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PERFORMANCE OF NUTRISEED PACK ON MAIZE GROWTH AND SOIL MICROBIAL BIOMASS

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ABSTRACT

Nutriseed pack technique is a way of deep placing fertilizers and seeds in the root zone instead of sowing crop seeds. To study the effect of deep placement of Nutriseed pack on maize growth and soil microbial biomass, a green house experiment was conducted. The growth of maize measured in terms of plant height, root length, dry root weight and per plant yield (g). The plant height (191 cm), root length (25.1 cm) and root weight (5.03 g) recorded the highest in Nutriseed pack with DAP as P source treatment than Nutriseed pack with SSP as P source treatment and the lowest registered in control. During harvest of maize, the highest population of bacteria and *Actinomycetes* were observed in Control (12.0 x 10^{-5} and 6.5 X 10^{-4} respectively) followed by fertilizer pellet pack with SSP (7.8 x 10^{-5} and 2.9 X 10^{-4} respectively) and fertilizer pellet pack with DAP (5.4 x 10^{-5} and 2.3X 10^{-4} respectively). Fungi population found to be reduced with fertilizer pellet pack with SSP (15.2X10^{-4}) followed by fertilizer pellet pack with DAP (17.1X10^{-4}). The highest fungi population was observed in control (21.1 x 10^{-4}). The results revealed that fertilizer pellets placed in soil greatly increased the maize growth but decreased the microbial population at the spot of placement.

INTRODUCTION

Maize (*Zea mays* L.) is emerging as third most important crop after rice and wheat with adaptability to diverse agro-climatic conditions around the world due to its immense potential. In India, it occupies third place among the cereals after rice and wheat, grown in an area of 9.26 million hectares with the production of 23.67 million tonnes and the average productivity is 2557 kg ha^{-1} (Agricultural Statistics at a glance, 2015). Fertilizer rates and placement of nutrients are important factors to be considered to produce maximum yield of field crops. Nutrient use efficiencies of maize are low for surface broadcast. Appropriate methods of N, P and K fertilizer application to increase grain yield under intensive crop and water management systems are needed to optimize fertilizer input for high crop yield. To increase use efficiency of nutrients deep placement of fertilizers is one of the oppurtunities. Precise deep placement of fertilizers will reduce the nutrient losses to the environment and increases the nutrient use efficiency. Global soil fertility research has indicated that use efficiency of fertilizers was usually high when fertilizers were deep placed as well as when combined with organic sources under integrated nutrient management. To address the nutrient losses through surface broadcasting, Nutriseed pack concept has been developed. Nutriseed pack is a small tubular assembly consisting seed with bio-inoculants on top, manure pellet in middle and biodegradable polycoat encapsulated fertilizer pellet at bottom. Deep placement using Nutriseed holder resulted in the grain yield increase to tune of 81.8 per cent over surface broadcast (Asha and Arulmozhiselvan, 2006). Several studies have reported yield benefits to deep band nutrient placement in maize (Vyn and Janovicek, 2001). Increased early growth has been observed with deeper P and K placement when compared to broadcast application (Borges and Mallarino, 2001). The soil microbial biomass and its processes like plant nutrient supply, Organic matter decomposition and nutrient dynamics are crucial for soil fertility (Parthasarathi, 2006). Deep placement of fertilizers may have negative effect on microbial population than broadcasting. With the prolonged application of inorganic fertilizers, soils have lost half or more than its original levels of soil organic matter and microbial population (Matson *et al.,* 1998). With these considerations, in the current investigation an attempt has been made to examine the influence of Nutriseed pack placement on maize growth, soil microbial population and fertility.

MATERIALS AND METHODS

A green house experiment was conducted in mixed black clay loam soil (*Periyanaickenpalayam* series) taxonomically grouped under *Vertic Ustropept*. The maize (NK 6240) crop was raised in rigid PVC tubes having 20.0 cm diameter, 15 cm height. In a rectangular frame PVC tubes were arranged as tubular pot, by laying the bottom end on granite floor. This tubular pot was filled uniformly with soil to occupy up to 30 cm height. The following treatments were imposed and replicated six times. In between spaces of tubular pots were also filled with soil to give uniform soil moisture and temperature conditions.

Calculated quantity of 100 % recommended dose of NPK (250:75:75 N, P_2O_5, K_2O kg ha^{-1}) fertilizers for individual crop was mixed up thoroughly and fertilizer pellet was prepared by using the fertilizer pellet making machine. Then each fertilizer pellet was encapsulated in polyester coated paper pouch having micropores and sealed by sealing machine. Manure pellet was prepared by enriching vermicompost with 10% SSP, 1% micronutrients ($FeSO_4$ 0.5% & $ZnSO_4$ 0.5%) and 1% pesticides. Uniformly about 60% of moisture was maintained throughout the enrichment period. To achieve complete enrichment frequent mixing of vermicompost was done (Arulmozhiselvan *et al.,* 2009). After incubation for about 30 days, the enriched manure was pelletized by using manure pellet making machine. Bio-inoculant treated seeds were the component of Nutriseed pack. Instead of sowing seeds, Nutriseed Packs were placed in soil at 5 cm depth. Nutriseed packs were placed as per treatments based on completely randomization. In control treatments, direct maize seeds were placed. After placing of Nutriseed packs, irrigation was given immediately and on the third day of sowing, subsequent watering was given at weekly intervals to maintain optimum soil moisture condition.

During harvest stage of maize, the growth parameters and soil fertility were assessed in order to find out the effect of nutriseed pack – fertilizer pellet on soil microbes. These soil fertility statuses were compared with the initial soil fertility. After maize harvest, the microbial population of the root zone soil was estimated by serial dilution method using nutrient agar medium for Bacteria (James, 1958), Martins Rose Bengal agar for fungi (Parkinson *et al.,* 1971) and Ken Knights agar medium for *Actinomycetes* (Wellingtonn and Toth, 1963) and expressed in Colony forming units.

RESULTS AND DISCUSSION

Maize growth and yield

Imposition of Nutriseed pack treatments significantly influenced the plant height, root length and root weight etc (Table 2). Among the treatments, Nutriseed pack with NP(DAP)K recorded significantly higher plant height (191.7 cm) than Nutriseed pack with NP(SSP)K (187.7 cm). The smallest plant height was observed in control (166.8 cm). Similar to plant height, the longest root length was recorded in Nutriseed pack with NP(DAP)K (25.10 cm) followed by Nutriseed pack NP(SSP)K (24.80 cm). The smallest root length was observed in control (13.20 cm). As like plant height and root length, the highest root dry weight (5.03 g) was recorded in Nutriseed pack with NP(DAP)K which was significantly varied from Nutriseed pack with NP(SSP)K (4.42 g). The lowest root dry weight (2.18 g) was observed in control. Grain and straw yield (g $plant^{-1}$) of the maize was recorded at harvest. Compared to control, the placement of Nutriseed pack significantly increased the grain and straw yield. The increase in yield might be owing to beneficial effect of organics in improving the soil environment for better absorption of nutrients by the crop with combination of organic and inorganic fertilizers (Anish Sahay *et al.,* 2016 & Kalaivanan *et al.,* 2015). Though the highest grain yield and straw yield was recorded in NP(DAP)K treatment, the source of phosphorus did not make any significant difference on grain and straw yield. This conspicuous effect of 'nutriseed pack' could be attributed to placement of N, P and K fertilizers in the root zone, which would have synergistically induced crop height and root growth (Takahashi and Ohyama, 1999).

Soil microbial population

Since there is continuous release of nutrients and high salt index are expected at the location of nutriseed pack placement, the soil may have retarding effect on the growth of microbes. The microbial population like bacterial, fungal and *Actinomycetes* population were assessed (Table 2). The highest population of bacteria was observed in Control (12.0×10^{-5}) followed by fertilizer pellet pack with SSP (7.8×10^{-5}) and fertilizer pellet pack with DAP (5.4×10^{-5}). Population of Bacteria reduced to half under Nutriseed packs. The fungal population was high under control (21.1×10^{-4}) which was reduced to 15.6×10^{-4} in fertilizer pellet pack with DAP and 17.1×10^{-4}. The population of *Actinomycetes* was observed to be high in control (6.5×10^{-4}) and found to be reduced considerably under fertilizer pellet pack with SSP (2.9×10^{-4}) and DAP (2.3×10^{-4}). Since, bioinoculants are important component of

Table 1: Treatment details of the experiment

Tr. No	Treatment Details
T_1	Nutriseed Pack with DAP contains fertilizer pellet NP(DAP)K: N as urea, P as DAP and K as MOP along with Manure pellet and bioinoculant mixture
T_2	Nutriseed Pack with SSP contains fertilizer pellet NP(SSP)K: N as urea, P as SSP and K as MOP along with Manure pellet and bioinoculant mixture
T_3	Control

Table 2: Effect of Nutriseed pack placement on growth and yield of maize

Treatments		Plant height (cm)	Root length (cm)	Root dry weight (g)	Yield Grain yield	(g $plant^{-1}$) Straw yield	Soil microbial population Bacteria (10^5 CFU)	Fungi (10^4 CFU)	*Actinomycetes* (10^4 CFU)
T_1	NP(DAP)K	191.7	25.1	5.03	122.5	283.0	5.4	15.6	2.3
T_2	NP(SSP)K	187.7	24.8	4.42	121.7	281.0	7.8	17.1	2.9
T_3	Control	166.8	13.2	2.18	79.4	209.0	12.0	21.1	6.5
Mean		182.07	21.03	3.88	107.87	257.67	8.40	17.93	3.90
SEd		2.42	0.28	0.10	1.50	5.81	0.13	0.24	0.03
CD(P=0.05)		4.13	0.47	0.17	2.55	9.90	0.22	0.40	0.06

Table 3: Effect of Maize Nutriseed pack placement on soil nutrient status

Treatments		pH Inner Core	Outer Core	EC (dS m^{-1}) Outer Core	Inner Core	Available N(kg ha^{-1}) Outer Core	Inner Core	Available P(kg ha^{-1}) Outer Core	Inner Core	Available K(kg ha^{-1}) Outer Core	Inner Core
T_1	NP(DAP)K	8.16	8.32	1.02	0.94	310	169	28.5	19.4	638	593
T_2	NP(SSP)K	8.22	8.31	0.95	0.71	301	165	27.6	18.2	638	590
T_3	Control	8.39	8.38	0.56	0.62	143	153	14.3	16.1	556	560
	Mean	8.26	8.34	0.84	0.76	251.3	162.3	23.47	17.90	610.7	581.0
	SEd	0.18	0.15	0.08	0.08	4.11	2.51	0.36	0.29	13.2	9.83
	CD(P=0.05)	NS	NS	0.13	0.14	7.00	4.27	0.62	0.50	22.5	16.7

Integrated Nutrient Management the organic manure pellet was kept as component of Nutriseed pack. Release of organisms in the root zone would effectively benefit plants by symbiosis/ non-symbiosis or by other mechanisms in the rhizosphere region. The microbial population was reduced to half due to the increased doses of fertilizer in a particular location (Ranjith *et al.,* 2015). Though the population was reduced about a half, after a period of time the microbes can be replenished as Nutriseed pack was a spot placement and it did not affect the whole soil microbial population away from the point of placement because of its high rate of multiplication.

Soil fertility status

The status of available nitrogen, phosphorus and potassium was assessed in the inner soil core covering the roots and outer core containing less number of roots (Table 3). Initial experimental soil was non saline (0.76 dS m^{-1}) and calcareous (pH 8.27). The available nutrient status of the soil was low in nitrogen (158.2 kg ha^{-1}), medium in phosphorus (16.4 kg ha^{-1}) and high in potassium (571.0 kg ha^{-1}). The treatments had no significant influence on the pH of inner core and outer core of experimental soil. The results revealed that electrical conductivity (EC) of soil in inner and outer core was significantly influenced by source of fertilizers as well as method of application. In inner core, the highest EC of soil was observed in Nutriseed pack with NP(DAP)K (1.02 dS m^{-1}) which was on par with Nutriseed pack with NP(SSP)K (0.95 dS m^{-1}). The lowest EC was found in control (0.56 dS m^{-1}). Outer core EC was lowest in control (0.62 dS m^{-1}). The treatment of Nutriseed pack with NP(DAP)K recorded high EC (0.94 dS m^{-1}) when compared to other treatments. Between the cores, inner core showed high EC when compared to outer core. The placement of Nutriseed pack was having profound effect on available nutrient content in inner core and outer core. The availability of nutrients in inner core is higher than outer core invariably. The available nitrogen in inner core was higher in Nutriseed pack with NP(DAP)K (310.9 kg ha^{-1}) which was followed by Nutriseed pack with NP(SSP)K (301.3 kg ha^{-1}). The lowest available nitrogen was recorded in control (143.8 kg ha^{-1}). In outer core, control recorded the lowest available nitrogen (153.3 kg ha^{-1}). The highest available nitrogen was recorded in Nutriseed pack with NP(DAP)K (169.6 kg ha^{-1}) followed by Nutriseed pack with NP(SSP)K (165.5 kg ha^{-1}) which indicates that NSP made higher nutrient availability with in 15 cm than outer core. The available phosphorus in inner core and outer core varied highly due to treatments. In inner core, available phosphorus was higher in Nutriseed pack with NP(DAP)K (28.5 kg ha^{-1}) which was significantly different with Nutriseed pack with NP(SSP)K (27.6 kg ha^{-1}). In both outer and inner core, the lowest available phosphorus was recorded in control (14.3 kg ha^{-1} and 16.1 kg ha^{-1} respectively). The treatment of Nutriseed pack with NP(DAP)K had significantly high phosphorus (19.4 kg ha^{-1}) over Nutriseed pack with NP(SSP)K (18.2 kg ha^{-1}). In inner core, the treatment of Nutriseed pack with NP(DAP)K recorded the highest available potassium (638.8 kg ha^{-1}), which was on par with Nutriseed pack with NP(SSP)K (638.2 kg ha^{-1}). The lowest available potassium was observed in control (556.3 kg ha^{-1}). Placement of fertilizer pellet pack treatments recorded comparable available potassium in inner core. The available potassium in outer core was lowest in control (560.2 kg ha^{-1}). Nutriseed pack with NP(DAP)K recorded 593.2 kg ha^{-1} followed by Nutriseed pack with NP(DAP)K (590.2 kg ha^{-1}). These results confirm that the slow release characteristics of Nutriseed pack might be the responsible factor for increasing available nutrient status in the root zone so that the growth of the plant would be supported with sufficiency of nutrients. Greater available nutrients noticed under deep placement with NPK fertilizers due to steady dissolution which was earlier reported by Alam *et al.,* 2013.

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