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Adoption of Agricultural Intensification Options for Increasing Productivity of Farmers in Semi-Arid of West Africa

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Abstract: To ensure sustainable increase in agricultural productivities of smallholder farmers in West Africa, Agricultural Scientists have developed varieties of component crops. Nutrient management options combining inorganic and organic fertilizer in different dosages have been developed. The research institutes are collaborating with extension outfits, development partners and key stakeholders to disseminate these technologies to farmers and provide market and financial linkages. On-farm grain and fodder yields advantage of 20 to 50% were recorded by participating farmers. P fertilizer application on legumes increased yield 26 to 62%. Increase in plant hill population from 8,889 hills/ha to 53,333 plant/ha led to corresponding increase in millet yield by 48%. Cultivation of improved varieties coupled with fertilizer application and appropriate plant hill population will increase productivities of smallholder farmers in the semi-arid West Africa.

Keywords: Adoption, Increase, Intensification, Productivity, Semi-Arid

Introduction

Throughout much of the Sudan and Sahel region of West Africa, rural livelihood is undermined by poverty, rapid environmental and resource base degradation due to drought, desertification, precipitation variability, *Striga* infestation, soil degradation and poor agronomic practices. These constraints cause hardship to the people resulting in low agricultural productivities, serious malnutrition and poor health condition among the vulnerable groups, especially women and children. The rapid increases in human population and exploitative use of the renewable resources have worsened food shortages. Production of sufficient food has become a major challenge.

The use of sub-optimum plant densities is an inherent practice among the smallholder farmers, who adopt the traditional practice of wide spacing, warranted by intercropping practices and often low use of inputs including seeds of improved varieties. The importance of planting density as a factor determining crop growth and yield has been well documented (Maobe *et al.*, 2014). Separate findings on plant density and fertilizer requirement of millet showed that optimum plant density is on the decline possibly due to the serious decline in soil fertility as exemplified by the increase in required level of applied N (Singh and Thakare, 1986). The increase in required level of applied N at even the standard plant density (53, 000 plants ha^{-1}) is therefore indicative of the fact that the native soil N is also on the decline, hence a decline in the optimum plant density is inevitable. According to Tran (2003), inadequate fertilizer use is one of the main factors limiting groundnut yield, with its application depending on farmer's experience and capital.

To meet the increasing demand for food, integrated crop management options through efficient use of organic and inorganic fertilizer and identifying appropriate plant population and variety

will play a crucial role in increasing productivity. In view of the above, this study was designed to intensify productivity by comparing the effect of different fertilizer application method and rate and to identify appropriate population for high millet and groundnut productivity in the Sudan savanna ecological zone of Nigeria.

Materials and Methods

Trials were carried out in Jigawa State in 2013 and 2014 cropping seasons. The treatments included three (3) millet varieties (GB-8735, SOSSAT-C88, and a Local cultivar), four fertilizer levels (NPK micro-dose, NPK 60:30:30, NPK micro-dose + organic manure, and four plant populations (53,333, 26,667, 13,333, and 8,889 plants per hectare). NPK micro-dose was applied at 3 g per hill and cow dung was used as manure. The trials were laid out in a Split-Split Plot Design with variety as the main plot, fertilizer as sub-plot and spacing as sub-sub plot, replicated 4 times. The groundnut trials were conducted in 2012 and 2013 cropping seasons at Wudil and Minjibir in Kano State. Samnut-22 and 24 varieties of groundnut were used for the experiment, with two fertilizer levels (45 $kgha^{-1}$ P_2O_5) and plant population of 133,333; 66,667 and 44,444 plants per hectare and laid out in a Split-Split Plot Design with four replications.

Results and Discussion

Results revealed significantly different ($P \leq 0.001$) for days to 50% flowering, maturity, logging, panicle length, grain and stalk yield and 1000 seed weight in 2013 and 2014 cropping seasons (Table1). The three varieties also had significant differences for days to 50% flowering, maturity, logging, plant height, panicle length, grain and stalk yield with SUPERSOSAT having the highest mean grain yield of 789 $kgha^{-1}$. Fertilizer application in form of NPK 60:30:30 increased the yield from 467 $kgha^{-1}$ in the control plots to 1187 $kgha^{-1}$. Spacing at 25 cm also recorded the highest mean yield (743 $kgha^{-1}$), while wider spacing of 150 cm had the lowest mean yield (Table 1). There was also a significant positive correlation between grain and stalk yield.

For groundnut, significantly higher differences were observed between 2012 and 2013 on days to 50% flowering, number of days to maturity and fodder yields with no significant difference between pod yields of the two years. The two varieties also revealed significantly higher variation with respect to days to flowering, maturity, plant height and pod yield, while application of Phosphorus at the rate of 45 $kgha^{-1}$ P_2O_5 revealed significantly higher pod yield (1280 $kgha^{-1}$) compared to the control (909 $kgha^{-1}$). This is similar to the report by Tran (2003), that Phosphorus fertilizer significantly increased groundnut yield in both poor alluvial and sandy soils. Fertilizer application also revealed significant effect on plant height as well as fodder yield of groundnut (Table 2). Both pod and fodder yields of groundnut were found to be significantly higher with closer spacing of 10 x 75 cm with the yield obtainable per hectare decreasing with increasing spacing.

Conclusion

Efficient use of appropriate agronomic practices adds not only to development of healthy crops, but also economic yield and profitable farming venture. There is a need therefore, for farmers to adopt simple agronomic practices of appropriate plant population of improved varieties and fertilizer application for optimum crop yield especially in the semi-arid tropics of West Africa where the seasons are short coupled with manifold production constraints.

Table 1: Effect of variety, fertilizer and plant population on productivity of millet in Jigawa State

Treatments	50% flowering	Days to Maturity	Logging	Plant height (cm)	Panicle length (cm)	Grain yield ($kgha^{-1}$)	Stalk yield ($kgha^{-1}$)	1000 seed weight (gm)
Year								
2013	63.98	88.17	4.35	140.2	24.06	458	1453	6.44
2014	59.52	90.09	3.05	143.2	27.98	966	2208	8.23
P of F	**<.001**	**<.001**	**<.001**	**0.264**	**<.001**	**<.001**	**<.001**	**<.001**
SED	0.381	0.370	0.282	2.68	0.337	29.8	82.5	0.209
Variety								
BG8765	51.76	74.98	6.15	122.8	19.42	631	1389	7.39
Local	69.50	98.87	2.04	153.3	35.96	715	2073	7.37
S. Sosat	63.99	93.54	2.92	149.1	22.69	789	2029	7.23
P of F	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**0.804**
SED	0.467	0.454	0.346	3.28	0.413	36.5	101.0	0.256
Fertilizer								
Control	66.33	93.86	2.78	117.6	24.54	467	1163	7.03
MicNPK	61.69	88.77	2.81	142.6	26.01	604	1717	7.19
MicNPK + OM	60.96	88.15	3.53	145.9	25.74	590	1543	7.26
NPK 60:30:30	58.02	85.73	5.69	160.8	27.80	1187	2899	7.85
P of F	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**0.036**
SED	0.539	0524	0.399	3.79	0.477	42.1	116.6	0.296
Population								
13333	61.56	88.83	3.19	144.6	26.34	731	1668	7.39
8889	61.01	88.31	2.77	143.5	27.06	636	1646	7.69
53333	62.70	89.84	4.99	136.5	24.87	743	2077	6.91
26667	61.73	89.52	3.86	142.3	25.81	738	1931	7.34
P of F	**0.018**	**0.017**	**<.001**	**0.146**	**<.001**	**0.033**	**<.001**	**0.075**
SED	0.539	0.524	0.399	3.79	0.477	42.1	116.6	0.296
Mean	61.75	89.13	3.70	141.7	26.02	712	1830	7.33
CV	6.1	4.1	74.7	18.5	12.7	41.0	44.1	28.0

Table 2: Effect of variety, fertilizer and plant population on productivity of groundnut in Kano State

Treatment	Days to 50% flowering	No. of days to maturity	Plant height (cm)	Pod weight (kg/ha)	Fodder weight (kg/ha)
Year (Y)					
2012	28.97	96.37	38.72	1105	1809
2013	27.10	100.08	37.94	1084	1485
P of F	**<.001**	**<.001**	**0.392**	**0.580**	**<.001**
SED	0.1485	0.1634	0.909	38.6	60.6
Variety (V)					
Samnut-22	30.97	109.04	31.78	754	1592
Samnut-24	25.01	87.42	44.87	1436	1703
P of F	**<.001**	**<.001**	**<.001**	**<.001**	**0.070**
SED	0.1485	0.1634	0.909	38.6	60.6
Fertilizer (F)					
Control	28.09	98.17	37.12	909	1494
45 kg/ha P_2O_5	27.88	98.29	39.53	1280	1801
P of F	**0.163**	**0.445**	**0.009**	**<.001**	**<.001**
SED	0.1485	0.1634	0.909	38.6	60.6
Spacing (S)					
10 cm	27.89	98.09	39.40	1327	1785
20 cm	27.89	98.08	37.98	1009	1647
30 cm	28.18	98.52	37.60	948	1510
P of F	**0.173**	**0.049**	**0.237**	**<.001**	**0.001**
SED	0.1819	0.2001	1.114	47.2	74.2
Mean	27.99	98.23	38.33	1095	1647
CV	3.7	1.2	16.4	24.4	25.5

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