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Residual effects of agro industrial wastes and biofertilizers in groundnut -finger millet cropping sequence

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ABSTRACT

Investigations were carried out during *Summer*, 2015-2019 at farmer's field in Cuddalore District, Tamilnadu to evaluate residual effects of agro industrial wastes (bagasse ash, pressmud and distillery spentwash), crop residues, farmyard manure with 50 % inorganic sources, with and without *Rhizobia* on finger millet *cv*. CO 14 under irrigated condition. There were twelve treatments replicated thrice. After harvesting of groundnut, succeeding crop finger millet was sown. It was observed that the combined application of Pressmud @ 12.5 t ha^{-1} + *Rhizobia* @ 2 kg ha^{-1} + 50% RDF (T_7) gave significantly higher growth and yield components such as plant height (40.37, 59.51 and 91.46 cm), DMP (1.13, 1.59 and 2.99 t ha^{-1}) at 30, 60 DAT and harvest stage respectively, LAI (5.34) at flowering stage, number of productive earheads m^{-2} (125.17), number of fingers $earhead^{-1}$ (11.63), thousand grain weight (2.77 g), grain yield (1964 kg ha^{-1}).Also, use of agro industrial wastes and biofertilizers in any cropping sequence minimize the cost of inorganic

fertilizers, thereby act as a boom to farmers by making the waste into wealth and maintain the soil health and fertility.

Key words ; Millets, cropping sequence, bio fertilizers

INTRODUCTION

Millets represent a diverse group of small seeded grasses grown for food, feed or forage. The fast maturation and all season growth characteristics make them a desirable crop for more intensive cropping systems and they could also be utilized as a catch or relay crop in combination with other crops. Millets are sometimes referred as ***Orphan crops*** or even ***Lost crops***. Furthermore, finger millet is an important millet grown extensively in India. It is commonly called as ***Ragi*** in India and also known as ***African millet***. It has higher dietary fiber, minerals and sulphur containing amino acids compared to white rice (Sanjay Mohan Gupta *et al.,* 2017). It is an important crop grown in South India and sustainable even under low rainfall situation. It is a promising source ***of*** Ca, Fe, Zn and protein. Hence, it is popularly known as ***Poor man's food***. A legume followed by millet based cropping system under any farming situations prefers a greater importance in increasing food security (Ananda Sharanappa and Kalyana Murthy, 2017).Keeping this in view this study was planned to evaluate residual effects of agro industrial wastes (spentwash, pressmud, bagasse ash) with and without biofertilizer (*Rhizobia*) and organic sources (FYM, Crop residues) on growth, yield, yield attributes and microbial population in the post harvest soil of succeeding finger millet. Hence, an attempt was made to find out the direct and residual effects of agro industrial wastes and biofertilizers in groundnut and succeeding finger millet in farmer’s field of Kodukkanpalayam village

Materials and methods

The nursery was raised in the experimental field. The nursery area was ploughed to get fine tilth and levelled. Five raised beds of size 3 m length and 1.5 m width were prepared. The area for nursery is about 60 m^2 to plant 30 cents of main field.Finger millet seeds @ 5 kg ha^{-1} were mixed with four times its volume of dry sand and sown in the nursery bed. The watering was done using a rose-can at an interval of 5 days. So that, the nursery bed remained always in moist condition but not stagnated.The bunds and channels prepared for the first crop was not disturbed and the soils were loosen using a spade.

The bunds and channels were strengthened to prevent seepage.The 17- 21 days old seedlings were planted @ one seedling $hill^{-1}$ adopting a spacing of 25 × 25 cm. The gap filling was done on 5th day after transplanting with identical aged seedlings.Two hand weeding were given to the crop on 20th and 40th day after transplanting. Need based plant protection measures were also provided to the crop.The crop was given with adequate amount of irrigation at the time of transplanting. Second irrigation was given at the time of gap filling (5 DAT). Subsequent irrigations were given according to different growth stages and soil conditions.As the finger millet crop does not mature uniformly, the harvesting was done at two stages. The ear heads were harvested from the net plot area separately after observing the maturity symptoms of 50 per cent ear heads turning brown. The matured ear heads were nipped, brought to the threshing floor and heaped for a few days and then threshed. The grain were dried to 14 per cent moisture content and cleaned by winnowing. Seven days after the first harvest, all the ear heads including the green ones were cut and processed as did in the first harvest. After second harvesting, the stalks were cut dried in the field and weighed.

RESULTS

Results of the residual effects of agro industrial wastes and biofertilizers on succeeding finger millet revealed that at all the stages of crop growth, T_7 (pressmud @ 12.5 t ha^{-1} + *Rhizobia* @ 2 kg ha^{-1} + 50% RDF) was found to be significantly superior than rest of the treatments. It recorded the highest plant height of 40.37, 59.51 and 69.46 cm at 30, 60 DAT and harvest stage, respectively. Treatments T_8 (diluted distillery spentwash @ 100 m^3 ha^{-1} + *Rhizobia* @ 2 kg ha^{-1} + 50% RDF) and T_6 (bagasse ash @ 10 t ha^{-1} + *Rhizobia* @ 2 kg ha^{-1} + 50% RDF) were next in the order. The least plant height of 22.83, 38.91 and 41.75 cm at 30, 60 DAT and harvest stage was recorded in T_1 (control), respectively. **(Table .1)**

Table .1Residual effects of agro industrial wastes and biofertilizers on plant height of finger millet at 30, 60 DAT and harvest stage (cm)(pooled Data)

Treatments			*Summer*, 2015-19		
			30 DAT	**60 DAT**	**Harvest**
T_1	-	Control	22.83	38.91	41.75
T_2	-	Bagasse ash @ 10 t ha^{-1} + 50% RDF	30.69	51.68	64.29
T_3	-	Pressmud @ 12.5 t ha^{-1} + 50% RDF	35.91	56.81	79.38
T_4	-	Diluted distillery spentwash @ 100 m^3 ha^{-1} + 50% RDF	33.57	54.45	72.04
T_5	-	Crop residues @ 6.25 t ha^{-} + 50% RDF	29.80	49.73	56.94
T_6	-	T_2 + *Rhizobia* @ 2 kg ha^{-1}	35.42	55.78	86.60
T_7	**-**	**T_3 + *Rhizobia* @ 2 kg ha^{-1}**	**40.37**	**59.51**	**91.46**
T_8	-	T_4 + *Rhizobia* @ 2 kg ha^{-1}	37.06	58.14	87.07
T_9	-	T_5 + *Rhizobia* @ 2 kg ha^{-1}	32.91	51.29	86.92
T_{10}	-	*Rhizobia* @ 2 kg ha^{-1}	26.24	44.32	49.15
T_{11}	-	FYM @ 12.5 t ha^{-1} + *Rhizobia* @ 2 kg ha^{-1}	33.38	52.14	86.75
T_{12}	-	100% RDF	29.51	49.69	56.81
SEd			1.34	2.21	2.84
CD (p = 0.05)			2.78	4.58	5.99

Yield Attributes

The residual effects of the treatment T_7 (pressmud @ 12.5 t ha^{-1} + *Rhizobia* @ 2 kg ha^{-1} + 50% RDF) significantly improved the yield attributes *viz.*, number of fingers $earhead^{-1}$ (11.63). The number of grains $earhead^{-1}$ (1963) and test weight (2.77 g). This was followed by the treatments, T_8 (diluted distillery spentwash @ 100 m^3 ha^{-1} + *Rhizobia* @ 2 kg ha^{-1} + 50% RDF) and T_6 (bagasse ash @ 10 t ha^{-1} + *Rhizobia* @ 2 kg ha^{-1} + 50% RDF). The lowest value was registered in the treatment T_1 (control) with the values of 2.04 fingers $earhead^{-1}$, 197 grains $earhead^{-1}$ and test weight (2.53 g) in finger millet of groundnut-finger millet sequence.The residual effects of agro industrial wastes influenced the grain yield of finger millet significantly. The grain yield was higher with the values of 1964 kg ha^{-1} in the treatment T_7 (pressmud @ 12.5 t ha^{-1} + *Rhizobia* @ 2 kg ha^{-1} + 50% RDF). This was followed by the treatments T_8 (diluted distillery spentwash @ 100 m^3 ha^{-1} + *Rhizobia* @ 2 kg ha^{-1} + 50% RDF) and T_6 (bagasse ash @ 10 t ha^{-1} + *Rhizobia* @ 2 kg ha^{-1} + 50% RDF). The lowest grain yield of 1004 kg ha^{-1} was registered in the treatment T_1 (control) of succeeding finger millet(**Table .2)**

BIOLOGICAL PARAMETERS

The soil microbial count after the harvest of finger millet was significantly influenced by the residual effect of different treatments applied for groundnut crop. The highest soil bacterial count of 59.69 × 10^6 g^{-1} of soil was recorded in the treatment T_7 (pressmud @ 12.5 t ha^{-1} + *Rhizobia* @ 2 kg ha^{-1} + 50% RDF) in finger millet. The treatments T_8 (diluted distillery spentwash @ 100 m^3 ha^{-1} + *Rhizobia* @ 2 kg ha^{-1} + 50% RDF) and T_6 (bagasse ash @ 10 t ha^{-1} + *Rhizobia* @ 2 kg ha^{-1} + 50% RDF) were second and third in order of ranking. The least bacterial count of 10.52 × 10^6 g^{-1} of soil was recorded in the control treatment (T_1).The same trend was followed in fungi and actinomycetes by recording 24.51 × 10^4 g^{-1} and 9.56 × 10^5 g^{-1}, respectively in T_7 (pressmud @ 12.5 t ha^{-1} + *Rhizobia* @ 2 kg ha^{-1} + 50% RDF). This was followed by T_8 (diluted distillery spentwash @ 100 m^3 ha^{-1} + *Rhizobia* @ 2 kg ha^{-1} + 50% RDF) and T_6 (bagasse ash @ 10 t ha^{-1} + *Rhizobia* @ 2 kg ha^{-1} + 50% RDF)(**Table 3).**The application of pressmud (12.5 t ha^{-1}) along with *Rhizobia* (2 kg ha^{-1}) and 50% RDF increased the plant height, leaf area index and dry matter production due to favourable residual effect of the organics and inorganics. Greater availability of nutrients from pressmud and favourable atmospheric nitrogen fixation by *Rhizobia* resulting from the addition of 50 % RDF has influenced the growth components in finger millet. The post harvest soil status of the first crop (groundnut) lends support to the above reasoning. It shows that combined application of organic and inorganic nutrients plays a very important role due to their residual effect.

Table .2Residual effects of agro industrial wastes and biofertilizers on yield attributes of finger millet(pooled data)

Treatments	*Summer*, 2015-19			
	Number of earheads m^{-2}	Number of fingers $earhead^{-1}$	Number of grains $earhead^{-1}$	Grain yield
T_1 - Control	49.99	2.04	197	1004
T_2 - Bagasse ash @ 10 t ha^{-1} + 50% RDFS	75.45	4.56	788	1437
T_3 - Pressmud @ 12.5 t ha^{-1} + 50% RDF	91.62	6.42	1145	1465
T_4 - Diluted distilled spentwash @ 100 m^3 ha^{-1} + 50% RDF	83.96	5.45	957	1451
T_5 - Crop residues @ 6.25 t ha^{-} + 50% RDF	67.59	3.79	597	1432
T_6 - T_2 + *Rhizobia* @ 2 kg ha^{-1}	109.63	8.77	1597	1879

T_7 - T_3 + *Rhizobia* @ 2 kg ha^{-1}	**125.17**	**11.63**	**1963**	**1964**
T_8 - T_4 + *Rhizobia* @ 2 kg ha^{-1}	117.61	10.31	1795	1921
T_9 - T_5 + *Rhizobia* @ 2 kg ha^{-1}	101.50	7.76	1414	1814
T_{10} - *Rhizobia* @ 2 kg ha^{-1}	59.00	2.85	365	1195
T_{11} - FYM @ 12.5 t ha^{-1} + *Rhizobia* @ 2 kg ha^{-1}	100.19	7.64	1355	1905
T_{12} - 100% RDF	66.72	3.70	535	1409
SEd	3.59	0.27	48.24	72.91
CD (P = 0.05)	7.46	0.57	100.05	151.22

Table .3 Residual effects of agro industrial wastes and biofertilizers on microbial population in post harvest soil of finger millet(Pooled Data)

Treatments	*Summer*, 2015-19		
	Bacteria	Fungi	Actinomycetes
T_1 - Control	10.52	6.07	3.71
T_2 - Bagasse ash @ 10 t ha^{-1} + 50% RDF	25.26	12.49	5.67
T_3 - Pressmud @ 12.5 t ha^{-1} + 50% RDF	37.59	16.46	6.88
T_4 - Diluted distillery spentwash @ 100 m^3 ha^{-1} + 50% RDF	30.16	14.71	6.29
T_5 - Crop residues @ 6.25 t ha^{-} + 50% RDF	20.79	10.66	5.07
T_6 - T_2 + *Rhizobia* @ 2 kg ha^{-1}	50.01	21.08	8.26
T_7 - T_3 + *Rhizobia* @ 2 kg ha^{-1}	**59.69**	**24.51**	**9.56**
T_8 - T_4 + *Rhizobia* @ 2 kg ha^{-1}	55.04	22.95	8.87
T_9 - T_5 + *Rhizobia* @ 2 kg ha^{-1}	44.03	18.94	7.60

T_{10} - *Rhizobia* @ 2 kg ha^{-1}	15.30	8.40	4.38
T_{11} - FYM @ 12.5 t ha^{-1} + *Rhizobia* @ 2 kg ha^{-1}	43.47	18.62	7.51
T_{12} - 100% RDF	20.58	10.47	5.01
SEd	1.52	0.66	0.27
CD (p = 0.05)	3.16	1.37	0.56

.Combined application of pressmud @ 12.5 t ha^{-1} + *Rhizobia* @ 2 kg ha^{-1} +50% RDF (T_7) significantly influenced the yield attributes *viz.*, number of earheads m^{-2}, number of fingers earhead^{-1}, number of grains earhead^{-1}, test weight and ultimately grain and straw yield of finger millet. The trend of the effect of pressmud @ 12.5 t ha^{-1} + *Rhizobia* @ 2 kg ha^{-1} + 50% RDF was almost consistent with that of growth attributes.Availability of macro and micro nutrients from pressmud and atmospheric nitrogen fixation by *Rhizobia* might be contributed to increased number of earheads plant^{-1}, number of fingers earhead^{-1}, 1000 grain weight, grain yield and straw yield of finger millet in the pressmud @ 12.5 t ha^{-1} + *Rhizobia* @ 2 kg ha^{-1} + 50% RDF (T_7) applied treatment. This result was in agreement with the findings of Manikandan and Subramanian (2010), Muhammad Aleem Sarwar *et al*. (2010) and Debiprasad Dash *et al*. (2011). Increased in yield and yield attributes of aforesaid treatment could be attributed to the complimentary effects of agro industrial wastes and *Rhizobia* on the nutrient status of the soil. The availability of potash and other trace elements along with major nutrients from agro industrial wastes might have also contributed to increased plant height, DMP, LAI and test weight in the aforesaid combination.Application of pressmud @ 12.5 t ha^{-1} + Rhizobia @ 2 kg ha^{-1} + 50% RDF resulted in increased microbial activity, which facilitates increased mineralization of nutrients. Among the various treatments, T_7 recorded the highest soil organisms due to congenial environment.

Use of nutrients for agricultural production is an essential factor to increase the food production, but continuous use of chemical fertilizers cause deleterious effects on soil which inturn cause decline in productivity, low nutrient recovery efficiency and increase in cost of production and create environmental pollution. Use of fertilizers are considered as a barometer for agricultural production but use of fertilizers alone in the intensive cropping system creates infertility, unfavourable physical, chemical and biological condition of the soil and this deteriorating soil health. These can be mitigated by use of organic sources. Integrated approach of nutrient management by chemical fertilizers along with organic manures and bio fertilizers is gaining importance.

Conclusion;

The study clearly proved the beneficial effects of integration of agro industrial wastes such as bagasse ash/pressmud/distillery spentwash with *Rhizobia* in the improvement of crop yield in groundnut-finger millet sequential system without prejuidice to soil fertility system.

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