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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 7 (6): 963-965, 2004
ISSN 1028-8880

Effect of Planting Date, Harvest Stage and Pod Location on Seed Protein Content and Water Uptake of Lima Bean (*Phaseolus lunatus*)

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Abstract: Studies on the planting date, harvest stage and pod location on seed protein content and water uptake characteristics of lima bean (sieva type) were conducted at the teaching and research farm of the Federal University of Technology, Owerri, Nigeria. Results indicated that on plant, seed located at the basal and middle region absorbed more water than those at the apical region whereas there were no differences in their seed protein content. However, pod location on peduncle showed that seeds at the nodular and middle regions of the peduncle imbibed more water and had higher seed protein content and were significantly different ($P<0.05$) from the seeds at the terminal region. Similarly, planting in April and May, produced seeds with better hydrational properties than seeds planted in June and July. The superiority of the early planting is attributed to better light reception, dry matter accumulation and more mature cells. Also, harvesting dry produced seeds with higher water imbibition percentage and seed-protein content than harvesting mature green.

Key words: Planting date, harvest stage, pod location on plant/peduncle, lima bean (sieva type), water uptake, seed protein content

INTRODUCTION

The major constituents of nutrition are calories and protein. On a world scale plant resources provide about 70% and animal about 30% of human protein needs[1]. They explained that cereals contribute about 68%, grain legumes 18.5% and roots, nuts, fruits and vegetables total 13.5% of plant protein. However, in many developing countries of the tropics, plant sources provide up to 88% of food protein[2]. The lima bean is a food legume crop belonging to the species of plant family, leguminoseae. It is of major importance in the African lowland tropics as well as in many other tropical areas where it requires moist climate and well drained aerated soil[3]. Many authors have emphasized the importance of lima bean for relieving protein malnutrition in the humid tropics[4-8]. There are many varieties of lima bean[9], of all these varieties the green and dry seeds are the main products. Reports show that both the seeds and leaves can be eaten as pot herb when they are young and tender[10-12]. The lima bean possesses many agronomic attributes valuable to the sustainability of its production. It sheds copious leaves which decay rapidly and enrich the soil[11]. They emphasized that when found in association with maize, it can yield two tonnes of beans and five tonnes of maize per hectare.

Several limitations however, deter the popular acceptance and use of lima bean as food legume by many people. It is among the few pulses that contain toxic amount of cyanide producing glucoside[7]. The lima bean is limited also by poor cookability due to impermeable seed coat. This is undesirable in domesticate species of pulses. The slow rate of water uptake and long cooking time necessitate a high consumption of fuel wood which has become increasingly important to many stake holders in Agriculture and Environmental sustainability in recent times. Based on the above limitations, investigations were conducted to study the effect of planting date, harvest stage and pod location on seed-protein content on water uptake of lima bean (sieva type) (*Phaseolus lunatus*) seeds. It is believed that agronomists and breeders have some importance attached to nutritional quality and water uptake characteristics and by the understanding and improving these attributes of the Lima crop will help them develop varieties or cultivars with wide acceptance.

MATERIALS AND METHODS

The experiment was conducted at the teaching and research farm and laboratory, Federal University of Technology, Owerri (5°27' N and 7°02' E). Owerri is

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located in the tropical rainforest zone of Southeastern Nigeria. It has a mean annual rainfall of 2630 mm, temperature of 30.5°C and a relative humidity of 89%. The soil is sandy, an ultisol with 86% sand, 7.5% clay and 6.5% silt. The soil chemical characteristics include pH 4.75 (1 soil: 2.5 water). Organic matter 1.92%, total nitrogen 0.41, phosphorus Bray II-P, 9.39 ppm and exchangeable cations, calcium, magnesium and potassium of 0.38, 0.33 and 0.26 meq 100 g^{-1}, respectively. Two year fallow field was ploughed and harrowed for planting in four consecutive months April, May, June and July in 1999.

Viable lima beans the sieva type were collected from the germplasm accessories of the Department of Crop Science and Soil Science Technology. The lima seeds were planted at the spacing of 1.0x1.0 m. The trials were laid out in the field as a split plot design in three replications with planting dates split for two harvest stages, mature green pod stage and dry pod stage. Weeding with hand hoe was done 5 and 9 weeks after planting. There were 40 plants per plot at 2 plants per stand. The seeds were harvested first at green pod stage, 93 days after planting for 20 plants and the other 20 plants were harvested at dry pod stage, 137 days after planting. The seeds from the dry pods were harvested at 3 pod locations on the plant–apical, middle and basal. In addition, dry pods on the peduncle were collected and separated according to location–terminal, middle and nodular. The seeds dried after harvest in the laboratory drier to a standard moisture content of 14% at a constant temperature of 60°C for 12 h. The seeds were stored in the refrigerator at 5°C. The water uptake characteristics and seed-protein content analysis were conducted at the School of Agriculture and Agricultural Technology laboratory. The entire procedures were repeated in the year 2000.

The following data were collected

a Chemical characteristics: nitrogen in the seed was determined using the Micro kjeldahl method and % protein content was determined by multiplying % N by 6.25.

b Percentage water imbibition = (Turgid weight* − Oven dry weight**) / Oven dry weight

* Turgid weight is the weight of seed soaked for 24 h

** Oven dry weight is the weight of seed dried in the oven for 24 h at 60oC to constant weight

c Water imbibitions coefficient = Weight of water absorbed for 24 h of soaking / Weight of seed after oven drying to constant weight

RESULTS AND DISCUSSION

Results of the experiment on the effect of pod location on plant indicate that water uptake was higher in seeds located at the middle and basal portion of the plant than at the apical region. Similarly, seeds located at the nodular and middle regions of the peduncle absorbed more water than seeds at the terminal region (Table 1). This may be attributed to the proximity of these locations to the source of mineral absorption and it's distillation up the plant. This is in line with Ibeawuchi and Emebiri [13] who reported that the water absorption characteristics of the sieva cultigroup was only slightly lower than that of cowpea IT86D 1010. The pods located on plant showed no significant difference in protein content whereas significant differences exist for seeds in different regions of the peduncle. The older the lima seeds the higher the protein content and water uptake. The protein may be as a result of high P-content as reported by Ibeawuchi and Emebiri[13] and El-Saied and Hamid[14] who studied the physico-chemical properties of dry broad bean (*Vicia faba* L.) varieties and found that varieties with high phytic acid phosphorus content had corresponding high protein content. The protein content in the results ranged from 22 to 24% and it is in agreement with what has been reported by NAS[11], Mayhew and Penny[15] and Ibeawuchi and Emebiri[13]. The results of the experiment on planting date and harvest stage showed that seeds harvested from April and May planting had better hydrational properties

Table 1: Effect of pod location on protein content and water uptake qualities of sieva lima bean.

Pod location on plant	% Water imbibition	Water imbibition coefficient	% Seed protein content
Apical region	29.36	0.18	22.6
Middle region	51.6	0.46	22.6
Basal region	62.79	0.46	22.6
$LSD_{(0.05)}$	14.84	0.11	N.S.
Pod location on peduncle			
Terminal region	65.56	0.66	21.62
Middle region	87.78	0.67	22.48
Nodular region	91.11	0.69	23.58
$LSD_{(0.05)}$	5.40	0.03	0.78

N.S. = Non-significant

Table 2: Effect of planting and harvest stage on protein content and water uptake qualities of sieva lima bean

Planting date	% Water imbibition	Water imbibition coefficient	% Seed protein
April	98.40	0.76	22.90
May	96.80	0.78	22.89
June	84.11	0.58	22.68
July	86.67	0.61	22.70
$LSD_{(0.05)}$	8.39	0.06	0.08
Harvest stage			
Mature green	83.21	0.70	22.89
Dry pod	86.17	0.70	22.89
$LSD_{(0.05)}$	2.75	0.14	0.09

than seeds from June and July planting (Table 2). Planting in April and May produced seeds with higher protein content, percentage water imbibition and imbibition coefficient than seeds from June and July planting and were significantly different ($P<0.05$). The superiority of the April and May planting could be as a result of early dry matter accumulation which produced more mature cells and high concentration of minerals thereby improving water uptake characteristics and protein concentration in the seed material. Harvesting at dry pod stage gave seeds, which were significantly higher in percentage protein content and water imbibition than harvesting at green pod stage.

One of the limitations of lima beans seeds is staying longer than required when being cooked. Since more water has to be absorbed by the dry seeds, more lime will be required by seeds to get soaked before it could be cooked thereby using more fuel wood than required if no soaking is done.

In conclusion therefore, the results of this experiment indicate that potential exists for improvement of the seeds nutritive protein and water imbibition characteristics in lima bean through early planting and appropriate harvest stage so as to reduce cooking time. The relative positions of pod both on plant and peduncle also influenced the protein content in the harvested seeds.

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