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Effect of Nitrogen and Zinc on Summer Cowpea (*Vigna unguiculata* L. Walp) under South Gujarat Condition

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A B S T R A C T

A field experiment entitled "Effect of nitrogen and zinc on summer cowpea (*Vigna unguiculata* L. Walp) under south Gujarat condition" was carried out during summer 2019 at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari (Gujarat). The experiment comprising sixteen (16) treatment combinations were laid out in randomized block design with factorial concept in three replications. The treatment consisted combinations of 4 level of zinc *viz*., Zn_0: 0 kg Zn/ha, Zn_1: 2.5 kg Zn/ha, Zn_2: 5.0 kg Zn/ha and Zn_3: 7.5 kg Zn/ha and 4 level of nitrogen *viz*., N_0: 0 kg N/ha, N_1: 10 kg N/ha, N_2: 20 kg N/ha and N_2: 30 kg N/ha. An application of different levels of zinc significantly increased number of pods/plant, number of seeds/pod, protein content, nutrient content in seed and stover, seed and stover yield of cowpea. Similarly, plant height, number of branches/plant, protein content, nutrient content of seed and stover, number of pods/plant, number of seeds/pod, seed yield and stover yield were significantly increased with increasing levels of nitrogen. While, 1000 seed weight and harvest index were not significantly influenced by different levels of zinc and nitrogen. There was no significant effect of interaction between different levels of zinc and nitrogen on growth and yield attributes, yield, protein content and nutrient content in seed and stover of cowpea.

Introduction

Pulses are a wonderful gift of nature. The importance of pulses is more in a country like India, where majority of people are vegetarian. Stagnant production together with increase in population has led to sharp decline in per capita availability of pulses from 71 g/day in the year 1995 to 34.4 g/day in the year 2009 in against the minimum requirement of 70 g/capita/day. Therefore, increase pulse production continues to remain a thrust area (Anonymous, 2009). This disturbs nutritional balance of population especially of poor and weaker sections who cannot afford expensive animal proteins. The family Leguminaceae has the special characteristic that its members are able to participate in a symbiotic relationship with a group of bacteria that can oxidize atmospheric nitrogen; e.g. Rhizobium, Clostridium etc.

Cowpea (*Vigna unguiculata* L. Walp) is commonly known as "Lobia". It is also known as black eye pea, black eye bean, southern pea, china pea, marble pea, chowli. Cowpea grains complement the grains of cereals as foods for people by enhancing the quantities and qualities of proteins and vitamins. Like, other pulses, the protein in cowpea grain is rich in the amino acids lysine and tryptophan, compared to cereal grains. However, it is deficient in methionine and cystine when compared to animal proteins (Timko *et al.,* 2007). It is crop of low and high rainfall regions, an important component of cropping system grown as introduction catch crop, mulch crop, intercrop, mixed crop and green crop (Singh *et al.,* 2012). In India, it is mainly grown in central and northern regions. In India, cowpea grown states are Gujarat, West Bengal, Tamil Nadu, Andhra Pradesh, Kerala, and Orissa. The major cowpea growing district in Gujarat is Banaskantha, Ahemdabad, Kheda, Anand, Junagadh, Vadodara, Surat and Navsari. In India, it is cultivated in 654 lakh ha with an annual production of 599 lakh tones leading to average productivity of 916 kg/ha (Anonymous, 2015).

Cultivation of cowpea in summer season is increasing in Gujarat due to perennial water supply. From Ukai-Kakarapar project, south Gujarat also gets high production in summer season. The efficient application of fertilizers has played important role in providing nutrients for growth and development of plants. Plant requires essential elements for growth and development. Among all different nutrients, nitrogen is most important nutrient. Nitrogen is the most important nutrient for plant growth and is the most limiting nutrient in our soils. Nitrogen application increase crude protein and metabolizable energy, besides improving succulency and palatability of fodder crops. It is the important constituent of chlorophyll and protein. It imparts dark green colour to the plants, promotes vegetative growth and rapid early growth (Bhoya *et al.,* 2014). Plants require large amounts of nitrogen for adequate growth. Plants take up N from the soil as NH_4^- (ammonium) or NO_3^- (nitrate). Although leguminous crops e.g. cowpea, can fix nitrogen in plants, at the initial stage of growth it needs nitrogen fertilizer before formation of nodules in the root system. Therefore, nitrogen fertilizer is also sometimes used as starter dose.

Legume crops require not only adequate macronutrients but also micro nutrients for increasing the bacterial activity of nodule. Therefore, an optimum supply of micronutrients under balanced condition is very important for achieving higher productivity (Mondal *et al.*, 2011). Zinc is a bluish-white metallic element, accounting for about 0.02% of the earth's crust (Singh *et al.,* 2011). Zinc plays vital role in plant growth and development and formation of chlorophyll in plant. It is also involved in several enzyme systems, growth hormone (auxins) and the synthesis of nucleic acids and plays an important role in the intake and use of water by plants. Zinc also catalyses the biosynthesis of indole acetic acid (IAA), acting as metal activator of the enzyme, there by ultimately increasing crop yield. Plants suffering with zinc deficiency exhibit delayed maturity, short internodes and decrease in leaf size. Deficiency of Zn in the soil leads to the dietary malnutrition and health problems in human and animals. The crops grown in Zn deficient soils are generally having lower zinc content (consequently lower Zn uptake) and intake of produce of such crops leads to health related problems in the humans and animals.

Since zinc is not mobile in the plants, thus zinc-deficiency symptoms occur mainly in new-terminal growth. Due to poor mobility in plants, constant supply of zinc is essential for optimum growth. Zinc should be applied with initial fertilizer or just after the sowing. Delaying in application of zinc may show signs of zinc deficiency. Keeping all these considerations in view an experiment was planned to study, "Effect of nitrogen and zinc on summer cowpea (*Vigna unguiculata* L. Walp) under south Gujarat condition" during summer season in 2019.

Materials and Methods

A field experiment was conducted in summer season of 2019 at the college farm, Navsari Agricultural University, Navsari, Gujarat. The soil of experiment field was slightly alkaline in reaction with normal electrical conductivity, soil pH 7.96, EC 0.43 dS/m and organic carbon content 0.46 %. The soil was low in available nitrogen (198.82 kg/ha), medium in available phosphorus (28.05 kg/ha), high in available potassium (412.54 kg/ha), medium in available zinc (0.74 mg/kg) were determined by Alkaline $KMnO_4$ method, Olsen's method, Flame photometric method and DTPA (Diethylene triamine penta acetic acid) method, respectively and clayey in texture. The experiment comprising sixteen (16) treatment combinations were laid out in randomized block design with factorial concept in three replications. The treatment consisted combinations of 4 level of zinc *viz*., Zn_0: 0 kg Zn /ha, Zn_1: 2.5 kg Zn/ha, Zn_2: 5.0 kg Zn/ha and Zn_3: 7.5 kg Zn/ha and 4 level of nitrogen *viz*., N_0: 0 kg N/ha, N_1: 10 kg N/ha, N_2: 20 kg N/ha and N_2: 30 kg N/ha. Cowpea variety "GC-4" seeds were sown at 45 cm x 10 cm spacing. Full dose of phosphorus (40 kg/ha) was applied as basal just before sowing in the form of SSP. The experimental plots were also fertilized with dose of nitrogen and zinc as per treatments at same time just before sowing in the form of urea and zinc sulphate, respectively. Other operation were performed as per recommendations of the crops. The statistical analysis of data recorded for various characters studied in the investigation was followed by using statistical procedures appropriate to the Factorial Randomized Block Design (FRBD) as described by Panse and Sukhatme (1985) and differences were tested by 'F' test.

Results and Discussion

Effect of zinc

Growth attributes

The variation in growth attributes of cowpea *viz*., plant height and number of branches per plant were found non significant due to different levels of zinc. However, numerically maximum plant height (32.43 cm) and number of branches/plant (3.63) at 45 DAS were recorded with application of Zn @ 7.5 kg/ha (Zn_3). This study was close conformity as observed by Patel *et al.*, (2011).

Yield attributes and yield

The variations in the yield attributing parameters (Table 1) *viz*., number of pods/plant and number of seeds/pod were significantly influenced by different levels of zinc. Significantly higher number of pods/plant (16.77) and number of seeds/pod (10.60) were recorded with application of Zn @ 7.5 kg/ha (Zn_3), but it found at par with application of Zn @ 5.0 kg/ha (Zn_2). Significantly minimum pods/plant (14.70) and seeds/pod (9.60) were recorded without application of zinc (Zn_0). The treatment Zn_3 and Zn_2 increased pods/plant by (14.08 and 7.61 %, respectively) than Zn_0 and seeds/pod by (10.4 and 7.18 %, respectively) than Zn_0. Increasing in the yield attributes may be due to the fact that application of zinc increased chlorophyll synthesis, photosynthesis and in turn accumulation of indole acetic acid (IAA) and especially due to role in initiation of primordial for reproduction parts and portioning of photosynthesis towards them which result in better flowering and fruiting. Zinc is also vital for the oxidation process in plant cells and helps in transformation of carbohydrates, regulation of sugar in plant and realisation of flower into pods. Similar type of results are finding by Shinde *et al.*, (2015); Balai *et al.*, (2017); Bhamare *et al.*, (2018); Thamake *et al.*, (2019) and Gidaganti *et al.*, (2019).

Test weight and harvest index were found non significant due to different levels of zinc. However, the numerically maximum test weight (96.50 g) and harvest index (24.99 %) were recorded with application of Zn @ 7.5 kg/ha (Zn_3). These results corroborated the findings of Balai *et al.*, (2017).

The different levels of zinc showed significant difference on seed and stover yield of cowpea. An application of Zn @ 7.5 kg/ha (Zn_3) was recorded significantly higher seed yield (1039 kg/ha) which was remaining at par with application of Zn @ 5.0 kg/ha (Zn_2) (976 kg/ha). Significantly minimum yield (759 kg/ha) was obtained without application of zinc (Zn_0). The treatment Zn_3 and Zn_2 increased the seed yield by (36.89 and 28.59 %, respectively) than Zn_0 and (24.13 and 16.61 %, respectively) than Zn_1. The increase in seed yield with different levels of zinc was mainly due to higher number of pods/plant and numbers of seeds/pod were found with similar treatment which tends to increasing seed yield. These results are also in agreement with finding Patel *et al.,* (2011); Singh and Singh (2012); Chavan and Khafi (2013); Khan and Prakash (2014); Shinde *et al.,* (2015); Upadhyay and Singh (2016); Balai *et al.,* (2017); Bhamare *et al.,* (2018); Thamake *et al.,* (2019) and Gidaganti *et al.,* (2019).

Moreover, stover yield (3101 kg/ha) also found significantly higher with application of Zn @ 7.5 kg/ha (Zn_3) was remaining at par with Zn @ 5.0 kg/ha (Zn_2) (2995 kg/ha) and Zn @ 2.5 kg/ha (Zn_1) (2878 kg/ha). While, significantly lowest stover yield (2643 kg/ha) was obtained under without application zinc (Zn_0). This might be due to cumulative effect in increasing growth contributing characters which increases the stover yield. These finding are sustained with those reported by Patel *et al.,* (2011); Singh and Singh (2012); Khan and Prakash (2014); Shinde *et al.,* (2015) and Balai *et al.,* (2017).

Protein content and nutrient content of cowpea

Application of Zn @ 7.5 kg/ha (Zn_3) gave significantly higher protein content (13.20 %) in seed but, found at par with Zn @ 5.0 kg/ha (Zn_2) (12.65 %). Significantly minimum protein content (11.88 %) was recorded without application of zinc (Zn_0). Similar finding were also reported by Singh and Singh (2012); Shinde *et al.,* (2015); Deepanshu *et al.,* (2017) and Thamake *et al.,* (2019).

Significantly higher nutrient content like, N content (2.11 and 0.89 %, respectively), P content (0.26 and 0.37 %, respectively), K content (1.31 and 2.24 %, respectively) and Zn content (41.48 and 29.73 ppm, respectively) in seed and stover were recorded with application of Zn @ 7.5 kg/ha (Zn_3). However, it was remained at par with application of Zn @ 5.0 kg/ha (Zn_2) escape Zn content in stover. In case of N and P content in stover, application of Zn @ 7.5 kg/ha (Zn_3) was remained at par with application of Zn @ 2.5 kg/ha (Zn_1). Significantly lowest N (1.90 and 0.79 %, respectively), P (0.21 and 0.31 %, respectively), K (1.10 and 1.86 %, respectively) and Zn (31.02 and 23.96 ppm, respectively) content in seed and stover were recorded under without application of zinc (Zn_0). This is might be due to favourable effect on availability of N, P, K and Zn at higher levels of zinc.

Economics

The result presented in Table 2 indicated that application of Zn @ 7.5 kg/ha (Zn_3) was found superior by recording the maximum net realization of 76513 ₹/ha with BCR 2.91 which was closely followed by application of Zn @ 5.0 kg/ha (Zn_2) of net realization of 70975 ₹/ha with BCR 2.75 while the lowest net realization 51289 ₹/ha with 2.06 BCR was found under without application of zinc (Zn_0). These findings are substantiated with that reported by Patel *et al.,* (2011); Balai *et al.,* (2017) and Chavan and Khafi (2013).

Effect of nitrogen

Growth attributes

Nitrogen in ample quantity is known to stimulate plant growth, increasing plant height might help in increasing dry matter production, in addition to this nitrogen increases plant growth by cell elongation and cell division both in turn enhancing cell multiplication, thereby increasing plant height. The variations in the growth attributes *viz.,* plant height and number of branches/plant were remarkably influenced by different levels of nitrogen. Significantly higher plant height (33.27 cm) at 45 DAS was recorded with application of N @ 30 kg/ha (N_3) but, it was remained at par with application of N @ 20 kg/ha (N_2) (32.13 cm) and N @ 10 kg/ha (N_1) (30.78 cm). The treatment N_3, N_2 and N_1 increased plant height by 15.60 %, 11.64 % and 6.94 %, respectively than N_0. Significantly lowest plant height (28.78 cm) was recorded under without application of nitrogen (N_0). This increase in plant height with increasing levels of nitrogen might be due to nitrogen influences favorably the meristematic activity, which increased the number and length of internodes ultimately resulting in better growth. These results are in line with those published by Mozumder *et al.,* (2003) and Upadhyay and Singh (2016). The result pertaining showed in Table.1 revealed that significantly higher number of branches/plant (3.94) at 45 DAS were recorded with application of N @ 30 kg/ha (N_3) which was remained at par with application of N @ 20 kg/ha (N_2) (3.80). The treatment N_3 and N_2 increased number of branches/plant by (24.68 and 20.25 %, respectively) than N_0 and (12.57 and 8.57 %, respectively) than N_1. Significantly minimum number of branches/plant (3.16) was recorded under without application of nitrogen (N_0). These might be due to the application of nitrogen promoted vegetative growth. These finding are in accordance with those reported by Upadhyay and Singh (2016).

Yield attributes and yield

The various yield attributing parameters *viz*., number of pods/plant and number of seeds/pod were significantly influenced by different levels of nitrogen. Significantly higher number of pods/plant (16.47) and number of seeds/pod (10.83) were obtained with application of N @ 30 kg/ha (N_3) which was remained at par with N @ 20 kg/ha (N_2). In case of number of pods/plant application of 10 kg/ha (N_1) was also remained at par with application of application of N @ 30 kg/ha (N_3).

The treatment N_3, N_2 and N_1 increased number of pods/plant by (16.39, 14.27 and 8.83 %, respectively) than N_0. The treatment N_3 and N_2 increased number of seeds/pod by (17.33 and 12.67 %, respectively) than N_0 and (8.62 and 4.31 %, respectively) than N_1. Significantly lowest number of pods/plant (14.15) and number of seeds/pod (9.23) were recorded under without application of nitrogen (N_0). This result is obtained because nitrogen fertilization made the plants more efficient in photosynthesis activity, growth promoting substances and consequently increased absorption of mineral nutrients with lesser plant energy. Similar views in direction of present finding were also expressed by Mozumder *et al.,* (2003); Kulsum *et al.,* (2007); Asaduzzaman *et al.,* (2008) and Sadeghipour *et al.,* (2010).

Application of N @ 30 kg/ha (N_3) was significantly increased seed yield (1088 kg/ha) but, remained at par with N @ 20 kg/ha (N_2) (1018 kg/ha). Significantly minimum seed yield (719 kg/ha) was obtained under without application of nitrogen (N_0).

Application of N @ 30 kg/ha (N_3) and N @ 20 kg/ha (N_2) increased the seed yield by (51.32 and 41.58 %, respectively) than N_0 and (38.42 and 29.51 %, respectively) than N_1. This might be due to number of pods/plant and numbers of seeds/pod were found higher with similar application. These results are in conformity with those reported by Mozumder *et al.,* (2003); Kulsum *et al.,* (2007); Asaduzzaman *et al.,* (2008) and Sadeghipour *et al.,* (2010). Significantly higher stover yield (3443 kg/ha) were recorded with application of N @ 30 kg/ha (N_3) but, it was remained at par with application of N @ 5.0 kg/ha (N_2) (3308 kg/ha).

Moreover, significantly minimum stover yield (2329 kg/ha) was obtained under without application of nitrogen (N_0). All growth parameters like, plant height and number of branches/plant as well as yield parameters like number of pods/plant and number of seeds/pod were found higher with same application which ultimately increased the stover yield. This finding confirmed with Mozumder *et al.,* (2003). However, harvest index and test weight were found non significant due to different levels of nitrogen. Numerically maximum harvest index (24.00 %) and test weight (94.75 g) were recorded with application of N @ 30 kg/ha (N_3). This finding confirmed with Asaduzzaman *et al.,* (2008).

Table.1 Growth and yield attributes, protein content and nutrient content of seed and stover as influenced by different levels of zinc and nitrogen

Treatments	Plant height (cm)	Number of branches/plant	Number of pods/ Plant	Number of seeds/ pod	1000 seed weight (g)	Protein content (%)	Nutrient content							
							N (%)		P (%)		K (%)		Zn (ppm)	
							Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover
Zinc (Zn)														
Zn_0: 0 kg/ha	30.15	3.58	14.70	9.60	91.25	11.88	1.90	0.79	0.21	0.31	1.10	1.86	37.02	23.96
Zn_1: 2.5 kg/ha	30.93	3.58	14.90	9.93	91.50	12.31	1.97	0.82	0.23	0.35	1.17	1.94	37.83	25.56
Zn_2: 5.0 kg/ha	31.45	3.61	15.82	10.29	92.58	12.65	2.02	0.84	0.24	0.36	1.24	2.10	40.83	25.69
Zn_3: 7.5 kg/ha	32.43	3.63	16.77	10.60	96.50	13.20	2.11	0.89	0.26	0.37	1.31	2.24	41.48	29.73
S.Em.±	0.99	0.11	0.53	0.21	2.17	0.26	0.04	0.03	0.01	0.01	0.03	0.05	0.77	0.51
C.D. at 5 %	NS	NS	1.54	0.61	NS	0.76	0.12	0.08	0.02	0.04	0.10	0.15	2.24	1.48
Nitrogen (N)														
N_0: 0 kg/ha	28.78	3.16	14.15	9.23	92.17	11.91	1.91	0.76	0.20	0.32	1.00	1.85	33.34	24.35
N_1: 10 kg/ha	30.78	3.50	15.40	9.97	92.42	12.25	1.96	0.83	0.22	0.34	1.11	1.96	36.32	24.74
N_2: 20 kg/ha	32.13	3.80	16.17	10.40	92.50	12.64	2.02	0.86	0.25	0.37	1.30	2.09	45.25	26.80
N_3: 30 kg/ha	33.27	3.94	16.47	10.83	94.75	13.23	2.12	0.89	0.26	0.38	1.41	2.24	45.25	29.06
S.Em.±	0.99	0.11	0.53	0.21	2.17	0.26	0.04	0.03	0.01	0.01	0.03	0.05	0.77	0.51
C.D. at 5 %	2.86	0.33	1.54	0.61	NS	0.76	0.12	0.08	0.02	0.04	0.10	0.15	2.24	1.48
Interaction (Zn x N)														
S.Em.±	1.98	0.23	1.06	0.42	4.34	0.53	0.08	0.05	0.01	0.03	0.07	0.11	1.55	1.02
C.D. at 5 %	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %	10.98	10.85	11.75	7.19	8.08	7.30	7.30	10.93	8.93	14.36	9.94	8.93	6.82	6.75

Table.2 Seed and stover yield and economics as influenced by different levels of zinc and nitrogen

Treatments	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)	Total cost of cultivation (Rs./ha)	Gross realization (Rs./ha)	Net realization (Rs./ha)	B: C ratio
Zinc (Zn)							
Zn_0: 0 kg/ha	759	2643	22.33	24950	76239	51289	2.06
Zn_1: 2.5 kg/ha	837	2878	22.81	25400	83964	58564	2.31
Zn_2: 5.0 kg/ha	976	2995	24.68	25850	96825	70975	2.75
Zn_3: 7.5 kg/ha	1039	3101	24.99	26300	102813	76513	2.91
S.Em.±	26	99	0.80	-	-	-	-
C.D. at 5 %	74	287	NS	-	-	-	-
Nitrogen (N)							
N_0: 0 kg/ha	719	2329	23.55	24950	71697	46747	1.87
N_1: 10 kg/ha	786	2535	23.67	25079	78345	53266	2.12
N_2: 20 kg/ha	1018	3308	23.59	25208	101544	76336	3.03
N_3: 30 kg/ha	1088	3443	24.00	25337	108249	82912	3.27
S.Em.±	26	99	0.80	-	-	-	-
C.D. at 5 %	74	287	NS	-	-	-	-
Interaction (Zn x N)							
S.Em.±	51	199	1.59	-	-	-	-
C.D. at 5 %	NS	NS	NS	-	-	-	-
C.V. %	9.84	11.87	11.63	-	-	-	-

Protein content and nutrient content of cowpea

The data presented in Table.1 showed that different levels of nitrogen produced significant effect on protein content of cowpea seed. Significantly higher protein content (13.23 %) was obtained with application of N @ 30 kg/ha (N_3) which was found at par with N @ 20 kg/ha (N_2). While, significantly minimum protein content (11.91 %) was recorded under without application of nitrogen (N_0). The protein content was increase due to higher nitrogen content in grain. The similar result finding is agreement with finding of Ashour and Thalooth *et al.*, (1983); Hasan *et al.*, (2010) and Daramy *et al.*, (2016).

Different levels of nitrogen significantly influenced on N, P, K and Zn content of seed and stover. Significantly higher N content (2.12 and 0.89 %, respectively), P content (0.26 and 0.38 %, respectively), K content (1.41 and 2.24 %, respectively) and Zn content (45.25 and 29.06 ppm, respectively) in seed and stover were recorded with application of N @ 30 kg/ha (N_3). However, it was remained at par with application of N @ 20 kg/ha (N_2) escape K content in seed and Zn content in stover. In case of N and P content by stover N @ 10 kg/ha (N_1) also found at par with N @ 30 kg/ha (N_3). Significantly lowest N content (1.91 and 0.76 %, respectively), P content (0.20 and 0.32 %, respectively), K content (1.00 and 1.85 %, respectively) and Zn content (33.34 and 24.35 ppm, respectively) in seed and stover were recorded under without application of nitrogen (N_0).

Economics

The result presented in Table.2 indicated that application of N @ 30 kg/ha (N_3) gave maximum net realization of ₹ 82912/ha with 3.27 BCR which was closely followed by N @ 20 kg/ha (N_2) of net realization of ₹ 76336/ha with 3.03 BCR. While the lowest net realization of ₹ 46747/ha with 1.87 BCR was obtained under without application of nitrogen (N_0). These results are in agreement with finding of Rahman *et al.*, (2018).

Interaction effect of zinc and nitrogen

The interaction between zinc and nitrogen was found non significant for plant height and number of branches/plant. The interaction between zinc and nitrogen was found non significant for all the yield attributes and yield *viz.*, number of pods/plant, number of seeds/pod, test weight, harvest index, seed yield and stover yield. Quality parameter *viz.*, protein content did not influenced by interaction between zinc and nitrogen. The interaction between zinc and nitrogen found non significant for N, P, K and Zn content in seed and stover.

On the basis of the results obtained from this investigation, it can be concluded that application of recommended dose of fertilizer (20:40 kg NP/ha) in addition with 5.0 kg Zn/ha for achieving higher and profitable yield of cowpea.

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