

- ① using the rate of manure applied and all nutrients content the authors should provide the actual amount of nutrients applied as treatments
- ② The soils in two sites had different pH meaning that availability of nutrients would differ. The authors did not do any soil analysis prior experiment to determine the magnitude of change, nor did they do analysis on site effects.

1 Enhancing Dry Season Production of Indian Spinach (*Basella Alba*) Through 2 Fertilization

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8

9 Abstract

10 Optimum and qualitative production of vegetables in the depleted soils during the dry season
11 are best achieved through fertigation. Two experiments were concurrently conducted in 2010
12 to determine the effect of fertigated poultry manure on the vegetative growth and nutritional
13 quality of Indian Spinach (*Basella alba*) in South Western Nigeria. Poultry manure rates at 0
14 (P_0+W), 5 (P_1+W), 10 (P_2+W), 15 (P_3+W) and 20 t/ha (P_4+W) were each diluted with 6,000
15 litres of water per hectare and the plots were arranged on a complete Randomized Block
16 Design with four replications. The plot that had no manure but irrigated with 6,000 litres of
17 water served as control. Compared with control, all the treatments significantly increased
18 *Basella* height, leaf area, wet leaf weight and dry matter yield. The percentage increase in the
19 leaf area of *Basella alba* were $P_1 + W$ (0.68%), $P_2 + W$ (6.48%), $P_3 + W$ (10%) and $P_4 + W$
20 (25.95%). Accumulation of crude protein, fat and ash were highest in $P_3 + W$ and were
21 respectively 19.47, 4.34 and 13.49%. Crude fiber and dry matter yield were highest in $P_4 + W$
22 with increase of 15.3 and 0.1% respectively. Treatment P_1+W had the highest carbohydrate
23 with percentage increase of 18.51%.

24

25 Key words: Poultry manure, Moisture, Crude protein, fat, carbohydrate.

26

27 Introduction

28

29 Vegetables attract ^{higher} prices during the dry season when they are ⁱⁿ short of market supply
30 than during the raining seasons termed "glut season". Vegetables are naturally found
31 everywhere as weeds during the wet season because of adequate moisture supply. Indian
32 Spinach is one of the cherished but scarce vegetables during the dry season in southern
33 Nigeria.

③ There appears to be no emphasis

④ On what basis was the 6000 litres per ha of water decided? What was How much was supplied in respect to prevailing soil water contents? This is an important part of study for dry season experiment.

not true!
see text!

34 Among the importance of Indian spinach is its richness in vitamins A and C, low less calories
35 or highness in calories compared with other vegetables (Grubben and Denton, 2004). It is
36 very good as ^a laxative; its high water content and fiber provide roughage for human diet. It
37 ^{is} sometimes ^{used locally} locally used to treat hypertensive patients. The young leaves of Indian spinach are
38 good as salad.

39
40 It is advisable to grow Indian spinach during the dry season by farmers who intend to grow
41 the crop for sale. The two major problems ^{faced} allayed by farmers are the inherent low nutrients
42 supply by the native soil and inadequate moisture supply. Fertilization and irrigation are the
43 two agronomic measures that can be used to solve the problems of nutrients deficiency and
44 shortage of water for the production of the crop. Hebbler *et al.* (2004) observed higher yield in
45 tomato fruit through fertigation than irrigation alone.

46
47 Poultry manure could be an excellent source of nutrients for Bassella as it has been
48 extensively used for the production of other crops such as maize, Amaranth, tomato e.t.c
49 (Ayeni *et al.*, 2010, Makinde *et al.* (2011)). In order to minimize cost and make the poultry
50 manure readily soluble and effective as source of fertilizer; there is need to dilute poultry
51 manure with water, a process called fertigation. Hence, the objective of this work was to
52 determine the effect of fertigation on the growth, vegetative yield and nutritional quality of
53 Indian Spinach (*Basella alba*) in Southern Nigeria.

54 Materials and Methods

55
56
57 Two experiments were concurrently carried out at Adeyemi College of Education and Fagua
58 both located in Ondo southwestern Nigeria in 2010 to determine the effect of fertigation of
59 poultry manure on growth and nutritional quality of *Basella alba*.

60
61 The initial soil chemical properties of the soil used for the study at the two locations and the
62 nutrient composition of poultry manure were collected, sieved and analysed with the normal
63 analytic procedures set out by Association of Analytical Chemist (AOAC, 1990)

64
65 The land was cleared, harrowed, pegged and ridged. Twenty plots of size 5m x 5m with 1m
66 discard area were made in each location.. The experiment was laid out in a randomized
67 complete block design with four replications.

rephrase
the dilution
process =
fertigation
or the process of
fertilizer + water to a
plant?

design
& layout
needs to
be clear.

68

69 The seeds of Indian Spinach were collected from the local farmers. The seeds were sown
70 directly in the field at a spacing of 1m x 1m, four seeds were sown per drill and thinned to
71 one plant per stand.

72

73 Poultry manure at 0 (P_0+W), 5 (P_1+W), 10 (P_2+W), 15 (P_3+W) and 20 (P_4+W) t/ha were

74 calculated per plot and mixed with equal amount of water as (6,000 litres of water /ha) There

75 was a plot that was planted with *Basella alba* without any treatment application (that is no

76 poultry manure and no water applied). This plot was discarded at the middle of the

77 experiment since all the *Basella alba* sown on this plot wilted before the data collection

78 There was another plant irrigated with water but without poultry manure which served as

79 control ($P_0 + W$). There were five treatment replicated four times to make a total sum of

80 twenty four ridges. The whole plots were irrigated with clean water for three weeks before

81 the treatments were applied. The treatments were applied for two weeks.

82

83 The poultry manure used for the experiment was collected from abattoir and mixed with

84 water and kept in dry cool room in the laboratory. The treatments were applied daily for two

85 consecutive weeks after planting. Each basella plant was staked.

86

87 Data such as plant height, leaf area dry matter yield, fresh stem and root weight were

88 determined two weeks after the completion of treatment application. The leafs were collected

89 from each plant/plot and bagged in brown envelope for the determination of the nutritional

90 quality of *Basella alba*. The leaf area was determined by graphical method and calculated in

91 cm^2 . Fresh leaf weight was determined by cutting the fresh leaf/plant weekly, weighed with

92 sensitive scale and recorded. The cumulative weight of the leaves per plot was used to

93 determine the fresh leaf weight.

94

95 The fresh leaves were washed and rinsed with the distilled water and dried in the oven at

96 65°C . The leaves were digested with 10ml of concentrated H_2SO_4 in the presence of selenium

97 catalyst before the distillation and titration processes were carried out. The crude protein of

98 *Basella alba* was determined by kjedahl method. The N content was determined and

99 multiplied by 6.25 to get the crude protein

100

101 The crude fibre content of *Basella alba* leaves was analyzed by weighting 5.0g of the sample
 102 into 500g conical flask and boiled gently with 1.25% H_2SO_4 and 1.25% of $NaOH$. The residue
 103 from the filtrate of the digest was dried in the oven at $105^{\circ}C$, cooled in desiccators and
 104 weighed. This was also placed in the muffle furnace at about $300^{\circ}C$ for 30 minutes, cooled
 105 and re-weighed. Percentage crude fibre was calculated by deducting the weight of the
 106 crucible and the sample after furnace from the weight of crucible and wet sample divided by
 107 weight of the sample used and multiplied by 100. Soxhlet extraction method was used to
 108 extract crude fibre. The percentage crude fibre was calculated by subtracting weight of the
 109 sample after extraction from the weight of the sample used and multiplied by 100.

110
 111 The total ash content of *Basella alba* was determined by ashing the leaves until the ash
 112 became whitish in colour. The crucible and ^{the} content were re-weighed and calculated in
 113 percentage. The percentage moisture content was calculated by deducting oven dried weight
 114 of leaves from the fresh weight and multiplied by 100.

115
 116 Carbohydrate content of *Basella alba* was determined by deducting the sum of ash, protein,
 117 crude fibre and fat from 100 on dry matter basis.

118 Data Analysis

119
 120
 121 The data obtained were subjected to analysis of variance and the means were separated by
 122 fishers at 5% level of probability.

123 Result and Discussion

124
 125 Before the ^{start} conduct of the experiments, the soil nutrient status of Adeyemi College of
 126 Education (ACE) consisted of pH 5.92, N, 0.09%, P 6.23 mg/kg, K 0.12c mol/kg, Ca 0.27 C
 127 mol/kg and Mg 0.19 C mol/kg. while Fagun soil consisted of Ph 6.0, N 0.16%, P 6.38 mg/kg,
 128 K 0.14 C mol/kg, Ca 2.13 C mol/kg, and Mg 0.83 C mol/kg. This shows that the two soils
 129 were deficient in major nutrients hence; they needed additional supply of plant nutrients.

130 Analysis of poultry manure used for the ~~conduct of the~~ experiments showed that it contained
 131 1.85, 1.24, 3.95, 3.63, and 0.92% for OC, N, P, K, Ca and Mg respectively. This shows that
 132 the poultry manure was likely to add the essential nutrients to the soil.

	pH	N	P	K	Ca	Mg	OC
ACE	5.92	0.09	6.23	0.12	0.27	0.19	
Fagun	6.0	0.16	6.38	0.14	2.13	0.83	
Manure	-	1.85	3.95				1.85

OC for the soil?

needs to be checked

5 H₂O₂?
LSD?

You are given five values for six parameters

Put in tabular format for ease of comparison
is there a common or standard inspired values

improve the nutrient status of the soil

133 The effect of poultry manure at different rates combined with fixed water rate of 6,000
134 litres/ha on growth, yield and nutritional quality of *Basella alba*. are presented in tables 1 and
135 2. Compared with control, ~~5 t/ha of poultry manure dissolved in 6,000 litres of water/ha (P₁),~~
136 ~~10 t/ha of poultry manure dissolved in 6,000 litres of water (P₂), 15 t/ha of poultry manure~~
137 ~~dissolved in 6,000 litres of water (P₃) and 20 t/ha poultry manure dissolved in 6,000 litres of~~
138 ~~water. (P₄)~~ significantly increased ($P < 0.05$) basella height, wet stem weight and wet root
139 weight (Table) ^{former} while there was no significant different in the basella leaf area among the
140 treatments.

this statement
contradicts what
is in the Abstract

141 The better performance of *Basella alba* fertigated with poultry manure ~~and water~~ might be
142 ^{attributed} traced to the adequate nutrients supplied by the poultry manure and the adequate water
143 supplied. Adequate nutrients, air and moisture are known to provide good medium of growth
144 for plants (Haggin and Lowengart, 1996).

145 The major problem of vegetable during the dry season is inadequate supply of moisture.
146 Water also helps in the mineralisation of plant nutrients in the soil. The highest ^{values in} growth
147 parameters recorded by P₄ might be ^{due to amount of} the highest nutrient released by poultry manure.

148 The *Basella alba* without manure ^{or} and water application clearly showed the significant effect
149 of water on growth and yield of the crop as all of the plants wilted before harvesting. Also,
150 the growth and yield of *Basella alba* watered without poultry manure had lower yield
151 compared with the fertigated plants. This shows that there is synergistic relationship between
152 poultry manure and water in *Basella alba* production as evident in this experiment.

✓ same

153 The percentage increase in the leaf area of *Basella alba* compared with control were P₁
154 (0.68%), P₂ (6.47%), P₃ (10%) and P₄ (25.95%). The percentage change in the leaf area of
155 *Basella alba* fertigated compared with control indicated that application of 20 t/ha poultry
156 manure mixed with 6,000 litres of water/ha. This shows that application of 20t/ha poultry
157 manure + 6,000 litres of water during the dry season is economical where poultry manure is
158 abundant like the urban cities of southwestern Nigeria where poultry dung is dumped beside
159 the road.

? not complete
any economic
analysis?

160 Compared with control (P₀), treatments P₁+W, P₂+W, P₃+W and P₄+W significantly
161 increased crude protein, fat and fibre content of *Basella alba* Fertigation had influenced on
162 nutritional quality of *Basella alba*. Accumulation of protein, crude fat and ash were highest in

163 P_3+W and were respectively 19.47, 4.34 and 13.49% ^{while} why accumulation of carbohydrate was
164 highest in P_1+W with percentage increase of 18.51%.

165 Crude fibre and dry matter yield were highest in plots fertigated with 20 t/ha poultry manure.
166 P_1 had the highest moisture. — *NS*.

167 Adequate supply of N, P, and K, by 10 t/ha poultry manure mixed with 6,000 t/ha water
168 might have led to highest accumulation of protein and fat contents of *Basella alba* grown in
169 this medium. Makinde *et al* (2011) observed that adequate supply of N, P, K, Ca and Mg
170 enhanced their uptake by *Amaranthus cruentus*, ^{an} in the experiment conducted to show the
171 effects of organic, organomineral and NPK fertilizers on the nutrient uptake of *Amaranthus*
172 *Cruentus*. Also, Makinde ^{they also} *et al* (2010) observed that organic manure increased accumulation
173 of protein, fat and crude fibre in *Amaranthus cruentus*. Grubben nad Dentus (2004) observed
174 that *Basella alba* thrives well in soils that are rich in organic manure. Zakaria and Vimala
175 (2002) and Sunassee (2001) observed increase in yields of vegetables crops with application
176 of poultry of manure.

177 Table 1: Growth of *Basella alba* as affected by fertigation (ACE and Fagun sites)

179	Treatment	height	Leaf Area	Wet leaf weight	Root wet	Stover Yield
180		<i>cm?</i>	cm^2	-----	g/plant-----	-----
181						
182	P_0+W	29.43	19.00	206.93	15.70	195.13
183	P_1+W	52.13	19.13	214.23	16.77	202.37
184	P_2+W	61.67	22.23	283.10	21.67	268.13
185	P_3+W	65.23	<u>20.90</u>	<u>278.10</u>	18.93	263.20
186	P_4+W	75.67	23.93	234.46	<u>16.17</u>	223.07
187	Lsd(0.05)	5.12	2.00	11.07	ns	7.03
188		<i>cv 7</i>				

189 P = poultry manure

190 W = water

191

4 — P_1, P_2, P_3 all have similar leaf areas, only P_2 & P_4 (also similar) are higher, which could be the reason?

192

193

194

195 Table 2: Nutritional quality of *Basella alba* as influenced by fertigation (ACE and Fagun
196 sites)

197

198 Treatment	Protein	Fat	Crude Fibre	Total ash	carbohydrate	Moisture	Dry Matter
199 P ₀ +W	16.79	3.89	17.38	13.21	43.25	9.46	90.54
200 P ₁ +W	13.38	3.76	19.13	12.62	51.21	9.57	90.43
201 P ₂ +W	17.92	4.05	18.86	13.18	45.99	9.39	90.61
202 P ₃ +W	19.47	4.34	19.61	13.49	43.09	9.51	90.49
203 P ₄ +W	18.65	3.95	20.08	12.76	44.56	9.37	90.63
204 LSD(0.05)	1.10	1.02	0.91	NS	3.45	NS	NS

205

206 P = poultry manure

207 W = water

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