Performance Assessment of Honey Bee on Pollination of Onion Flower (*Allium cepa L.*)

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ABSTRACT

This research has focused on the difference between mechanical pollination and pollination by insects such as flies, bees etc. This research shows that the production and seed quality of onion become well if the pollination is caused by bees. I have worked in three zones named paba, patnitala, BaraigramUpazilla. I have collected data and information which reveal that the farmers are being benefited allowing bees for pollination of onion. This experiment has been carried out in units. The best result had been found in Barigram. In Patnitala the production of onion has been bad because pollination was not well there. In Paba it was satisfactory.

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INTRODUCTION

1.1 BOTANICAL ASPECT OF ONION

1.1.1 History, origin and distribution

Onion ***(Allium cepa*** L.) is one of the oldest cultivated plant species in the word. References to the edible onion can be found in the Koran, Bible and in the inscriptions of ancient civilisations such as Egypt, Rome, Greece China and India. Onion is mentioned in the Egyptian inscription as a source of food for the builders of the great pyramid of King Cheops. The Israelites wandering in the desert after the exodus from Egypt bemoaned the lack of appetising onions. Onion has got a Sanskrit equivalent 'Palandu' mentioned Apastaniala Dharma Sutra-1 (dated 800 B.C. to 300 B.C) which signifies its very early introduction in Indian subcontinent.

Onion had been domesticated independently in several places. It occupies a vast area in Western Asia, extending perhaps from Palestine to India (Jones and Mann, 1963); In the view of Me Collum (1976), the primary centre of origin of onion is central Asia and Mediterranean a secondary centre for large types of origin.

Onion is widely distributed throughout the temperate northern hemisphere of the globe. It is assumed that Bangladesh, India and Pakistan are the areas where onion started its tropical domesticated existence and the probable route is taken by onion to reach other parts of tropics (Currah and Proctor, 1990). Zeven and Zhukovsky (1975) recorded ***Allium sp*** in different centres of diversity.

1.1.2. Taxonomy and cytology

Onion ***(Allium cepa*** L.) belongs to the family Liliaceae under the genus ***Allium.*** It is well known species and widely cultivated in Bangladesh and many other countries of the world. Family Liliaceae has 250 genera and about 350 species. ***Allium sp*** are bulbous biennial or perennial herbs which give distinctive and pungent odour of onion when the tissues are crushed. Flowers are borne in simple umblels at the apex of floral stem which is commonly hollow when mature.

The umbels are. aggregates of cymes of 180-1000 flowers each and the flowers open in definite sequence. The flowers are greenish white in colour. The perianth segments are 6 in 2 whorls spreading, reflexed, free and ovate. The flowers are protandrous in nature and genetically cross-pollinated and fruit is capsule.

Jones and Mann (1963) have indicated that the basic number of chromosome in the genus ***Allium*** is 7 or 8. The species that are cultivated for food have the basic number n = 8. ***Allium cepa*** L. is known only as diploid(2n- 16).

1.2 IMPORTANCE

Onion is one of the most common and important spice crop of Bangladesh. It is used in almost all food preparations and is an integral part of Bangladeshi diet (Hossain and Islam, 1994). It is also used as delicious vegetable and salad in many countries of the world. Onion is an important spice because of its excellent flavour which increases the taste of various types of foods and curries like gravies, soups, stew, stuffings, fried fish andmeat. It is also used as preservative and medicine

(Vohra *et al,* 1994). Nutritionally, onion is very rich spice because it contains appreciable amount of various nutrients which are readily available and assimilable by human body. According to Sharfuddin and Siddique (1985), every 100 g of edible portion of onion furnishes different kinds of biochemical substances **(Appendix** I).

Onion ranks first in terms of area of cultivation and production among the bulb crops grown in the world. (FAO, 1997). World production of onion is about 25 million tons and is commercially cultivated over hundred countries of the world. However, about three-fourth of global, production is accounted for by eighteen countries, important in which are China, India, U.S.A., U.S.S.R, Japan, Spain, Turkey, Brazil, Iran, Pakistan, Romania etc. As the production is not sufficient, Bangladesh has to depend on imported onion from India and Pakistan (Hossain and Islam, 1994). Onion suply in the market cannot often satisfy the consumer's demand. Its price always remains high except few months after harvest.

Among the spies crops grown in Bangladesh, onion ranks top in respect of production and second in respect of area (BBS, 1997). It grows in almost all the districts of Bangladesh, but it is commercially cultivated in the greater districts of Rajshahi, Faridpur, Dhaka, Comilla, Mymensingh, Jessor, Rangpur and Pabna (BBS, 1993). During the year 1996-1997, 1,42,000 m. tons of onion bulbs were produced from 34,412.955 hactares of land with an average yield of 4.13 tons/ha (BBS, 1997). However, this yield is quite low as compared to other leading onion producing countries of the world such as Korea Rep., USA, Japan, Germany, Canada, etc. where perhactare yield was reported as, 59.11,

42. 97, 42.6, 39.86 and 34.80 tons/ha, respectively. The ten leading onion producing countries of the world, their area, yield and production of onion in 1997 as compared to Bangladesh are shown in **Appendix II.** Since the annual onion requirement of Bangladesh is 4,50,000 m. tons. (Rahim, 1992) and total onion production of Bangladesh is 1,42,000 m. tons, a shortage of 3,08,000 m. tons per years has been prevailing in our country (BBS, 1997).

The availability of natural insect pollinators is decreasing rapidly due to the continuous use of pesticides and decline of necessary habitat (Richards, 2001). Pollinators provide an essential ecosystem service that contributes to the maintenance of biodiversity and ensures the survival of plant species including crop plants. Insect pollination is necessary for many cross pollinated crops especially in the case of hybrid seed production e.g. onion (*Allium cepa* L.) (Mayer and Lunden, 2001). The role of managed honey bee (*Apis mellifera* L.*)* in onion pollination has widely been documented by many authors (Kumar *et al*. 1989; Rao and Suryanarayans, 1989; Ahmed and Abdalla, 1984; Mayer and Lunden, 2001; Tolon and Duman, 2003), but managed bee pollination is not always possible in all environments. Conserving alternate native pollinators can be a good option in areas which are very hot e.g. Southern Punjab, Pakistan where the average temperature in summer is 46ºC (PARC, 1980) or very cold and dry Balochistan province, Pakistan, where stationery bee keeping can not be practiced because of prevailing dry and cold climatic conditions and lack of forage during the large part of the year.

Consequently, native pollinators should be assessed for their pollination potential, so as to conserve and manage the most efficient native pollinators to produce maximum crop yield. Pollinator species and their composition may vary with geographical area, latitude and time (Ollerton and Louise, 2002). For example, in the mountainous Hindu Kush Himalayan region *Apis mellifera*, *A. dorsata*, *A. cerana* and *A. florea* are the most frequent visitors (Chandal *et al*., 2004), but in the plains of Punjab, Pakistan, *A. mellifera* and *A. cerana* are poorly represented. Most of the experiments on the onion have been done in caged conditions using different flies and bees *e.g. Calliphora*, *Lucilia* (Diptera: Calliphoridae), *Eristalis* sp. (Diptera: Syrphidae), *Osmia rufa* (Hymenoptera: Megachillidae) (Moffett, 1965; Bohart *et al*., 1970; Currah and Ockendon, 1983; Free, 1993; Schittenhelm *et al*., 1997) but very few studies have been done in open field conditions.

Onion flowers are protandrous and pollen is shed within 2-3 days before the stigma is receptive (Lesley and Ockendon, 1978), therefore, self-pollination within a flower is not possible. In order for pollination to occur, pollen must come from another flower of the same or a different plant (Zdzislaw *et al.*, 2004). Thus, cross-pollination is common in onion (Chandel *et al.,* 2004), whichresults in early seed set and higher yields. Wind is not a factor of significance in onion pollination (Erickson and Gabelman, 1956) and onion does not produce quality seed if insects do not visit the flowers (Chandel *et al*., 2004). Non-availability of pollinators during the flowering period of onion causes only 17% fruit setting and free availability of pollinators increased fruiting up to 73% (Rao and Sunyanarayana, 1989).

Cross-pollination is obligatory in the fertilization of male-sterile onions used in hybrid seed production (Van der Meer and Van Bennekom, 1968). Onion suffers severe inbreeding depression with drastic decrease in growth bulb size, and seed production after only two cycles of self-pollination within a plant (Jones and Davis, 1944). In onion when the flowering begins, only a few flowers open each day on an umbel, but the number increases until at full bloom where 50 or more florets may be open on a single day (Moll, 1954). Apart from honeybees, onion flowers are visited by bumblebees, dipterans and butterflies (Jablonski *et al*., 1982). In various regions of India (Chandel *et al*., 2004), syrphids are important contributors in the process of pollination along with the most effective *Apis dorsata* and *A. florea*. The lack of intense attractiveness of onions may cause the bees to neglect the crop (Franklin, 1970), particularly if another highly attractive crop is in flowering nearby. The objective of this experiment was to study the diversity of most frequent pollinators of the onion and exploring their pollination effectiveness in perspective of conserving and managing the best pollinators for onion pollination.

MATERIALS AND METHODS

2.1 MATERIALS

The materials for the present investigation comprised of four varieties of onion ***{Allium cepa).*** The materials (bulbs) were collected from RANTIC Ltd., 62/62 NamoBhadra, Rajshahi. The four varieties were as follows :

Taherpuri

It is a local variety of Bangladesh. Plant height medium (30-60 cm) number of pseudo-stem branches medium (1-5), number of leaves medium (6- 15).Bulbs globse with deep pink colour outer scale, weight 25-60g. Total solible solid (TSS), pungency and dry matter content very high, however, yield is low. The var. Taherpuri is very famous in the world because of its store ability and test.

2.2 METHODS

The methods used in the experiment of the present study comprised the following steps:

2.3 PREPARATION OF EXPERIMENTAL FIELD

The experimental field was in RANTIC NURSERY, Chackpara, Bhadra, Rajshahi. Before planting the experimental field was ploughed thoroughly for several times. By repeated ploughing, laddering and hammering the surface layer of the soil was well pulverized. Weeds were completely removed from the field. The following doses of manure and fertilizers were applied in the experimental plots.

Manure/Ferti1izer	Doses/hac.
Well decomposed cowdung	05 tons
Triple super phosphate (TSP)	130 kg.
Murat of potash (MP)	160 kg.
Urea	120 kg.

The whole quantity of cowdung was applied just after opening the field. The total quantity of TSP and MP were applied during the final land preparation and were thoroughly mixed with soil. In addition, urea was applied as the source of nitrogen. Its 50% was applied during the final land preparation and 50% was applied during top-dressed along the line after 20 days of crop planting. As the experimental field was sufficiently moist, no irrigation was given before (or after) the planting of bulbs.

2.4 MAINTENANCE OF EXPERIMENTAL PLANTS

After planting the bulbs various kinds of inter culture operations were accomplished for better growth and development of the plants which are follows.

a. *Gap filling*

A few ***gap filling*** was done by healthy plants from the border whenever it was required.

b. *Weeding*and *mulching*

Weeding and ***mulching*** were accomplished as and whenever necessary to keep the crop free from weeds, for better soil aeration and to break the crust. It also helped in soil moisture conservation.

c. Irrigation

Two irrigations were given throughout the growing period. The first irrigation was given with water can 20 days after planting followed by another irrigation 25 days after the 1st irrigation. ***Mulching*** was also done after each irrigation at appropriate time by breaking the soil crust.

d. Plant protection

i) Insect pests

As preventive measure against the insect pests like cut worm and others, Diazinon 60 EC was applied at the rate of 1.2 litter with 568 litter water/hac regularly at an interval of 10-15 days. Heptachlor 40 WP was also applied at the rate of 3.4 kg with 568 litter water/hac during final land preparation.

ii) Diseases

Some of the plants were attacted by purple leaf blotch disease caused by ***Alternariaporri.*** It was controlled by spraying the crop with Redomil M (a) 2 g in 1 litter of water (Anonymous, 1990).

2.5TECHNIQUE OF ANALYSIS OF DATA

The collected data were analysed by following biometrical techniques developed by Mather (1949) based on the mathematical models of Fisher ***et al.{*** 1932) and those of Hyman and Mather (1959) and Allard and Bradshaw (1964).

The techniques used are described under the following sub heads :

2.6 MEAN

The means of different population of different replications were worked out by taking arithmetic mean of the individual selected plants of each plot. The arithmetic mean was calculated as follows:

$$\bar{X} = \frac{\sum_{i=1}^{n} xi}{n}$$

Where,

X = The individual reading recorded on each plant.

$\bar{X}$ = Arithmetic mean

n= Number of observation

i= 1,2,3, ..., n

∑= Summation.

2.7 STANDARD DEVIATION (SD)

Standard deviation is the average deviation of the individual observations from the mean. It was calculated as the square root of the variance as follows:

$$Sd = \sqrt{S^2}$$

Where,

S^2 = Variance

Sd = Standard deviation.

2.8 STANDARD ERROR OF MEAN (SE)

If instead of taking one sample, several samples are considered, it willbe found that standard deviations of the different sample also vary. This variation is measured by the standard error which was calculated as follows:

$$Se = \frac{Sd}{\sqrt{n}}$$

Where,

Se = Standard error of mean.

Sd = Standard deviation,

n = Total number of individuals.

2.9 COEFFICIENT OF VARIABILITY IN PERCENTAGE (C.V. %)

Coefficient of variability in percentage (C.V.%) was calculated according to following formula:

$$\text{C.V.\%} = \frac{Sd}{\bar{X}} \times 100$$

Where,

Sd= Standard deviation

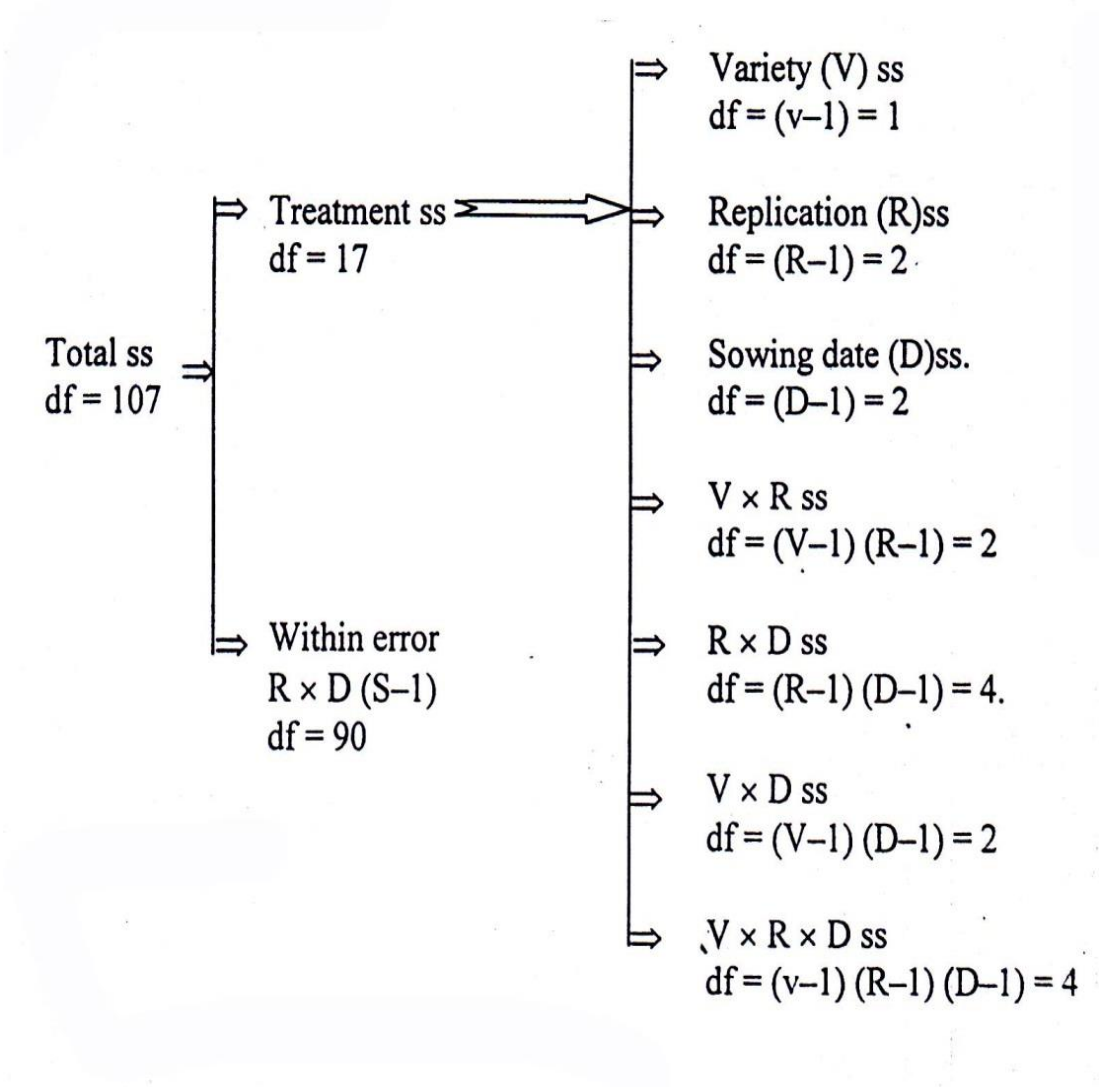
$\bar{X}$ = Mean

C.V.% = Coefficient of variability in percentage.

2.10 ANALYSIS OF VARIANCE

Analysis of variance is a measure of dispersion of a population. So, for testing the significant differences among the populations, the analysis ofvariance is necessary. Variance analysis for each of the character was done separately with raw data taken on individual plants.

The variance due to different sources such as variety (V), replication (R), sowing date (D), interaction V×R, interaction R×D, interaction V×D, interaction V×R×D and within error of a population were calculated as per following skeleton of analysis :



The plant to plant variation of a population was calculated according to the following formula:

$$\text{Variances}(S) = \frac{\sum_{i-1}^{n} Xi^2 - \left(\sum_{i-1}^{n} Xi\right)^2 / n}{n-1}$$

Where,

Xi = The individual reading recorded on each of the plants.

n= The total number of observations.

∑=Summation

n-1 = Degrees of freedom.

i = 1, 2, 3 n.

In the experiment, since the varieties were selected, the sowing date effect was fixed but the replication effect, the random factors were independent and could be repeated. So the analysis of variance of a mixed model was used, where population and sowing date were fixed and replication effect was random. The expectations in the analysis are shown in the following table. It is evident from the table that no single mean square is an appropriate denominator for an F-test of the main effect of varieties. An appropriate F-test following Snedecor and Cochran (1982) was conducted on the basis that HO: K^2_G=0.

RESULT

The results present **Table: 1.** Show that onion seed and Bulb yield in kg/hac were found to vary with location where they were cultivated. The Thairpuri showed the highest yield in Baraigramupozilla and the lowest yield in Patinitalaupozilla. Therefore, it indicate that the atmosphere and land of Baraigram are suitable for Tharipurivareity but atmosphere and land of patnitala are not favorable for Tharipurivareity the production of Tharipurivareity is quite satisfactory in paba. It is medium here. The production of any crop depends on pollination. From the table it is seen that the pollination rate of onion in patnitala is the lowest. It also shows that the pollination rate of Baraigram is the highest thats why the production is the highest here.

In case of Thairpuri the highest yield was recorded in the upozialBaraigram and the lowest in Patnitala.

The maximum production of Bulb of onion was recorded in Baraigram and minimum is Patnitala (Table 2).

Table-1 Yield performance in kg/hac of onion seed three location

Location	Range	Mean± SE	CV%
Poba	12-18	1.6±1.4	17.62
Patitola	9-4.2	1.9±0.77	81.57
Baraigram	1.2-2	1.52±0.16	21.71

Table-2 Yield performance of onion bulb in kg/hac three location

Location	Range	Mean± SE	CV%
Poba	35-45	40.75±2.17	10.65
Patitola	12-50	25.5±8.38	65.72
Baraigram	60-80	66.25±15.72	47.47

Analysis of Variance The analysis variance for two quantitative characters shows that the item location is significant.

3.1 ANALYSIS OF VARIANCE

The analysis of variance for two quantitative characters was done separately and the results are shown **Table: 2**for testing the effect of main items and their interacting effects, a mixed model was followed. Location and Replication was highly significant for all the chacracters

Table: 2. Analysis of variance of yield seed of onion (kg/hac) in three location onion.

Source of variation	df	SS	MS	F value	Level of Significance
Location	2	333.233	168.61	387.61	***
Replication	2	0.9938	0.4969	1.141	
Error	4	1.471	0.435	23.9745	
Total	8	339.9688			

***= Significant of 1% lavel

Table: 2. Analysis of Variance of bulb Yield of onion (kg/hac) in three location onion.

Source of variation	df	SS	MS	F value	Level of Significance
Location	2	2547.176	1273.588	67.668	***
Replication	2	193.367	96.683	5.1369	
Error	4	1.471	0.435	23.9745	
Total	8	2815.827			

***= Significant at 1%


বাংলাদেশ, ভারত ও নেপালের বৃষ্টি নির্ভর এলাকার ক্ষুদ্র কৃষকদের দক্ষতা
বৃদ্ধির মাধ্যমে জলবায়ু পরিবর্তনের সাথে খাপ খাওয়ানোর সক্ষমতা বৃদ্ধি
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DISCUSSION

Insect pollination is necessary for mans cross pollinated crops especially in the case of hybrid seed production e.g onion (*Allium cepa* L.). Most pollination of onion flowers is by insects although wind and gravity contribute in onion pollination. Onion plants are self-compatible and both self and cross pollination occur. Honey bees play an important role in pollination of onion. From my investigation in three upazilla of Bangladesh that are Baraigram, Patnitala, Paba it is seen that the farmers are becoming cariousday by day to use honeybox in their field for pollination. I have taken their interviews and learnt that the production has increased because of using honey box. In Baraigram is seen that the production of Thairpuri (Onionseed) is very encouraging. But in Patnitala the production rate is low. The main cause for this difference is the weather and land. In paba it was satisfactory. The survey shows that the production of onion is really increasing than the time when the farmersdidnot use honey box. The some experience havebeen shared by many investigators before me. I have collected data and various information regarding onion production in these three upazillas. The mean value of Baraigram was the highest (66.25), the mean value of patnitala was (25.5), the mean value of paba was (40.75).These mean

values show that the highest production is found in Baraigram, then in paba and the lowest in patnitala.

Because of using honey box, the farmers are becoming benefited in both ways. They are getting honey and also getting good crops. By using this process help them to get more profit.

At last my observation is that the farmers are curious about using honey bees in their field so that the pollination can occur more well. I hope the government will take proper step to provide the farmers with necessary materials for this.

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APPENDICES

Appendix I. Biochemical substances of onion bulb in 100 g of edible portion (Sharfuddin and Siddique, 1985).

Name of Substances	Quantities
Carbohydrate	11.10 g
Protein	1.20 g
Fat	0.10 g
Thiamine (Vit. B_1)	0.08 mg
Riboflavin (Vit. B_2)	0.01 mg
Vitamin C	11.00 mg
Calcium	47.00 mg
Iron	0.70 mg
Energy	50.00 cal

Appendix II.Area, yield and production of onion in 10 leading onion producing countries including world production as compared to Bangladesh in 1997.

Name of the country	Area '000' ha	Yield ton/ha	Production 1000 perton
World	2281	16.67	38022
Korea Rep	11	59.10	650
USA	65	42.97	2793
Japan	30	42.60	1278

Germany	7	39.86	279
Canada	5	34.80	174
Iran	43	27.91	1200
China	451	22.24	10030
Turkey	98	19.39	1900
Pakistan	80	14.03	1122
India	405	10.62	4300
Bangladesh	34	4.06	138

Source: FAO, Quarterly Bulletin of Statistics, 1997

Appendix III. Trend of onion production in Bangladesh (BBS,1996 and 1997).

Year	**Onion**		
	Total area (he)	Total production '000' ton	Production ton/ha
1987-88	34008.10	141	4.15
1988-89	34008.10	139	4.09
1989-90	34008.10	148	4.35
1990-91	34817.81	143	4.11
1991-92	34413.0	144	4.18
1992-93	34413.0	140	4.07

1993-94	34413.0	144	4.18
1994-95	34008.09	144	4.23
1995-96	34008.097	139	4.06
1996-97	34412.955	142	4.126

Appendix IV.Soil analysis data of the experimental plot.

Soil properties	Analytical data	Critical level
PH	6.8	-
Organic carbon (C)	0.68%	-
Total nitrogen (N)	0.077	-
Available phosphorus (P)	22 ppm	0.8 ppm
Available potassium (K)	0.09 me/lOOg soil	0.15 me/
Available sulphur (S)	68 ppm	8 ppm
Available zinc (Zn)	1.1 ppm	1.15 ppm
Available boron (B)	0.3 ppm	0.2 ppm
Textural class	Silky loam	-