended PK fertilizer (T₅) produced maximum pod length (6.10 cm), pod yield (3.40 ton ha⁻¹), number of nodules plant⁻¹ (457), number of effective nodules plant⁻¹ (221), dry root biomass (4.72 g plant⁻¹) and shoot dry biomass (23.60 g plant⁻¹) followed by the treatment having compost @ 5 t ha⁻¹ + recommended PK fertilizer (T₄) along with greater leaf macro and micro nutrients concentration. There was highly significant correlation among pea traits and leaf nutrient concentration which demonstrate that improvement in pea growth and yield was due to increased nutrient accumulation. Consequently, it is suggested that the integration of Biozote-N with compost and inorganic fertilizer have improved pea crop performance that can further be tested in the field at various locations of the province and is proved as good source of biofertilizer.

Keywords: Biofertilizer; Biozote-N; Compost; Leaf nutrient conc.; NPK fertilizer; Pea; Yield

Introduction

Green peas (*Pisum sativum*) is one of the world's most famous vegetables that belong to family leguminosae and is used in different foods cuisine globally. Nutritionally, pea is a proteinaceous vegetable enrich with >21% protein and is a rich source of minerals like

phosphorus, potassium, calcium and vitamins particular A and C. it also contain carbohydrates and amino acids and antioxidants in sufficiency range [1]. Globally, among the top ten peas producing countries China is the first larger peas producer with 10821 thousand tones leading to 61% of

world's production followed by India with global production of 3997 thousand tonnes and United States of America (USA) has contribution of 2% of world peas production and ranking third position. While Pakistan stand in ninth position with production of 122 thousand tonnes [2]. In Pakistan, the total area under peas cultivation was 22436 hectares with production of 144422 tonnes while the province wise contribution indicate that area and production of peas in Punjab was 17644 hectares and 112267 tonnes, Sindh was 1869 ha and 7368 tonnes, Khyber Pakhtunkhwa was 1852 ha and 12501 tonnes and Balochistan was 1071 ha and 12286 tonnes [3].

In developing countries including Pakistan, the main limiting factor in agriculture production is the soil infertility which has particularly affected small farmers having poor resources. There is little benefit to farmers in respect of improved crop varieties and other cultural practices before the refurbishment of soil fertility. Because, the availability of nutrients in balanced quantities is prerequisite for obtaining optimum crop growth [4]. There are number of approaches available to be used for effective refurbishment of soil fertility including use of resource conservation technologies, best management practices, use of biofertilizers and compost that all leading to enhance inputs efficiency [5].

The centuries old nutrient management is the use of organic fertilizer which originates from plants' materials like agricultural wastes i.e. crop residues, food processing wastes, kitchen wastes and animal's wastes like manures i.e. farmyard manure and poultry manure. These wastes can be converted into useful organic fertilizer through process of biodegradation called composting [6]. Such organic fertilizer has many fold functions in maintaining soil quality and health. It improves soil structure, enhance soil microbial activities, supply nutrients in available form, increase soil moisture retention, regulate overall soil biogeochemical processes that results in restoration of soil fertility. Together with that,

it supply and build up soil organic matter and work as chelating agent to protect nutrients from adsorption on soil matrix under both calcareous and acidic soil [7]. However, to apply organic fertilizer like compost on large scale is a challenge that require further intensification of best management practices encompassing the INM (integrated nutrient management) so that eco-friendly, cost-effective and sustainable nutrient management can be achieved [6].

For sustainable agriculture, biofertilizer is considered as one of the innovative tools to ensure input utilization in an efficient manner that result in higher crop yield with greater nutrients accumulation [8,9]. Different agriculturally important and beneficial microorganisms are used technologically in the development of biological fertilizer which is commonly known as biofertilizer [10, 11]. The concept of biofertilizer was brought firstly in 1834 by J.B. Boussingault who was French agriculture chemist indicated that the cultivation of leguminous crops results in buildup of soil nitrogen [12]. Other Dutch scientists [13, 14] recognized the concept of BNF (biological nitrogen fixation) and later on Noble F. and Hiltner first time formed inoculum of rhizobia as biofertilizer called Nitragin during 1896 while some other scientists contributed in the development of commercial biofertilizer and founded the first stone of sustainable agriculture [12, 15]. It is comprised of living microbes such as bacteria, blue-green algae and fungi when applied as biofertilizer on seeds/plant roots or directly mixed in the soil they form colonization interiorly and/or exteriorly and make nutrients available to plants and also secreted some plant growth promoting substances leading to improve soil fertility and increase crop yield [16-18].

The use of nitrogen fixing biofertilizer can increase yield of leguminous crops and the bacteria used in such biofertilizer might be rhizobium and bradyrhizobium [19]. Seed treatment of soybean with N-fixing inoculum enhanced green pod yield and soil carbon contents with 80% nitrogen requirement was

met through BNF [20]. According to Egamberdiyeva [21] that the application of biofertilizer function in soil by keeping nutrient steadiness in the form of N, P and K accumulation in the soil separately. It is reported by Galloway [22] that 90-130 Tg N year⁻¹ is estimated to be fixed naturally through process of biological nitrogen fixation globally and an estimate of 107 Tg N year⁻¹ reported by Boyer *et al.* [23]. In addition, Bhattacharyya [12] recently estimated 140 Tg N year⁻¹ of biological nitrogen fixation on land. Furthermore, Ngetich *et al.* [6] has stated that grain leguminous crop can fix approximately 48-300 kg N ha⁻¹ through BNF in a season.

In the developed countries, biofertilizers are developed and applied for both legumes and non-legumes crops on large scale whereas it also getting pace in developing countries. Pakistan is an agricultural country and its economy depends largely on agricultural products where the use of biofertilizers on different crops are limited and accounted to less than 2% of total chemical fertilizer consumption [24]. However, the existing potential for biofertilizer application is substantially high which is necessary for ensuring eco-friendly and sustainable agriculture system. Presently, huge amount of Rs. >100 billion are spent on the import as well as on production of 8.41 m tons of chemical fertilizer [25]. In Pakistan it is estimated that Rs. 10 billion year⁻¹ can be saved if biofertilizer contribute only 10% of chemical fertilizers. In Pakistan the first biofertilizer viz “Bej ka tika” was produced by Ayub Agriculture Research institute (AARI) in 1965 while another biofertilizer called “Bio power” was developed by NIBGE (National Institute for Biotechnology and Genetic Engineering) and PAEC (Pakistan Atomic Energy Commission) in 1996 and Biozote was developed by NARC (National Agriculture Research Center) in 1998. Similarly, biofertilizer named “Rice Biofert” produced by University of Agriculture Faisalabad (UAF) and “Humiphos Biophos” was introduced by CIIT in 2010. In Balochistan,

these biofertilizers have not been evaluated on various crops for their effects on soil fertility and crop yield so far. So, in this study, the Biozote-N was tested on peas aiming to investigate the performance of Biozote-N on peas integrated with compost under agro-ecological condition Quetta and to enhance the biological nitrogen fixation for meeting the N needs of peas.

Materials and methods

Biozote is a biofertilizer developed by National Agriculture Research Center (NARC), Islamabad in 1998 and have three types such as Biozote-N, Biozote-P and Biozote-Max. Biozote-N is nitrogen fixer for legume crops and has potential to increase legume yield by 20-25% and can furnish 20-25 kg N ha⁻¹ for succeeding crop. It has not been tested yet under Balochistan condition. For this purpose, a field study was carried out at experimental station of Agriculture Research Institute Sariab Quetta during 2015-16. The Biozote-N was investigated in five set of treatments including T₁ = control (Recommended dose of PK Fertilizer), T₂ = Biozote-N, T₃ = Biozote-N + T₁, T₄ = Compost @ 5 t ha⁻¹ + T₁ and T₅ = Biozote-N + T₄ which based in Randomized Complete Block Design with four replications.

Seed treatment with Biozote-N

Biozote-N (rhizobium inoculum-TAL 169) was purchased from NARC, Islamabad and pea seeds of Olympia variety was obtained from local market. For seed inoculation, jaggery solution was prepared by dissolving jaggery @ 250 g L⁻¹ then pea seeds were moistened with it and Biozote-N inoculum was applied on them in a thin film. The seeds were then placed in the shed for drying [26]. After drying, the inoculated seeds were used for sowing.

Compost making

Compost was prepared from farmyard manure (FYM) using windrow technique as described by Rynk [27]. The size of windrow was kept by 5'x4'x30' (width x height x length) and C:N ratio was maintained as 30:1 by mixing wheat straw with FYM. Approximately 50 to 75% water contents were retained throughout

composting processes by adding more water intermittently as well as mixing the windrow weekly or after 10 days regularly to ensure proper aeration and release of gasses. The windrow was covered with polythene sheets to conserve moisture and heat. The composting period comprised of 4 months (i.e. July to October 2015) including one month of curing which was ready for application at the time of pea sowing.

Experimental

Seed bed was prepared as per agronomic procedure keeping plot size by 42 m² (6m x 8m) with total of 20 plots. The recommended dose of phosphatic and Potassic fertilizer was applied @ 80 and 40 kg ha⁻¹ using Single super phosphate (SSP) and sulphate of potash (SOP) at the time of sowing while Compost was used @ 5 ton ha⁻¹ according to the set treatments. The inoculated Olympia pea seeds were sown @ 60 kg ha⁻¹ by hand drill with row to row distance of 60 cm. Plant population in each plot was maintained through thinning. While, irrigation, weeding and hoeing was carried out as per requirement of the pea crop. For data collection, five plants were randomly selected in each treatment. When crop reached to maturity and after pods harvest, these selected plants were uprooted and roots were washed carefully with tap water and then effective nodules were counted as pink from inside. At first bloom, leaflets samples were collected and analysed for macro and micronutrients.

Soil analysis

Before the application of treatments and sowing, pre composite soil sample was collected from the experimental site and analysed for soil texture, pH, electrical conductivity (EC), organic matter and nutrient status. Soil texture was determined by hydrometer method [28], organic matter by oxidation method [29, 30], pH and EC were found in 1:5 soil and water suspension following the method described by McKeague [31] and McLean [32]. While soil was extracted by ammonium bicarbonate-diethylenetriaminepentaacetic acid (AB-DTPA) solution and phosphorus (P), potassium (K), copper (Cu), iron (Fe),

manganese (Mn) and zinc (Zn) were determined in its clear filtrate [33]. Among them, P was detected on spectrophotometer [34], K on flame photometer [35] and micronutrients were determined on Atomic Absorption Spectrophotometer. In addition, soil total nitrogen was determined by Kjeldahl method [36].

Plant analysis

Plant samples from recent fully developed leaflets at first blooming were collected, decontaminated and washed with distilled water, dried in oven at 80°C, ground to a 20 mesh size and stored at 4 °C for analysis [37]. The plant samples were digested by wet oxidation method using hot H₂SO₄ and repeated additions of 30% H₂O₂ [38]. The digests were analyzed for P by vanadomolybdate phosphoric acid yellow color method [34], K by emission spectroscopy and Cu, Fe, Mn and Zn using atomic absorption spectrophotometer. Total N was determined by Kjeldahl's method by digesting the contents in H₂SO₄ followed by distillation [39].

Results and discussion

Pre soil analysis of the experimental site showed that soil was medium in texture with 52.1% sand, 24.8% silt and 23.1% clay, alkaline in nature (pH 8.12) and non-saline (EC_e = 2.31 dSm⁻¹). However, the soil organic matter (0.74%), total nitrogen (0.042%), and AB-DTPA extractable phosphorus (2.43 mg kg⁻¹) was found in low range but AB-DTPA extractable potassium (145.6 mg kg⁻¹) was in sufficiency range.

The effect of Biozote-N on peas traits showed statistically highly significant ($p < 0.05$) differences as given in (Table 1). The peas trait studied were included pod length (cm), pod yield (kg ha⁻¹), no of nodules plant⁻¹, effective nodules plant⁻¹, root dry biomass (g), shoot dry biomass (g), leaf macro and micro nutrients. So, pod length was ranged from 3.93 to 7.02 cm with overall mean value of 5.24 cm, pod yield was 1.90 to 3.56 ton ha⁻¹ with mean of 2.62 ton ha⁻¹, number of nodules plant⁻¹ were 88.48 to 552.97 with mean of 349.20, effective nodules were from 23.50 to

234.26 with mean of 134.80, root biomass was 3.14 to 8.84 g with mean value of 3.87 g and shoot dry biomass was 15.36 to 24.67g with mean of 19.34 g respectively. In case of leaf N, P, K, Cu, Fe, Mn and Zn concentration, the leaf N was found in range of 3.95 to 6.545% with mean of 5.54%, P was 0.29 to 0.82%

with mean of 0.58%, K was 1.70 to 3.80% with mean of 2.98%, Cu was 7.91 to 10.34 mg kg⁻¹, Fe was 42.96 to 69.34 mg kg⁻¹, Mn was 102.59 to 148.35 mg kg⁻¹ with mean value of 126.40 mg kg⁻¹ and Zn was 20.65 to 50.51 mg kg⁻¹ with mean value of 33.15 mg kg⁻¹ respectively (Table 1).

Table 1. Minimum, maximum, mean and mean square value of the studied parameters of peas under the influence of Biozote-N and compost

Parameters	Minimum	Maximum	mean	Mean square value
Pod length (cm)	3.93	7.02	5.24	1.184**
Pod yield (ton ha ⁻¹)	1.90	3.57	2.62	0.906**
No. nodules plant ⁻¹	88.48	552.97	349.20	55499.4**
Effective nodules plant ⁻¹	23.50	234.26	134.80	14786.8**
Root dry biomass (g)	3.14	8.84	3.87	1.278**
Shoot dry biomass (g)	15.36	24.67	19.34	32.103**
N (%)	3.95	6.54	5.54	1.727**
P (%)	0.29	0.82	0.58	0.114**
K (%)	1.70	3.80	2.98	1.694**
Cu (ppm)	7.91	10.34	9.00	0.807**
Fe (ppm)	42.96	69.34	53.46	178.445**
Mn (ppm)	102.59	148.35	126.40	14.16**
Zn (ppm)	20.65	50.51	33.15	313.049**

The least significant difference (LSD) test at 5% probability revealed significant variation in mean of pod length, pod yield, number of nodules plant⁻¹, number of effective nodules plant⁻¹, dry root biomass and dry shoot biomass of pea across the treatments (Table 2). The results showed that in plot when Biozote-N in combination with compost and recommended PK fertilizer was applied produced maximum pod length (6.10 cm), pod yield (3.40 ton ha⁻¹), number of nodules plant⁻¹ (457), number of effective nodules plant⁻¹ (221), dry root biomass (4.72 g plant⁻¹) and shoot dry biomass (23.60 g plant⁻¹) followed by the treatment having compost @ 5 t ha⁻¹ + recommended PK fertilizer exception the parameter of number of effective nodules that expressed best in treatment when only Biozote-N was applied. However, some treatments manifested statistically non-significant differences as in case of pod length both control plot and Biozote-N indicated same pod length which was lower as compared to other treatments while Biozote-

N+recommended PK fertilizer also produced at par differences for pod length which was higher over control and Biozote-N but lower than the treatment of Biozote-N+compost+recommended PK fertilizer. Whereas, number of nodules plant⁻¹ exhibited at par variations across treatment 2 and 3 while number of effective nodules plant⁻¹ indicated non-significant differences in treatment 3 and 4 respectively. These results demonstrate that the use of biofertilizer without any organic and inorganic fertilizer can't improve growth and yield of peas as the lowest yield of 2.0 ton ha⁻¹ was recorded in the plot where only Biozote-N was used. It is evidenced that the when Biozote-N was integrated with compost and recommended PK fertilizer as treatment 5 lead to enhanced overall yield and yield contributing components of peas. Because the application of compost resulted in improvement of physical, chemical and biological properties. It is further stated that the soil of experiment was alkaline and in such soil phosphorus remain

unavailable to plants and form insoluble compound with calcium as calcium phosphate. So, the combined use of biofertilizer, compost and PK fertilizer increased the efficiency of Biozote-N as evidenced by increased number of nodules plant⁻¹ and number of effective nodules plant⁻¹. The calcareous and alkaline soils are low in organic matter and total nitrogen as the case of this study, the sole application of PK fertilizer to peas (i.e. control plot) produced low yield as compared to its

integration with Biozote-N (Treatment 2) and compost (Treatment 3). There are reports that the biofertilizers increase overall plant growth including plant height, root and shoot length, nutrient accumulation and plant vigor [40-42]. The use of biofertilizer enhance the availability of nutrients and consequently increase yield up to 10-20%. The biofertilizers application in crops either through seeds or soil is environment friendly practice.

Table 2. Effect of Biozote-N application on pod length (cm), green pods yield (kg ha⁻¹), number of nodules plant⁻¹, number of effective nodules plant⁻¹, root and shoot dry weight (g) of peas

Treatments	Pod Length (cm)	Pod yield (ton ha ⁻¹)	Number of nodules plant ⁻¹	No. of effective nodules plant ⁻¹	Dry root biomass (g)	Dry shoot biomass (g)
Control ((Rec. PK fert.)	4.62 c	2.27 d	112 c	25 d	3.21 e	16.07 e
Biozote-N	4.62 c	2.0 e	381 b	151 b	3.35 d	16.73 d
Biozote-N + Rec.PK fert.	5.41 b	2.70 c	385 b	141 c	3.69 c	18.47 c
Compost @ 5 t ha ⁻¹ + Rec. PK fert.	5.43 b	2.80 b	411 ab	136 c	4.37 b	21.87 b
Biozote-N + compost+rec.PK fert.	6.10 a	3.40 a	457 a	221 a	4.72 a	23.60 a
S.E.±	0.077	0.0225	23.332	3.3731	0.0128	0.1282
LSD (p<0.05)	0.1791	0.0518	53.803	7.7784	0.0296	0.2957

The LSD test (p<0.05) for comparison of means of peas' leaf macro and micro nutrients showed significant differences across treatments (Table 3). Out of five treatments, the Biozote-N+compost+recommended PK fertilizer (treatment 5) increased leaf nutrients accumulation with higher concentration of N (6.13%), phosphorus (0.76%), potassium (3.63%), Cu (9.72 mg kg⁻¹), Fe (64.58 mg kg⁻¹), Mn (128.14 mg kg⁻¹) and Zn (44.99 mg kg⁻¹) respectively that immediately followed by treatment 4 (compost + recommended PK fertilizer). Among the macronutrients, the lowest leaf N concentration was recorded in control plot (recommended PK fertilizer) while the lower leaf P and K concentration was noted in treatment 2 where only Biozote-N was used. Leaf P concentration in treatment 4 and 5 showed statistically at par differences.

In case of leaf micronutrients, Cu, Fe and Zn concentration expressed statistically non-significant differences from one another in treatment 1 and 2 while their lowest concentration was recorded in control (Table 3). This fluctuation in leaf peas' nutrients concentration was might be due to changes in soil properties because the addition of Biozote-N with recommended PK fertilizer and with compost separately and/or in combination improved the availability of nutrients as reflected in treatment 3, 4 and 5. According to Kachroo and Razdan [43] and Son *et al.* [44] that biofertilizers have crucial role in improving soil fertility and soil health. Further, its usage make soil structure better and indirectly helps in minimizing inorganic fertilizer. Biological nitrogen fixation is a natural mechanism found in legumes that they

symbiotically fix atmospheric nitrogen and in case of soybean, its 80-90% nitrogen requirement is met through symbiotic N fixation [45].

The performance of peas investigated under these set of treatments revealed changes in the growth traits like pod length, pod yield, number of nodules plant⁻¹, number of effective nodules plant⁻¹, dry root and shoot biomass as well as leaf macro and micro nutrients concentration. There was increase in green pods yield and yield components of peas in treatment 5 where Biozote-N was integrated with compost and recommended fertilizer. The reason behind this improvement was due to increase in the availability of nutrients as indicated with high leaf N, P, K, Cu, Fe, Mn and Zn concentration which is evidenced by Pearson correlation analysis as represented in Table 4. The pod length (cm) was found to be highly significantly correlated with pod yield, number of nodules plant⁻¹, effective nodules plant⁻¹, dry root & shoot biomass and leaf nutrient concentration such as N, P, K, Cu, Fe, Mn and Zn concentration. Pod yield also expressed highly significant correlation with pea traits and leaf nutrient concentration except Mn where correlation was non-significant. While, number nodules plant⁻¹ were positively but non-significantly correlated with leaf K concentration and

number of effective nodules plant⁻¹ were only non-significantly correlated with leaf P, K and Mn concentration. Likewise, root and shoot dry biomass showed positive and highly significant correlation with leaf macro and micro nutrient concentration except Mn which expressed positive but non-significant correlation with them. Together with that the correlation among leaf nutrients concentration were also found positive as leaf N concentration indicated positive but non-significant correlation with P, K and Mn while leaf P, K and Fe also manifested positive but non-significant correlation with leaf Mn concentration. Further, the correlation between leaf Mn concentration and Zn concentration were too positive but statistically at par. Similar correlation study was conducted by Adhikari [46] who observed that yield was correlated with mineral concentration. According to him, the relationship between Fe and Cu ($r = 0.468$) was positive and significant while Cu and P ($r = 0.709$) expressed correlation strong, positive and highly significant. Likewise, correlation between Mn and Fe ($r = 0.503$) was also positive and significant whereas, correlation between Zn and P ($r = 0.447$) was also positively significant. Significant positive correlation was found between Fe and Cu ($r = 0.468$).

Table 3. Effect of Biozote-N application on leaf macro (%) and micro (ppm) nutrients concentration of peas

Treatments	N	P	K	Cu		Fe	Mn	Zn
	%			mg kg ⁻¹				
Control ((Rec. PK fert.))	4.21 d	0.45 c	2.82 d	8.48 d	46.54 d	122.78 c		23.36 d
Biozote-N	5.72 c	0.31 d	1.78 e	8.51 d	46.62 d	126.55 b		23.95 d
Biozote-N + Rec.PK fert.	5.82 b	0.62 b	3.11 c	9.20 b	51.94 c	126.48 b		30.75 c
Compost @ 5 t ha ⁻¹ + Rec. PK fert.	5.83 b	0.75 a	3.56 b	9.10 c	57.61 b	128.04 a		42.68 b
Biozote-N + compost+rec.PK fert.	6.13 a	0.76 a	3.63 a	9.72 a	64.58 a	128.14 a		44.99 a
S.E.±	0.0421	0.0115	0.0271	0.0276	0.4742	0.2865		0.9951
LSD (p<0.05)	0.0970	0.0264	0.0625	0.0638	1.0935	0.6606		2.2947

Mean bearing the same letters are statistically alike

Table 4. Pearson correlation among the study parameters of peas under the influence of Biozote-N, compost, recommended fertilizer separately and in combination

	Pod length (cm)	Pod yield (kg ha ⁻¹)	No. of nodules plant ⁻¹	Effective nodules plant ⁻¹	Root dry biomass (g)	Shoot dry biomass (g)	N (%)	P (%)	K (%)	Cu (ppm)	Fe (ppm)	Mn (ppm)
Pod yield (kg ha⁻¹)	0.798**											
No. nodules plant⁻¹	0.742**	0.612*										
Effective nodules plant⁻¹	0.574*	0.676**	0.883**									
Root dry biomass (g)	0.708**	0.928**	0.692**	0.745**								
Shoot dry biomass (g)	0.773**	0.934**	0.724**	0.741**	0.995**							
N (%)	0.718**	0.612*	0.992**	0.902**	0.684**	0.711**						
P (%)	0.728**	0.928**	0.520*	0.478 ^{NS}	0.894**	0.897**	0.513 ^{NS}					
K (%)	0.652**	0.874**	0.308 ^{NS}	0.319 ^{NS}	0.796**	0.798**	0.2969 ^{NS}	0.969**				
Cu (ppm)	0.996**	0.817**	0.749**	0.607*	0.714**	0.775**	0.733**	0.731**	0.651**			
Fe (ppm)	0.896**	0.946**	0.731**	0.708**	0.939**	0.967**	0.711**	0.874**	0.792**	0.898**		
Mn (ppm)	0.799**	0.284 ^{NS}	0.536*	0.206 ^{NS}	0.225 ^{NS}	0.322 ^{NS}	0.486 ^{NS}	0.255 ^{NS}	0.202 ^{NS}	0.772**	0.505 ^{NS}	
Zn (ppm)	0.818**	0.913**	0.725*	0.725**	0.969**	0.986**	0.702**	0.828**	0.828**	0.810**	0.967**	0.415 ^N _s

Conclusion

The use of biofertilizer in agriculture is an integral part of integrated nutrient management particularly in leguminous crops including peas. From this study it was inferred that the performance of Biozote-N in peas production was noted better when integrated with compost and recommended PK fertilizer and the sole Biozote-N application did not improve peas growth and yield well. The study demonstrated that improvement in pea growth and yield was due to increased nutrient accumulation. Consequently, it is suggested that under agro-ecological condition of Quetta Balochistan the Biozote-N application along with organic and inorganic fertilizer results in improved peas yield.

Authors' contributions

Conceived and designed the experiments: GM Panezai, Mirwise, Performed the experiments: R Kethran, SAH Agha, Analyzed the data: A Khan, A Jan, Contributed materials/ analysis/ tools: GM Panezai, Wrote the paper: GM Panezai.

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