

Effect of Vermicompost and Foliar Spray of Zinc on Soil Properties and Nutrient Uptake by Groundnut (*Arachis hypogaea* L.)

Abstract

A field experiment was conducted during 2018-19 and 2019-20 to study the effect of vermicompost and foliar spray of zinc on growth, quality and productivity of groundnut (*Arachis hypogaea* L.) The experiment comprising of 10 treatments viz., T₁ (NPK, 15:60:30), T₂ (NPK + VC), T₃ (NPK + VC + Soil Zn 100%), T₄ (NPK + VC + Soil Zn 75%), T₅ (NPK + foliar spray of 0.25% ZnSO₄), T₆ (NPK + foliar spray of 0.50% ZnSO₄), T₇ (NPK + foliar spray of 0.75% ZnSO₄), T₈ (NPK + VC + foliar spray of 0.25% ZnSO₄), T₉ (NPK + VC + foliar spray of 0.50% ZnSO₄) and T₁₀ (NPK + VC + foliar spray of 0.75% ZnSO₄) were replicated thrice under randomized block design (RBD). The experimental soil was loamy sand in texture, low in N, high in available P and medium in K. Groundnut variety, RG 559-3 was tested. The results of the experiment revealed that significantly higher values of soil properties viz., Organic carbon (0.56 %), available N (156.59 kg/ha), P₂O₅ (50.39 kg/ha), K₂O (183.14 kg/ha), Zn (0.65 mg/kg) and lower values of pH (7.34), EC (0.22 dSm⁻¹) and nutrient uptake were recorded under the treatment receiving NPK (15:60:30) + VC (5 t ha⁻¹) + Soil Zn 100% (T₃) over control (T₁) while at par with the application of NPK + VC + Soil Zn 75% (T₄), NPK + VC + foliar spray of 0.25% ZnSO₄ (T₈), NPK + VC + foliar spray of 0.50% ZnSO₄ (T₉) and NPK + VC + foliar spray of 0.75% ZnSO₄ (T₁₀).

Introduction

Groundnut (*Arachis hypogaea* L.) is an annual legume crop and it's native from South America. The groundnut crop is unique among the leguminous crops and it's designated as "Wonder legume". This is also known as various names such as earthnuts, peanuts, goober peas, pindas, jacknuts, pindars, manilanuts and monkeynuts [1]. Groundnut is also known as poor man's almond. Groundnut has a useful role in offspring deficiencies as it's a rich source of edible oil and protein, which holds an important position in Indian diet. Hence, groundnut is known as the king of oilseed crops [2] and important food legume of tropical as well as subtropical part of the world. Groundnut is one of the most popular and universal crops cultivated in more than 120 countries. The uses of groundnut are diverse; all parts of the plant can be used. Its seed contains

high quality of 45-50 per cent edible oil, 25-30 percent digestible protein, 20 percent carbohydrates and 5 percent fiber and ash, which make a sustainable contribution to human nutrition [3]. The oil is primarily used for cooking, manufacture of margarine, shortening and soaps. Seeds are consumed directly either raw or roasted, chopped in confectioners or grounded into peanut butter. The young pod may be consumed as vegetables.

The main factors responsible for low yield in groundnut are inadequate and imbalance use of nutrients as well as nutrient deficiencies. Groundnut crop suffers from deficiency of nutrients, especially immobile elements in soil viz; phosphorus and zinc, which is essential for plant growth and pod formation besides N-fixation activity [5].

The use of organic sources is helpful for improving soil aggregation, structure and fertility improving the moisture holding capacity and increasing crop yield [6]. Application of organic manures produced / prepared from various organic wastes can save our environment as a whole [7,8]. The application of organic manures helps in mitigating multiple nutrient deficiencies and at the same time, provides a better environment for growth and development by improving physical, chemical and biological properties of soil [9]. In this context, use of organic manures such as farm yard manure (FYM), vermicompost (VC), press mud cake (PMC) may supply a sufficient number of micronutrients in available form to crops and improve the quality of the agricultural produces [10]. Due to prohibitive cost of chemical fertilizers, farmers do not apply the recommended doses of nutrients to this energyrich legume crops. Indigenously available organic sources of nutrients have enhanced the efficiency and reduced the requirements of chemical fertilizers [11]. Hence, it is necessary to integrate different sources of nutrients to meet the crop requirement. Sustainable yields in groundnut can be achieved through the conjunctive use of organic and inorganic fertilizers [12]. The efficiency of native micronutrients is further improved when these are used in conjunction with organic manures especially when the soils are belonging to arid and semi-arid areas having light texture, low in organic carbon, low moisture retention and microbial activity. Improvement in available nutrient status of the soil with the incorporation of vermicompost alone or integration with chemical fertilizer could be attributed to the slow decomposition of organic manure and enhancing soil biological activity. These, in turn, provides congenial physical condition, conserves soil nitrogen and increases the availability of other nutrients. Organic manures improve the soil physical, chemical and biological properties and also increase the efficiency of the applied nutrients, especially in light soils [13]. The

increasing use of chemical fertilizer, day-by-day is a serious matter of concern and their frequent application is deteriorating bio-physicochemical properties of soil [14]. As a result, soil fertility is being diminished gradually. This in turn is leading to a reduction in crop yield per unit area. The soils of arid region are characterized with low organic matter content and deficient in zinc. Zinc functions in plants are largely associated with activity. It plays as an activator of several enzymes in plants and is directly involved in the biosynthesis of growth substances such as auxin which produces more plant cells and more dry matter which in turn will increase seed yield. Several studies have demonstrated that application of vermicompost and foliar spray of zinc showed good behavior in increasing their growth and yield.

micronutrients recognized as essential for plants. It is a micronutrient most commonly limiting crop yields in Indian soils. Zinc is transported to plant root surface through diffusion. It aids in the synthesis of plant growth substances and enzyme systems and is essential for promoting certain metabolic reactions. It is necessary for production of chlorophyll and carbohydrates. Iron plays an important role in the synthesis of chlorophyll and also helps in the absorption of other nutrients. As a constituent of chlorophyll, it regulates respiration, photosynthesis, reduction of nitrates and sulphates. Thus, the use of organic manure (vermicompost) and supplementation of soil fertility through mineral nutrients is essential not only to harvest higher yields of crops but to maintain the physical, chemical and biological properties of the soil. Therefore, the present study was carried out ~~with objective~~ to study the effect of vermicompost and foliar spray of zinc on soil properties and nutrient uptake by groundnut.

Material and Methods

The experiment was conducted at research farm, Rajasthan Agricultural Research Institute, Durgapura, Jaipur (Raj.) during *kharif*, 2018-19 and 2019-20. Geographically, this place is situated at 75° 47" East longitude, at 26° 51" North latitude and at altitude of 390 m above mean sea level in Jaipur district of Rajasthan. This region falls under the Agro-climatic zone IIIA (Semi-arid Eastern plain zone) of Rajasthan. The climate of Durgapura is semi-arid characterized by extremes of temperature both in summer and winter, with low rainfall and moderate relative humidity. The average annual rainfall is approximately 500 mm which is mostly received during July to early September; sporadic showers in winters are also not uncommon. The maximum temperature ranges from 28 to 45°C during May and June, while in December and January, it

falls below 5°C, evaporation ranges from 1.3-17.5 mm/day. The experiment comprising ten treatments *viz.*, T₁ (NPK, 15:60:30), T₂ (NPK +VC), T₃ (NPK +VC+ Soil Zn 100%), T₄ (NPK + VC+ Soil Zn 75%), T₅ (NPK + foliar spray of 0.25% ZnSO₄), T₆ (NPK + foliar spray of 0.50% ZnSO₄), T₇ (NPK + foliar spray of 0.75% ZnSO₄), T₈ (NPK + VC + foliar spray of 0.25% ZnSO₄), T₉ (NPK + VC + foliar spray of 0.50% ZnSO₄) and T₁₀ (NPK + VC + foliar spray of 0.75% ZnSO₄) were evaluated in randomized block design with three replications. The soil of the experimental plot was Loamy sand in texture and slightly alkaline in reaction with pH 7.78, EC 0.22 dSm⁻¹ and organic carbon 0.13%. The soil was low in available nitrogen (134.2 kg ha⁻¹), high in available phosphorus (41.0 kg ha⁻¹), medium potash (169.1 kg ha⁻¹). Groundnut cv. RG 559-3 was sown at 30 cm x 10 cm spacing with 100 kg seed ha⁻¹. After crop harvest the soil samples were analyzed for pH and electrical conductivity [15], organic carbon [16], available nitrogen [17], phosphorus [18], potassium [19] and zinc [20]. The N, P, K and Zn contents in plant were estimated as per the procedures [21]. The uptakes of these nutrients were calculated by multiplication of concentrations with the respective yield data.

Result and Discussion

Soil Properties

The data (Table 1) showed that the pH and electrical conductivity of the soil decreased significantly with increasing vermicompost and soil zinc application. The lowest pH (7.42) and EC (0.16 dSm⁻¹) were recorded with the application of treatment T₃ (NPK +VC+ Soil Zn 100%) over the control. The decrease in pH and EC of soil with the application of vermicompost is due to the fact that production of organic acids on decomposition of organic matter and improvement in soil aggregation might have resulted in to lowering of soil pH and EC (22, 23). The maximum organic carbon (0.56 %), available nitrogen (156.6 kg ha⁻¹), phosphorus (50.39 kg ha⁻¹), potassium (183.14 kg ha⁻¹) and Zn (0.65 mg kg⁻¹) were observed under treatment T₃ (NPK +VC+ Soil Zn 100%) over the control. It may be ascribed to the beneficial role of vermicompost in mineralization of native as well as its own nutrient content by creating favorable conditions for microbial as well as chemical activities which enhanced the available nutrient pool of the soil. As a matter of fact, all the available nutrients are not taken up by the plant and the rest remains in the soil which improves the available nutrient status of soil after harvest of crop [22, 24].

Uptake of Nutrients

The data (Table 2) revealed that the uptake of N, P, K and Zn in plants. The highest uptake of nitrogen ($103.65 \text{ kg ha}^{-1}$), phosphorus (79.6 kg ha^{-1}), potassium (321.1 kg ha^{-1}) and Zn (0.143 mg kg^{-1}) in plant were observed under treatment T₃ (NPK +VC+ Soil Zn 100%) over the control. The positive influence of vermicompost was due to adequate supply of nutrients in root zone and plant system. The increased availability of these nutrients in the root zone coupled with increased metabolic activity at cellular levels might have synthesized more nutrients and their accumulation in various plant parts. Thus, crop supplied with higher dose of vermicompost had utilized more nutrients as compared to lower doses resulting in increased nitrogen, phosphorus, potassium and sulphur content in plant. The increased uptake of these nutrients seems to be due to the fact that uptake of nutrient is a product of biomass and nutrient content [23, 24]. The increase in content of Zn with application of vermicompost and zinc might be due to increased availability of native micronutrient cations. This is due to transformation of their solid phase form to soluble metalo-complexes and the application of micronutrients increased their contents [25].

Conclusion

Based on two-year field experimentation, it can be concluded that higher values of soil properties Organic carbon, available N, P₂O₅, K₂O, Zn and lower values of pH, EC and nutrient uptake were recorded under the treatment receiving NPK (15:60:30) +VC (5 t ha⁻¹) + Soil Zn 100% (T₃) over control (T₁) while at par with the application of NPK + VC+ Soil Zn 75% (T₄), NPK + VC + foliar spray of 0.25% ZnSO₄ (T₈), NPK + VC + foliar spray of 0.50% ZnSO₄ (T₉) and NPK + VC + foliar spray of 0.75% ZnSO₄ (T₁₀).

Table 1. Effect of vermicompost and foliar spray of zinc on soil properties (two years pooled data)

Soil properties							
Treatments	pH	EC (dSm ⁻¹)	OC (%)	N (kg/ha)	P (kg/ha)	K (kg/ha)	Zn (mg/kg)
T ₁ -NPK (15:60:30)	7.78	0.98	0.14	134.20	41.00	169.10	0.33
T ₂ -NPK +VC	7.65	0.66	0.36	142.20	44.30	176.12	0.47

T ₃ -NPK +VC+ Soil Zn 100%	7.34	0.22	0.56	156.59	50.39	183.14	0.65
T ₄ -NPK + VC+ Soil Zn 75%	7.55	0.23	0.51	148.40	46.98	180.54	0.61
T ₅ -NPK + foliar spray of 0.25% ZnSO ₄	7.60	0.90	0.20	135.40	42.78	170.30	0.37
T ₆ -NPK + foliar spray of 0.50% ZnSO ₄	7.69	0.82	0.28	136.80	43.15	169.42	0.40
T ₇ -NPK + foliar spray of 0.75% ZnSO ₄	7.71	0.32	0.32	139.60	43.49	170.96	0.43
T ₈ -NPK + VC + foliar spray of 0.25% ZnSO ₄	7.36	0.25	0.46	149.80	47.93	174.46	0.63
T ₉ -NPK + VC + foliar spray of 0.50% ZnSO ₄	7.42	0.24	0.49	149.20	48.02	179.11	0.62
T ₁₀ -NPK + VC + foliar spray of 0.75% ZnSO ₄	7.40	0.26	0.52	152.40	49.98	180.92	0.64
SEm _±	0.18	0.014	0.009	2.86	1.30	4.78	0.01
CD (P = 0.05)	0.23	0.04	0.12	8.48	3.85	11.22	0.03
CV	4.10	4.41	4.17	3.44	4.98	4.68	4.66

Table 2. Effect of vermicompost and foliar spray of zinc on nutrient uptake (two years pooled data)

Treatments	Nutrient uptake			
	N (kg/ha)	P (kg/ha)	K (kg/ha)	Zn (ppm)
T ₁ -NPK (15:60:30)	59.69	59.69	234.43	0.07
T ₂ -NPK +VC	78.95	65.32	274.75	0.10
T ₃ -NPK +VC+ Soil Zn 100%	103.65	79.60	321.10	0.14

T ₄ -NPK + VC+ Soil Zn 75%	96.45	76.41	296.15	0.13
T ₅ -NPK + foliar spray of 0.25% ZnSO ₄	68.50	61.19	261.35	0.08
T ₆ -NPK + foliar spray of 0.50% ZnSO ₄	72.68	63.24	269.35	0.08
T ₇ -NPK + foliar spray of 0.75% ZnSO ₄	76.20	64.15	271.21	0.09
T ₈ -NPK + VC + foliar spray of 0.25% ZnSO ₄	95.09	73.34	287.68	0.12
T ₉ -NPK + VC + foliar spray of 0.50% ZnSO ₄	96.35	74.38	292.16	0.12
T ₁₀ -NPK + VC + foliar spray of 0.75% ZnSO ₄	100.25	77.20	294.86	0.13
SEm _±	3.44	2.79	11.74	0.01
CD (P = 0.05)	10.23	8.28	34.88	0.02
CV	7.14	7.06	7.30	7.03

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