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RESPONSE OF PIGEONPEA TO NUTRIENT UPTAKE UNDER ZAI METHOD OF CULTIVATION

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Abstract

The field experiment was conducted at college of Agriculture Farm, Vijayapur during *kharif* season 2013-14 to study the performance of pigeonpea [*Cajanus cajan* (L.) Millsp.]. Under the different plant population and nutrient levels in Zai method of cultivation under dry land situation.Twelve treatments under Zai method of cultivationwith four levels of plant population (22, 18, 14 and 10 seeds per Zai pit) and three levelsof fertilizer application (25: 50: 0, 31.5: 62.5:0 and 37.5: 75: 0 kg N: P_2O_5: K_2O ha^{-1}, respectively) were compared with recommended practice. Thirteen treatments weretested in randomized complete block design with three replications. Nutrient uptake was found that there was significantly higher uptake of nitrogen (117.25 kg/ha), phosphorus (13.20 kg/ha) and potassium (87.55 kg/ha) in Zai method of *in situ* moisture conservation practice as compared to recommended (76.30 kg/ha), (9.16 kg/ha) and (60.95 kg/ha), respectively. And, it was higher to an extent of 53.67, 44.15 and 43.64 per cent respectively over recommended practice. Zai method of cultivation was found to be efficient increase in the fertility status of the soil. Hence, it may be advocated for up scaling among the farming community.

Key words : Zai method, pigeonpea, nutrient levels, flatbed.

Introduction

Pigeonpea being an important nitrogen fixing crop can fix atmospheric N up to 200kg N ha^{-1} (Anonymous, 2010), it is widely grown for enriching the soil. Its deep penetrating roots help in bringing nutrients from deeper layers of soil. Pigeonpea is a major source of dal which is important constituent in the food habit of Indian people.A variability of 20-21 per cent protein in pigeonpea makes it an important source for supplementing the energy rich cereal diet, it is estimated that pigeonpea could benefit subsequent crops with N equivalent to about 40 kg N ha^{-1}. The leaf drop helps in improving soil structure and fertility, the stalks of pigeonpea serve as an efficient fuel. Its deep strong root system breaks the plough pans and improves the soil structure. Hence, pigeonpea is often called as “a biological plough” and kalpavriksha of dry lands as all parts are useful. Maintaining bullock power or mechanical power by the marginal and small farmer become not only uneconomical, but also become no feasible. The affordable and potentially efficient cultivation technique for pigeonpea appears to Zai method.

Zai is a traditional land rehabilitation technology “invented” by farmers in Burkina Faso. In Zai method of cultivation circular pits of 15-20 cm diameter are opened at an interval of 2 × 1 meter. Sowing or dibbling of seeds is donealong the circumference of thepits. The Zai’s are filled with FYM or Vermicompost or Green leaf manures along with fertilizers. The seeds are sown such that recommended plant population per unit area is maintained. The pits ensure better interception and storage of rain water as well as runoff water thus supplying water to the crop for a longer period. The organic matter incorporated in zai attracts termites, which play a crucial role in improving soil structure and soil fertility restoration. Zai practice has the potential to increase yield of crops and yields increase further with the application of organic amendments. Zai method of cultivation is also advantages in areas, where availability of animal power is very meager. With this background a study was undertaken to evaluate the effect of varying levels of plant population and nutrient management on the yield components, yield and economics of pigeonpea under Zai method of cultivation in dry land situation.

Table 1 : Nitrogen balance sheet as influenced by planting geometry and fertility levels under Zaimethod of cultivation.

Treatments	Initial 'N' content in the soil (Kg/ha)	Total 'N' added before sowing (Kg/ha)	Opening balance of 'N' (Kg/ha)	'N' uptake (Kg/ha)	Actual 'N' residue left in the soil (Kg/ha)	Estimated residue of 'N' in the soil (Kg/ha)	Total 'N' loss/gain from
	1	**2**	**3 (1+2)**	**4**	**5**	**6 (3-4)**	**7 (5-6)**
T_1 : 22 seeds per zai – 100% RDF (91674 plants ha^{-1})	106.10	75.00	181.10	99.49	152.15	81.61	70.54
T_2 : 22 seeds per zai – 125% RDF (91674 plants ha^{-1})	105.13	81.25	186.38	117.25	157.88	69.13	88.75
T_3 : 22 seeds per zai – 150% RDF (91674 plants ha^{-1})	104.78	87.50	192.28	101.75	160.78	90.53	70.25
T_4 : 18 seeds per zai – 100% RDF (75006 plants ha^{-1})	105.65	75.00	180.65	96.33	153.33	84.32	69.01
T_5 : 18 seeds per zai – 125% RDF (75006 plants ha^{-1})	104.65	81.25	185.90	100.83	159.85	85.07	74.78
T_6 : 18 seeds per zai – 150% RDF (75006 plants ha^{-1})	106.15	87.50	193.65	93.82	163.70	99.83	63.87
T_7 : 14 seeds per zai – 100% RDF (58338 plants ha^{-1})	104.82	75.00	179.82	84.54	156.60	95.28	61.32
T_8 : 14 seeds per zai – 125% RDF (58338 plants ha^{-1})	104.73	81.25	185.98	96.24	161.60	89.74	71.86
T_9 : 14 seeds per zai – 150% RDF (58338 plants ha^{-1})	104.55	87.50	192.05	84.33	160.80	107.72	53.08
T_{10} : 10 seeds per zai – 100% RDF (41670 plants ha^{-1})	105.67	75.00	180.67	85.22	152.80	95.45	57.35
T_{11} : 10 seeds per zai – 125% RDF (41670 plants ha^{-1})	105.98	81.25	187.23	83.72	158.55	103.51	55.04
T_{12} : 10 seeds per zai – 150% RDF (41670 plants ha^{-1})	106.10	87.50	193.60	84.02	164.65	109.58	55.07
T_{13} : Recommended practice (Flat bed 90 cm x 20 cm with RDF) (55556 plants ha^{-1})	105.25	50.00	155.25	76.30	140.15	78.95	61.20
S.Em.±	1.26	-	-	2.85	1.87	-	-
CD at 5%	3.69	-	-	8.31	5.44	-	-
	Apparent balance of 'N'					65.55	

Table 2 : Phosphorus balance sheet as influenced by planting geometry and fertility levels under Zai method of cultivation.

Treatments	Initial 'P' content in soil (Kg/ha)	Total 'P' added before sowing (Kg/ha)	Opening balance of 'P' (Kg/ha)	'P' uptake by pigeonpea crops (Kg/ha)	Actual 'P' residue in the soil (Kg/ha)	Estimated 'P' residue at in the soil (Kg/ha)	Nutrient loss/ gain from the
	1	**2**	**3 (1+2)**	**4**	**5 (3-4)**	**6**	**7 (5-6)**
T_1 : 22 seeds per zai – 100% RDF (91674 plants ha^{-1})	13.10	79	92.10	12.509	18.410	79.60	-61.19
T_2 : 22 seeds per zai – 125% RDF (91674 plants ha^{-1})	13.45	91.5	104.95	13.204	19.120	91.75	-72.63
T_3 : 22 seeds per zai – 150% RDF (91674 plants ha^{-1})	12.45	104	116.45	12.170	19.300	104.28	-84.98
T_4 : 18 seeds per zai – 100% RDF (75006 plants ha^{-1})	13.30	79	92.30	11.130	18.400	81.17	-62.77
T_5 : 18 seeds per zai – 125% RDF (75006 plants ha^{-1})	13.30	91.5	104.80	11.380	19.150	93.42	-74.27
T_6 : 18 seeds per zai – 150% RDF (75006 plants ha^{-1})	12.45	104	116.45	11.430	19.400	105.02	-85.62
T_7 : 14 seeds per zai – 100% RDF (58338 plants ha^{-1})	13.25	79	92.25	9.920	18.600	82.33	-63.73
T_8 : 14 seeds per zai – 125% RDF (58338 plants ha^{-1})	13.25	91.5	104.75	10.190	19.300	94.56	-75.26
T_9 : 14 seeds per zai – 150% RDF (58338 plants ha^{-1})	12.70	104	116.70	10.080	19.650	106.62	-86.35
T_{10} : 10 seeds per zai – 100% RDF (41670 plants ha^{-1})	13.10	79.10	92.10	9.34	18.650	82.76	-64.11
T_{11} : 10 seeds per zai – 125% RDF (41670 plants ha^{-1})	12.90	91.5	104.40	12.560	19.450	91.84	-72.39
T_{12} : 10 seeds per zai – 150% RDF (41670 plants ha^{-1})	13.10	104	117.10	10.410	19.750	106.69	-86.94
T_{13} : Recommended practice (Flat bed 90 cm x 20 cm with RDF) (55556 plants ha^{-1})	13.20	67.5	80.70	9.160	16.390	71.54	-55.15
S Em. ±	0.23	-	-	0.636	0.228		-
CD at 5%	0.67	-	-	1.858	0.664		-
						Apparent balance of 'P'	-72.72

Table 3 : Potassium balance sheet as influenced by planting geometry and fertility levels under Zai method of cultivation.

Treatments	Initial 'K' content in soil (Kg/ha)	Total 'K' added before sowing (Kg/ha)	Opening balance for 'K' (Kg/ha)	'K' uptake by pigeonpea crops (Kg/ha)	Actual residue left in the soil (Kg/ha)	Estimated 'K' residue left in the soil (Kg/ha)	Net loss/ gain form estimated 'K'
	1	2	3 (1+2)	4	5	6 (3-4)	7 (5-6)
T_1 : 22 seeds per zai – 100% RDF (91674 plants ha^{-1})	269.13	41.00	310.13	72.930	310.87	237.20	73.67
T_2 : 22 seeds per zai – 125% RDF (91674 plants ha^{-1})	271.35	41.00	312.35	87.552	315.93	224.80	91.13
T_3 : 22 seeds per zai – 150% RDF (91674 plants ha^{-1})	261.32	41.00	302.32	72.790	318.95	229.53	89.42
T_4 : 18 seeds per zai – 100% RDF (75006 plants ha^{-1})	272.70	41.00	313.70	69.560	310.72	244.14	66.58
T_5 : 18 seeds per zai – 125% RDF (75006 plants ha^{-1})	271.00	41.00	312.00	71.840	316.65	240.16	76.49
T_6 : 18 seeds per zai – 150% RDF (75006 plants ha^{-1})	273.70	41.00	314.70	69.800	318.93	244.90	74.03
T_7 : 14 seeds per zai – 100% RDF (58338 plants ha^{-1})	269.40	41.00	310.40	61.020	315.03	249.38	65.65
T_8 : 14 seeds per zai – 125% RDF (58338 plants ha^{-1})	274.20	41.00	315.20	64.630	315.22	250.57	64.65
T_9 : 14 seeds per zai – 150% RDF (58338 plants ha^{-1})	274.60	41.00	315.60	62.530	320.72	253.07	67.65
T_{10} : 10 seeds per zai – 100% RDF (41670 plants ha^{-1})	274.00	41.00	315.00	61.320	313.70	253.68	60.02
T_{11} : 10 seeds per zai – 125% RDF (41670 plants ha^{-1})	276.50	41.00	317.50	64.000	317.63	253.50	64.13
T_{12} : 10 seeds per zai – 150% RDF (41670 plants ha^{-1})	275.50	41.00	316.50	61.830	321.55	254.67	66.88
T_{13} : Recommended practice (Flat bed 90 cm × 20 cm with RDF) (55556 plants ha^{-1})	272.55	25.00	297.55	60.950	291.05	236.60	54.45
S. Em±	3.21	-	-	2.2413	5.17	-	-
CD at 5%	9.38	-	-	6.542	15.08	-	-
						Apparent balance of 'K'	70.37

Materials and Methods

A field experiment was conducted at college of Agriculturalfarm, Vijayapur during *kharif* 2013-14 in *vertisols* under rainfed conditions. The soil of the experimental field was mediumdeepblack (100-135 cm), clay in texture (18.7% sand, 15.2% silt, 60.3% clay), pH 8.8, E.C 0.41, low in organic carbon (0.13%),medium in available nitrogen (204 kg ha^{-1}), low in available phosphorus (21.5 kg ha^{-1}) and low in available potassium (255.0 kg ha^{-1}). The treatments included four levels of plant population (22, 18, 14 and 10 seeds per Zai pit) and three levels of fertilizer application (25: 50: 0, 31.5: 62.5:0 and 37.5:75: 0 kg N:P_2O_5: K_2O ha^{-1}, respectively) under Zai method of cultivation, which was compared with farmers' practice. Thirteen treatments were tested in randomized complete block design with three replications in a plot size 12 × 9.6 m^2. The circular pits having diameter 60 cm and depth about 15cm were dug in straight lines 2 m apart. The intra row distance was kept at 1.2m. Seeds were dibbled along the periphery of the pit. FYM (6 t/ha) and *Glyricidia* (5 t/ha) were applied in all the pits. The data on yield attributes, yield and economics were recorded using standard procedures. Nutrient status in FYM and *Glyricidia* are referred in table 4.

Results and Discussion

Nutrient uptake of crops varies with soil types. Hence, it is important to apply the limiting nutrients through fertilizers; green manures to ensure balanced nutrition for the improvement of seed yield of given crop.

On the critical examination of the data on nutrient uptake, it was found that there was significantly higher uptake of nitrogen (117.25 kg/ha), phosphorus (13.20 kg/ha) and potassium (87.55 kg/ha) in Zai method of *in situ* moisture conservation practice as compared to recommended practice (76.30 kg/ha), (9.16 kg/ha) and (60.95 kg/ha), respectively. And it was higher to an extent of 53.67, 44.15 and 43.64 per cent respectively over flat bed. This was found in the treatment **T$_2$**: 22 seeds +125% RDF with plant population 91674 plants ha^{-1}. It was significantly higher over the flat bed (tables 1, 2 and 3). This might be attributed to better availability of nutrients and also development of better root system all these improvements might have led to better uptake of nutrient. This conspicuous improvement may be attributed which might have to better solubility of nutrients and their uptake.

The apparent balance sheet for N and K indicated, negative balance for P while positive balance for N and K in the study. In the present investigation, the higher balance of N, and K was noticed in Zai method of *in situ* moisture conservation practices compared to recommended practice. Further, the average apparent balance of N (65.55 kg/ha) and K (70.37 kg/ha) (table 3) was positively recorded and average apparent balance of P was recorded negatively (-72.72 kg/ha) (table 2).

Table 4 : Nutrient composition of *Glyricidia* and FYM.

Materials	Nitrogen (%)	Phosphorus (%)	Potassium (%)
Glyricidia	2.42	0.36	0.14
FYM	0.78	0.71	0.65

It is quite interesting to note that the available residue of K left over in the soil when estimated compared to actual residue worked out after harvest of the crop this clearly indicated there is greater depletion in the different labile pooles of Kin the soil. It warrants for taking precautionary measures in maintaining the optimum balance of different labile pooles of K in the soil.

On the other hand, when actual balance of nutrients was worked out considering nutrient content in the soil estimated before commencement of the experiment and at the nutrients content indicated higher positive balance. In the present investigation the net balance of N, and K was higher in Zai method of land layout compared to flat bed. Higher net gain of N was noticed in treatment **T$_2$**: 22 seeds per Zai + 125% RDF (88.75 kg/ha). Significantly higher net loss of P was noticed in treatment **T$_6$**:18 seeds per Zai +150% RDF (6.950 kg/ha). Higher net gain or loss of K was noticed in treatment **T$_{12}$**:10 seeds per Zai + 150% RDF (91.13 kg/ha).

The apparent net gain for N and K were higher in Zai method of *in situ* moisture conservation practice. This may be due to higher moisture content in soil throughout the all crop growth stages. The major portion of the phosphorus and potassium moves to roots by diffusion process between the water films around the soil particles and root hairs of the crop. Timely availability of nutrients required quantities in the rhizosphere of the plants for enhanced growth and development of plants assumes greater significance. In the present investigation, greater plant population in pigeonpea might have fixed more of N through symbiotic nitrogen fixation and higher K contents might have come from incorporation of *Glyricidia* to the soil. This might have favored higher apparent and net balance of N and K. However on the contrary greater balance for available P was observed. This may be attributed fixation of P because higher pH condition of the *vertisols*. These findings are confirming the results of Mike Bell *et al.* (2009), Gawai and Pawar (2007), Chakravarti *et al*. (1980) and Nambiar (1986).

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